Environmental Accounting:

a management tool for enhancing corporate environmental and economic performance

by

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Declaration by Student

I, PATRICK JAMES DE BEER, hereby declare that the work as contained in this document was compiled and set out by myself and it has not been submitted to any other university.

SIGNED ON THIS 23rd DAY OF FEBRUARY 2004.

PATRICK JAMES DE BEER

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I want to thank God for everyday strength and courage given in profusion. Thank You for the ability to learn and apply knowledge in the pursuit of future societal and environmental upliftment.

Thank you, Mom and Dad, for continuous support, love and encouragement. It is only through your contribution in my life that brought me this far.

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Environmental accounting:

a management tool for enhancing corporate environmental and economic performance

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Synopsis

Environmental accounting refers to the identification, measurement and allocation of environmental and social liability costs and the integration of these costs into business decisions. While environmental accounting now forms part of industrial decision making in first world countries, there is a lack of available and adequate South African environmental accounting systems. The EEGECOST model was developed to promote environmental accounting in South Africa. Implementation of the model will provide South African industries with the framework for corporate evaluation of alternative investments, projects and processes and for estimating economic and environmental performance in the present and especially the future. The model allocates internal and external environmental costs to five identified cost types, categorised into several environmental media groups. It also assists with risk valuation and the capital budgeting process for alternative investments. Applicability of the model was tested in a case study conducted on the life cycle assessment of a cigarette production process. The model proved that Types III to V costs, usually not considered in traditional fiscal accounting systems, can contribute significantly to the total production costs of one million cigarettes; however, implementation of suitable identified interventions and corrective actions can decrease this contribution. Benefit will be derived from further research and development of the model through case studies addressing a wider variety of industrial activities and application of the model during company planning and performance measuring cycles.

KEYWORDS: capital budgeting, environmental accounting, environmental media, external costs, internal costs, risk valuation

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CHAPTER 1

Introduction

Industries are becoming progressively more aware of the environmental liabilities pertaining to their operations and products (EPA, 2000a). These liabilities include impacts on the natural environment; conveyed through the three principal media: air, water and soil; and its associated financial effects. These financial effects are lately more often portrayed in corporate images and reporting (Goodstein, 2002). However, some companies still find it difficult to relate environmental liabilities to financial effects (Carter, Perruso and Lee, 2001). This is primarily due to inherent uncertainties in measuring these liabilities, and in ways of expressing them as part of corporate financial evaluations (Hayden, 1989).

Uncertainties in measuring environmental liabilities can be addressed by using environmental evaluation and accounting techniques, such as qualitative matrix evaluation and streamlined life cycle analysis methods (Labuschagne, 2002); and quantitative methods including quantitative life cycle analysis, life cycle costing and total cost assessment (Veefkind, s.a.). Environmental accounting can be used to demonstrate the potential for environmentally beneficial investments to yield significant financial pay-offs, through the avoidance of environmental liabilities (Hayden, 1989). While environmental accounting now forms part of industrial decision making in first world countries, there is a lack of similar commitment to the environment in South Africa (Labuschagne, 2002).

The objective of this dissertation is to evaluate environmental accounting systems currently available in the world market and customise an environmental accounting model appropriate for South Africa. The results of an existing life cycle analysis for a chosen process, the production of cigarettes, will then be used to evaluate the model, especially to determine the impact of external costs on a company's production costs.

In this dissertation the evaluation of existing systems and terminology was conducted via a literature survey and is presented in Chapter 2. The customised environmental accounting model is set out in Chapter 3, followed by the case study for the production of cigarettes, in Chapter 4. Conclusions and recommendations are presented in Chapter 5.

CHAPTER 2

Literature survey

2.1 BACKGROUND

Environmental management can be defined as the process of allocating natural resources so as to make optimum use of the environment in satisfying basic human needs, if possible, for an indefinite period and with minimal adverse effects to the environment (Barrow, 1997). However, earth's ecosystems cannot sustain current levels of economic activity and material consumption, therefore effective sustainability initiatives are required as basis of corporate environmental management frameworks to relieve pressure on ecological and social integrity (Wackernagel and Rees, 1996).

Environmental cost accounting is an innovative sustainability initiative (The World Bank Group, 2003). Coupled to the various standarised procedures and practices for effective environmental management, for example, ISO 14000 and Integrated Environmental Management Systems (IEMS), it defines the environmental management frameworks that exist at present that can assist companies in managing, measuring and improving the environmental aspects of their operations (Tibor, 1996) and within which industries must operate today (Grace *et al.,* 1999).

Recognition of environmental costs through environmental accounting systems reveals cost effective opportunities to prevent pollution and eliminate wastes, and encourages business decisions that are financially beneficial to the environment (UNDP, 2002).

2.2 ENVIRONMENTAL ACCOUNTING

Steele and Powell (s.a.) define environmental accounting as the identification, allocation and analysis of material streams and their related money flows by using environmental accounting systems to provide insight in environmental impacts and associated financial issues.

Companies utilise environmental accounting systems to include environmental costs into corporate decision making (ICF, 1996). Compared with conventional financial accounting, which typically includes environmental health and safety (EHS) costs as direct labour, direct material and overheads, environmental accounting improves the management of environmental costs and communication of risks by incorporating standard environmental accounting practices (Little, 2000).

Mainly three different types of environmental accounting practices are recognised at present (Figure 2.1), all with the same overarching goal of increasing the amount of relevant financial information available to decision makers. These are (EPA, 1995):

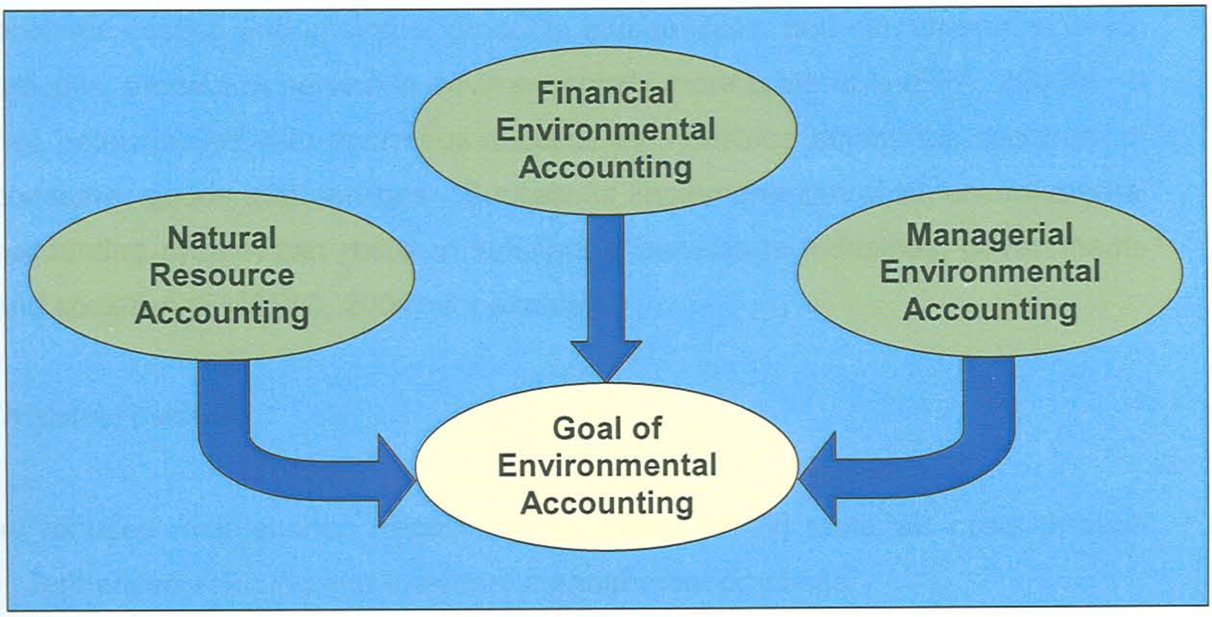

Figure 2.1 Types of Environmental Accounting Practices.

- *Natural Resource Accounting*: A macro-economic measure, expressed in consumption of a nation's natural resources, both renewable and non-renewable, in physical or monetary units.
- *Financial Environmental Accounting*: Company focused and refers to the estimation and public reporting of environmental liabilities. Generally accepted accounting principles form the basis of reporting in this context.

- *Managerial Environmental Accounting*: Uses data of environmental costs and performance in business decisions and operations. This type of accounting is also company specific and internally focused.

Based on the relevant environmental accounting practice, various types of environmental accounting systems can be used to account for environmental costs, depending on the scope of costs considered in the system (Veefkind, 2003). The scope of costs refers to the different environmental costs included in a system (Section 2.3).

2.2.1 Advantages gained through environmental accounting

Environmental accounting can enhance corporate advantage, promote more accurate costing and pricing of products and services, and can determine which process, product or service is environmentally more preferable (EPA, 2000a). It has been applied with enormous success by industries across the spectrum of consumer goods and services. Successful implementation of an environmental accounting system can result in substantial benefits to industries, governments and societies (EMARIC, 2004), for example:

Industrial benefits

- reduced maintenance, repair and operating (MRO) materials costs through enhanced sourcing and inventory management practices,
- decreased costs associated with scrap and material losses,
- lowered training, material handling and other extra expenses associated with hazardous materials,
- increased revenues by converting wastes to by-products,
- reduced use of hazardous materials through more timely and accurate materials tracking and reporting systems,
- decreased use and waste of solvents, paints and other chemicals through chemical service partnerships, and
- recovered valuable materials and assets through efficient product take back programmes.

Governmental benefits (EMARIC, 2004)

- the more that industry is able to justify environmental programmes on the basis of financial self-interest, the lower the financial, political and other burdens of environmental protection on government,
- implementation of environmental accounting by industry should strengthen the effectiveness of existing government policies/regulations by revealing to companies the true environmental costs and benefits resulting from those policies/regulations,
- government can use environmental accounting data to estimate and report financial and environmental performance metrics for government stakeholders, such as regulated industries or industry partners in voluntary programmes,
- environmental accounting data can be used to inform government programme/policy design,
- government can use environmental accounting data to develop metrics for reporting the financial and environmental benefits of voluntary partnership programmes with industry, innovative approaches to environmental protection, and other government programmes and policies, and
- environmental accounting data can be used for regional or national-level accounting purposes.

Societal benefits (EMARIC, 2004)

- more efficient and cost-effective use of natural resources, including energy and water,
- cost-effective reduction of pollutant emissions,
- reduced external costs related to industry pollution, such as the costs of environmental monitoring, control and remediation as well as public health costs,
- provision of improved information for improved public policy decision-making, and
- provision of industrial environmental performance information that can be used in the broader context of evaluations of environmental performance and conditions in economies and geographic regions.

The following examples illustrate the benefits obtained by industries that have incorporated environmental accounting as part of their environmental management framework (EPA, 2000a):

- General Motors reduced its disposal costs by $12 million by establishing a reusable container programme with its suppliers,
- Commonwealth Edison, a major electric utility company, realised $25 million in financial benefits through more effective resource utilisation,
- Andersen Corporation implemented several programmes that reduced waste at its source and had internal rates of return (IRR) exceeding 50% (EPA, 2000b), and
- Public Service Electric and Gas Company saved more than $2 million in 1997 by streamlining its inventory process.

In addition, government organisations can implement environmental accounting themselves, with the following benefits:

- Environmental accounting data can be used for environmental and other decisions within government operations, for example, purchasing, capital budgeting and government facility environmental management systems.
- Environmental accounting data can be used to estimate and report financial and environmental performance metrics for government operations.

Environmental accounting can therefore be used not only to determine the financial impact of environmental activities, but also to find less costly alternatives by either changing process or product designs, or developing an exit strategy to eliminate environmentally costly products (Goodstein, 2002).

2.2.2 Problems experienced with environmental accounting

Environmental accounting is not performed without inherent problems. This can be illustrated by a survey conducted by the Tellus Institute that focused on the use of environmental accounting for internal decision making regarding environmental investments.

The survey concluded that conventional financial project analyses often put environmental investments at a disadvantage. This is due to the following (Veefkind, 2003):

- incorrect allocation of costs and revenues,
- incomplete inventory of costs and revenues, and
- short time horisons of the analyses.

For example, companies typically tend to lump environmental costs, with the exception of water and energy costs, into the category of overhead costs; while others allocate environmental costs to individual processes using surcharges. These surcharges normally have no direct relation with the environmental related costs of the material stream, production volume and materials use. When improper allocation occurs, managers receive distorted signals regarding the true costs and benefits of retaining or changing processes and products. Like incomplete cost inventories, misallocation of environmental costs prevents effective performance monitoring, product pricing and other activities essential to maintaining a competitive enterprise (White *et al.*, 1995).

Also, companies generally recognise, for example, direct waste disposal costs but tend to forget about related costs such as that for handling and storing hazardous waste. None of the respondents to the Tellus survey recognised less tangible costs like future liability costs and health costs or less tangible benefits like an improved company image. Table 2.1 portrays the survey results of costs normally considered in financial analyses by percentage of respondents (White *et al.*, 1995).

The costs presented in Table 2.1 do not include all cost items that should be considered, nor are the listed costs pre-defined as environmental. At present, there is no single standardised list of environmental costs to which all firms adheres, nor is there likely to be one in the foreseeable future. Devoting substantial energy to defining what is and is not an environmental cost diverts attention from the fundamental challenge: enlarging the cost inventory to ensure that all costs, environmental and non-environmental, are properly accounted for in the capital budgeting process (Ditz, Ranganathan and Banks, 1995).

Table 2.1 Environmental costs normally considered in financial analyses.

Cost item	%
On-site air/wastewater/hazardous waste testing/monitoring	79
Energy costs	78
On-site wastewater pre-treatment/treatment/disposal	77
Licensing/permitting	76
Water costs	74
Production efficiency/yield	74
On-site hazardous waste pre-treatment/treatment/disposal	71
On-site hazardous waste handling (storage, labeling)	70
On-site air emission controls	69
Employee safety/health compensation claims	69
Off-site hazardous waste transport	62
Manifesting for off-site hazardous waste transport	59
Staff training for environmental compliance	59
Future regulatory compliance costs	59
Environmental penalties/fines	57
Insurance costs	55
Corporate image effects	55
Personal injury claims	54
Reporting to government agencies	53
Frequency of plant shutdown	51
Off-site wastewater/hazardous waste pre-treatment/treatment	50
Property damage	50
Environmental staff labour time	41
Air pollutant emission credits (SO_x, NO_x)	40
Marketable by-products	36
Natural resource damage	31
Legal staff labor time	28
Sales of environmentally friendly/green products	25

Finally, most companies use short time horisons when completing the relevant analyses (up to ten years); resulting in incompatible economic and ecological scales.

Certain environmental costs will have an impact over a much larger period, for example, the cost of environmental damage due to the effects of global climate change, which may only occur over a few decades (Holub *et al.*, 1999).

2.3 ENVIRONMENTAL COSTS

The main component to consider for environmental accounting is that of environmental costs. The EPA (1996) defines environmental costs as those costs that have a direct financial impact on a company (internal costs), and costs to individuals, society and the environment for which the company is not accountable (external costs). The type of costs included in the environmental accounting system determines the scope of the system (see Figure 2.2). EPA (1995) advises businesses to address at least all internal environmental costs in their environmental accounting systems and to correctly allocate these costs. Companies are also encouraged to move beyond consideration of internal costs to incorporate external costs, at least qualitatively, into their business decisions (EPA, 1995).

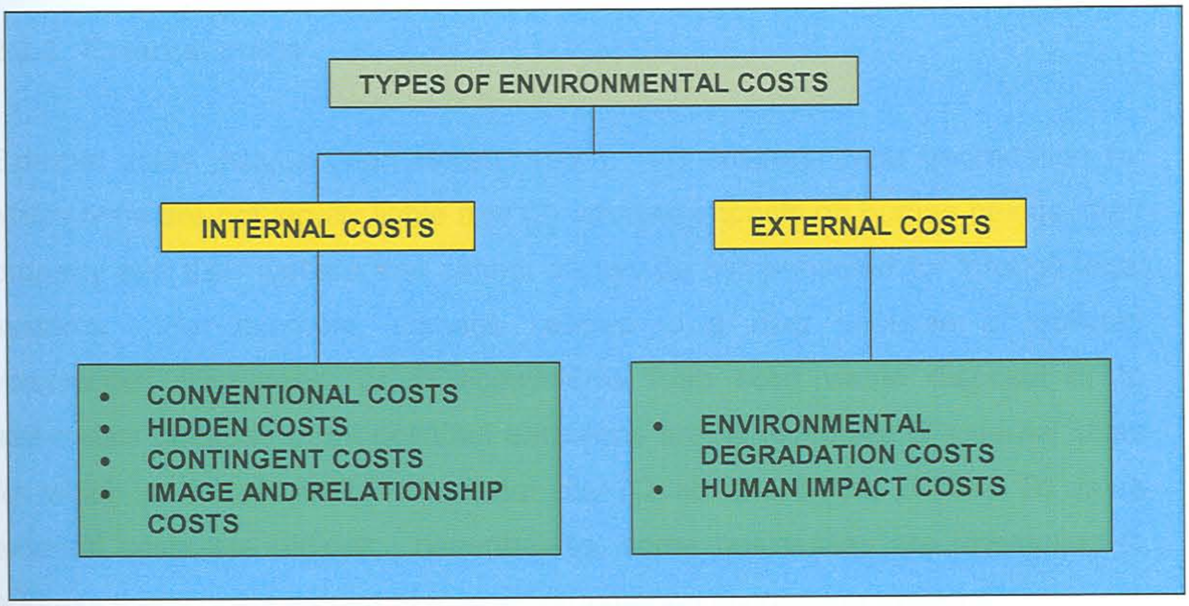

Figure 2.2 Types of environmental costs.

2.3.1 Internal costs

Internal costs may include conventional costs, potentially hidden costs, contingent costs and image or relationship costs (EPA, 1995).

- *Conventional costs* include costs of capital equipment, raw materials and supplies.
- *Hidden costs* refer to the results of assigning environmental costs to overhead pools or overlooking future and contingent costs (see Section 2.4).
- *Contingent costs* refer to environmental costs that are not certain to occur in the future but depend on uncertain future events, for example, the costs involved in remediating future spills.
- *Image and relationship costs* are less tangible costs because they are incurred to affect subjective perceptions of management, customers, employees, communities, and regulators. This category can include the costs of annual environmental reports and community relations activities and costs expended voluntarily for environmental activities such as tree planting. The costs themselves are not intangible, but the direct benefits that result from relationship or corporate image expenses often are.

2.3.2 External costs

External costs include (Van Horen, 1996): (1) environmental degradation for which firms are not legally liable and (2) adverse impacts on human beings, their property and their welfare that cannot always be compensated for through legal systems. For example, damage caused to a river because of polluted wastewater discharges, or to ecosystems from solid waste disposal or to asthmatics because of air pollutant emissions are all examples of external costs for which an industry often does not pay (Quah and Boon, 2003). To value external costs are difficult; nevertheless, some businesses are attempting to address these costs as part of their environmental accounting systems.

A precise method or model of accounting for external costs has not been defined up to this instance (Carter *et al.*, 2001). However, many techniques have been suggested to assist in the evaluation of external costs. These techniques include (Bishop *et al.*, 1979):

- contingent valuation,
- travel cost approach,
- conjoint analysis,
- hedonic pricing,
- direct costs,
- property approach, and
- averting behaviour technique

2.3.2.1 *Contingent valuation*

Changes in non-market values, associated with an alternative, are measured using information that stakeholders provide about their preferences or are derived implicitly from market data. The contingent valuation (CV) technique questions people about their willingness to pay (WTP) for hypothetical or actual policies that affect the allocation of resources. This approach is commonly used to estimate the value of changes in the condition of the natural environment where willingness to pay is used to gauge the potential economic benefits (that is, changes in stakeholder values) related to resource management decisions.

For example, the CV technique is used to determine, by means of surveys, how much residents would be willing to pay for recreational services supplied by, say for instance, a healthy wetland system. Surveyed information is then used to estimate the potential recreational opportunity cost of filling the wetland or, conversely, the benefit of preserving the wetland.

Contingent valuation researchers have identified at least four sources of possible error in their survey estimates that include free riding, strategic bias, hypothetical bias and embedding bias (Goodstein, 2002):

- Free riding exists when people are asked to pay for a public good. One individual might accept not to pay for preservation of a natural resource, in hopes that the cost would be borne by another member of society. In this case, the individual has an incentive to understate his true WTP to contingent valuation researchers.

- Strategic bias arises if people really do not have to pay their stated WTP for a resource in question. Under these circumstances, WTP estimates can be inflated, being a good strategy if respondents to the survey thought that larger WTP values in the survey results would lead to higher likelihood of protection of the resource.
- Hypothetical bias may lead respondents to provide hypothetical answers to the survey questions (poorly thought out or even meaningless).
- Embedding bias reveals the most serious problem with CV surveys. Answers will be strongly affected by the amount of information provided about the issues at stake. This is particularly evident when valuation questions are 'embedded' in a broader context.

2.3.2.2 Travel cost

The travel cost (TC) approach is a popular hedonic technique that estimates the value or price of environmental amenities based on the cost of traveling to recreational areas. This approach is useful because travel expenditures give an idea of the minimum cost that people are willing to pay for access to environmental amenities (Hayden, 1989).

Several significant assumptions are made in defining these costs - first, it must be determined what are substitutable sites or activities. Second, a decision has to be made on an appropriate value of time to travel to the site. Third, decisions have to be made on how to allocate the value of a site between its ambience and its various other activities.

There are a number of data requirement problems related to this approach. Cummings, Brookshire and Schulze, 1986, conclude that the problems in specification and data collection with the TC approach "result in the dispelling of what was once regarded as the TC method's greatest potential strength: appealing to the notion that visitor values must equal or exceed travel costs".

2.3.2.3 Conjoint analysis

Conjoint analysis is used to determine the relative value that people place on the attributes of a product or experience. This information is used to estimate the value of policies that change the distribution and/or availability of attributes (Goodstein, 2002).

2.3.2.4 Hedonic pricing

Hedonic pricing is used to determine the portion of property value that is attributed to its proximity to natural amenities (Pearson, 2000). For example, properties close to natural amenities have greater value compared to properties close to mine-tailing dams.

2.3.2.5 Direct cost

Direct costs include numerous non-monetary and non-market systems. Direct costs mean "off-the-shelf" or "real-world" prices and costs of buying goods and services to accomplish a project. It is most consistent with the price or cost we pay or expect to pay. Direct costs reflect the consequences of (Hayden, 1989):

- subsidies and taxes,
- collective bargaining,
- monopoly rents,
- government regulations,
- social customs,
- rent and price controls,
- labour laws, and
- court decisions etc.

These are usually the costs that must be paid to acquire resources. The costs are quite consistent with the cost measure for restoration due to natural resource damage, as well as for determining use value (Seller *et al.,* 1985).

2.3.2.6 *Property approach*

The literature on property approach is broad, varied in attempt, and diverse in purpose. The property concern with regard to ecosystem does not constitute a clear-cut technique for doing system evaluations or natural resource valuations or restoration assessments. The focus is on how to arrange and establish property institutions with regard to the use and abuse of the natural environment.

If the internalisation of external costs through the assignment of property rights is the answer to externality problems, then the creation of markets for resources that were not previously traded in markets follows. The problem of externalities is not market failure but rather the lack of a market. In cases where externalities affect resources that are not privately owned, markets should be created according to this approach. Thus, through the demand and supply mechanisms of a market, value can be determined. This approach will result in the following (Quiggin, 1988):

- individuals can rationally calculate all costs associated with externalities,
- individuals can calculate costs in monetary terms,
- the problems of transaction costs in the (potential) market can be overcome,
- property rights will develop when the costs associated with externality-producing behaviour exceeds the benefits,
- all resources can be privately owned, and
- society has no interest in protecting resources beyond what private interests wish to protect them.

2.3.2.7 *Averting behaviour technique*

The averting behaviour technique assesses expenditure incurred after a change in environmental quality has occurred. The common goal of this technique is to express the value of changes in stakeholder wellbeing in monetary terms, so the differences may be directly compared. It is important, however, that information on all potential changes in stakeholder value is carried to the final step of the cost assessment process, even if some of the changes in value cannot be quantified (Steele and Powell, s.a.).

Given the diverse nature of the techniques available to value external costs, it is more important to specify the approach used to value these costs than to develop a standalone technique. Once all corporate environmental and social impacts are valued, the costs need to be allocated to the specific activity that causes the costs. Cost allocation is the cornerstone to successful corporate environmental accounting.

2.4 COST ALLOCATION

Conventional management accounting systems most often attribute environmental costs to general overhead accounts with the consequence that product and production managers have no incentive to reduce environmental costs and executives are often unaware of the extent of these costs. By identifying, assessing and correctly allocating environmental costs, environmental accounting allows management to identify opportunities for cost savings (UN, 2001). Environmental costs should be allocated directly to the relevant cost drivers, that is, to the activity that causes the costs. For example, the costs of handling and treating a toxic waste brought about by the production of, say product X, should directly and exclusively be allocated to product X.

Understanding cost drivers and allocating costs accordingly is the conceptual cornerstone of activity-based costing (ABC). Activity-based costing improves internal cost calculation by allocating costs typically found in overhead accounts to the polluting activities and products. The strength of activity-based costing is that it enhances the understanding of the business processes associated with each product (UN, 2001). The activity-based costs of each product are calculated by adding the appropriate share of joint fixed and the joint variable costs to the direct costs of production.

A simple example illustrates the concept (EPA, 1995). Figure 2.3 depicts a conventional accounting system that assigns environmental and certain other costs to overheads. Such overhead costs are generally allocated to products A and B in proportion to their consumption of labour and materials. Suppose product B is solely responsible for toxic waste management costs and product A creates no toxic waste costs.

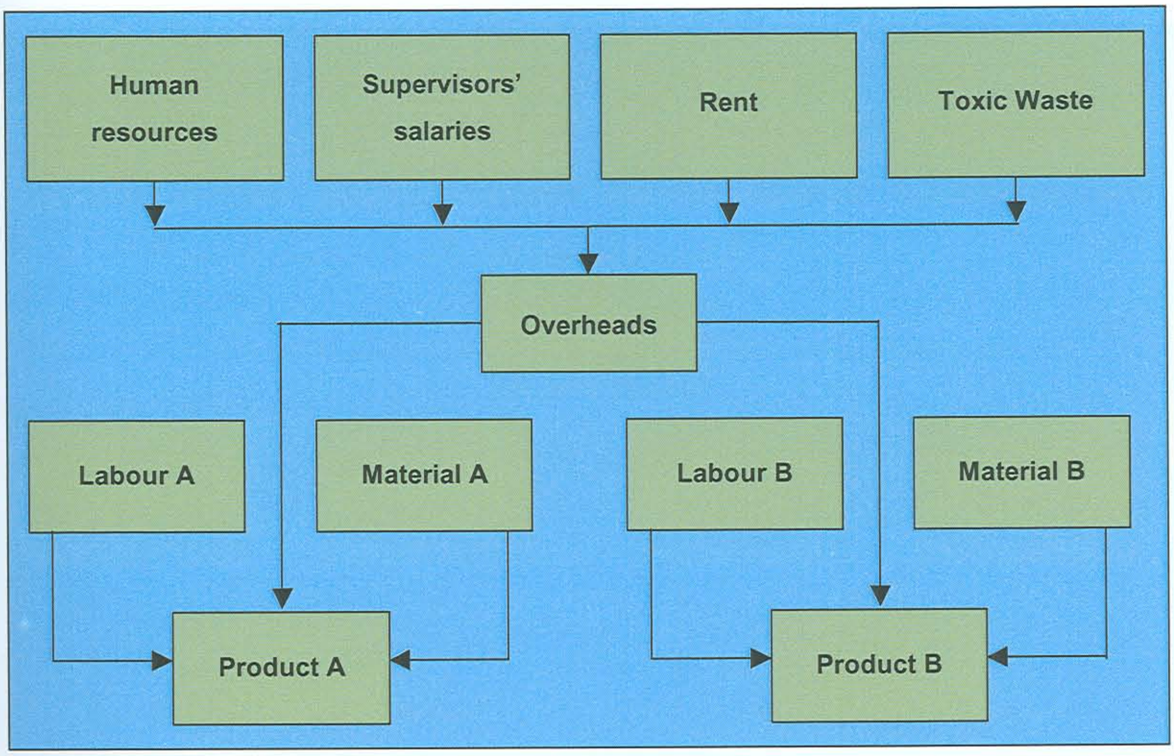

Figure 2.3 Conventional cost accounting system.

A misallocation occurs because the toxic waste management cost is lumped together in an overhead cost pool that is misallocated to both products A and B, even though none of the toxic waste management cost results from the production of product A. The effect is to distort the actual costs of producing product A and product B. Figure 2.4 illustrates an environmental accounting system that correctly attributes the environmental costs of product B only to product B.

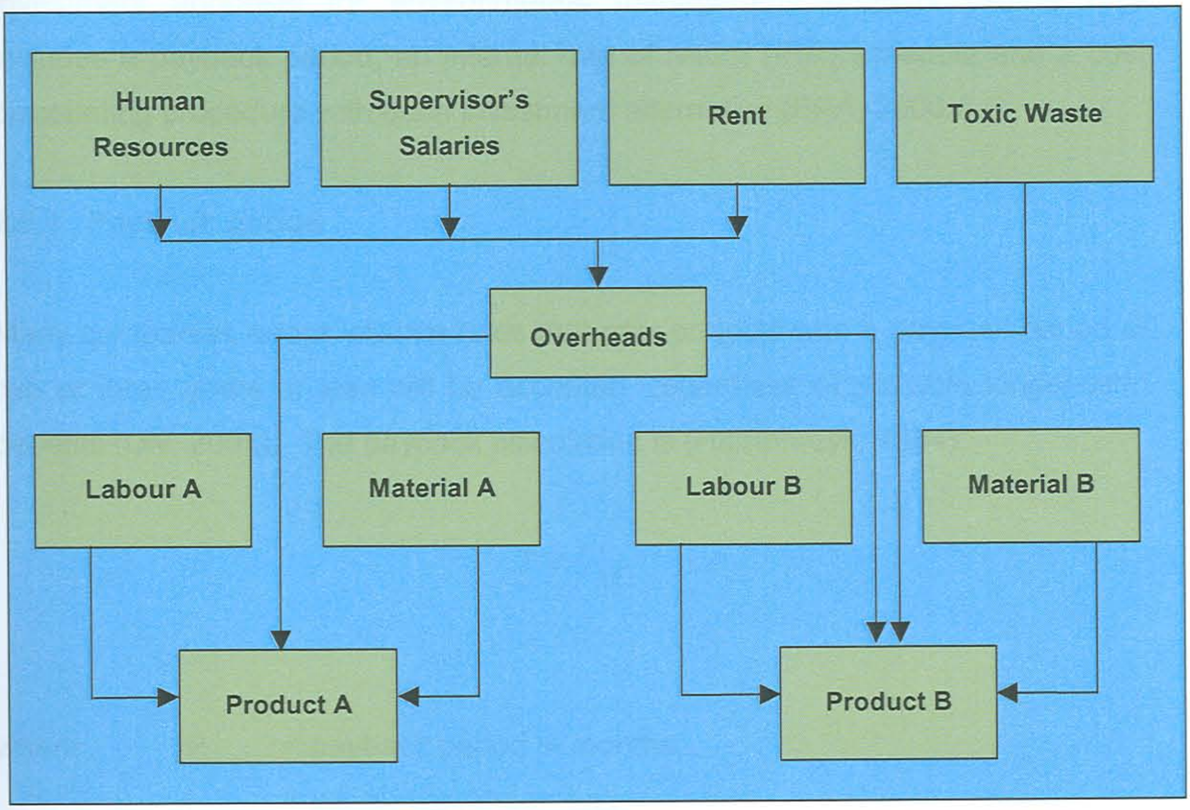

Figure 2.4 Revised environmental accounting system.

2.5 CAPITAL BUDGETING FOR ENVIRONMENTAL PROJECTS

Once all corporate environmental and social costs are allocated, capital budgeting can be performed. Capital budgeting is part of the environmental accounting process for determining financial returns on future environmental management investments to compare different investment alternatives by means of investment appraisal. Investment appraisal determines the cost savings of an investment with regard to its goals. The economic indicators for investment appraisal in capital budgeting analysis include (UN, 2001):

- initial investment costs,
- operating costs and earnings,
- profit,
- payback period,
- return on investment (rate of return), and
- cost discounting.

Investment appraisal for environmental management projects usually only includes a payback period, an internal rate of return (IRR) schedule and a cost discounting procedure with each investment alternative (EPA, 2000a).

2.5.1 Payback period

Many companies adopt internal rules that only projects with a payback period of two or three years or less will be accepted, regardless of possible longer-term benefits (UN, 2001). The payback calculation is (Humphreys, 1984):

$$P = \frac{I}{M}$$

where P = payback period in months,
I = initial investment, and
M = monthly saving.

2.5.2 Return on investment

Return on investment (IRR) is the interest rate at which the net present value (NPV) of an investment is zero. It takes into consideration the amount and timing of the costs, savings and revenues of the investment (UN, 2001). A money-saving project will have a high IRR; the higher the IRR, the better the project. The NPV calculation is shown below (Pearson, 2000):

$$NPV = 0 = C_0 + \sum \frac{C_i}{(1 + IRR)^i}$$

where NPV = net present value,
C_0 = initial investment,
C_i = monthly savings, and
i = number of months.

2.5.3 Cost discounting

Cost discounting is a procedure of expressing future costs or revenues in terms of its present value. Expected future monetary inflows and outflows are discounted to the time of the investment using an internal discount rate or annuity. Theoretically, the discount rate is a question of (Schmidt, 2003):

- the companies demands for profitability as well as the companies interest rates,
- the assumed consumer's specific interest and inflation rate, and
- the discounting assumptions for those financially responsible for end-of-life operations.

The high risks, difficult monetarisation and high uncertainty of many future environmental costs, as well as the potential cost savings of using cleaner technologies, have made estimation of future earnings and expenses difficult during cost discounting procedures. Estimation of these future earnings and expenses can be supported by a process of sound project appraisal (UN, 2001).

2.6 PROJECT APPRAISAL

Any project is constantly reviewed throughout its life cycle in terms of economic feasibility, environmental compatibility and technical justification (UN, 2001). Project appraisal is the critical determinant of an industry's competitiveness and its commitment to environmental management. The purpose of this initiative is primarily to reduce both costs and waste, to determine project alternatives and to determine project values (EPA, 2000a).

Although many companies are striving to improve their logistics and materials management processes at present, important environmental burdens are usually not addressed appropriately (EPA, 2000a). Project appraisal for environmental accounting systems is based on the output of product or project life cycle assessments by coupling a monetary value to identified environmental and social impacts.

Proper project appraisal, considering all stages over the whole life cycle of a project provides industries with the advantage to incorporate and address environmental attributes already during the early stages of a project.

Life cycle assessment (LCA) for project appraisal is a technique for assessing the potential environmental and social aspects associated with a product or project by compiling an inventory of relevant inputs and outputs, evaluating the potential impacts associated with these inputs and outputs, and interpreting the results of the inventory and impact phases in relation to the objective of the study (Senthil *et al.*, 2002b). Life cycle assessment is a cradle to grave approach, beginning with the use of raw materials from the earth to create the product and ending at the point where all materials are returned (disposed) to earth. The LCA framework is depicted in Figure 2.5 (Little, 2000).

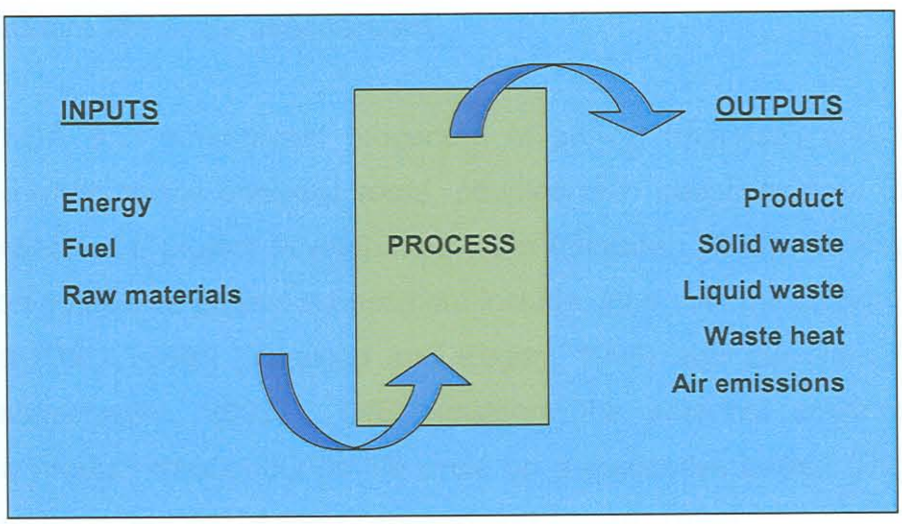

Figure 2.5 LCA framework.

Life cycle assessment evaluates all stages of a product's life from the perspective that they are interdependent, meaning that one operation leads to the next, in producing either quantitative or qualitative outputs (Senthil *et al.*, 2002a).

2.6.1 Quantitative life cycle assessment

Quantitative life cycle assessment entails coupling a quantitative value to environmental impacts associated with a project by (Little, 2000):

- compiling an inventory of relevant energy and material inputs and environmental releases,
- evaluating the potential environmental and social impacts associated with identified inputs and releases, and
- interpreting the results to make informed decisions.

Including all impacts throughout the project life cycle, quantitative life cycle assessment provides a comprehensive view of the environmental aspects of the project and a more accurate picture of the true environmental trade-offs in product and process selection (EPA, 2001).

2.6.2 Qualitative life cycle assessment

Qualitative LCA is a streamlined procedure of project appraisal, and usually follows an environmental checklist route, coupled with questionnaires used to survey members of a project development team (Graedel, 1998). Examples of work done on qualitative project assessment include, *inter alia*, the Design for the Environment (DfE) Toolkit (Yarwood and Eagan, 1998) and the Gate Review method (Labuschagne, 2002). DfE considers the potential environmental impacts of a product throughout its life cycle on a qualitative basis. There are three unique characteristics of DfE (Yarwood and Eagan, 1998):

- the entire life cycle of a product is considered,
- point of application is early in the product development process, and
- decisions are made using a set of values consistent with industrial ecology and integrative systems thinking.

DfE is an integral part of the product development process along with other design considerations, such as product economics, customer requirements, manufacturability and required product functionality (Yarwood and Eagan, 1998).

The Gate Review method determines a project's continuability through a procedure of asking certain feasibility questions relating to the environmental and social concerns of the project, at typical objective stages or gates throughout the project's development (Labuschagne, 2002). In order to answer these questions, a project must be evaluated against certain criteria at the different gates. All aspects of the project are addressed in parallel and gate criteria are often repeated in consecutive gates. This ensures that important issues and impacts are addressed throughout the project life cycle (Buttrick, 2000). The main stages usually considered in gate reviews are presented in Figure 2.6 (Labuschagne, 2002).

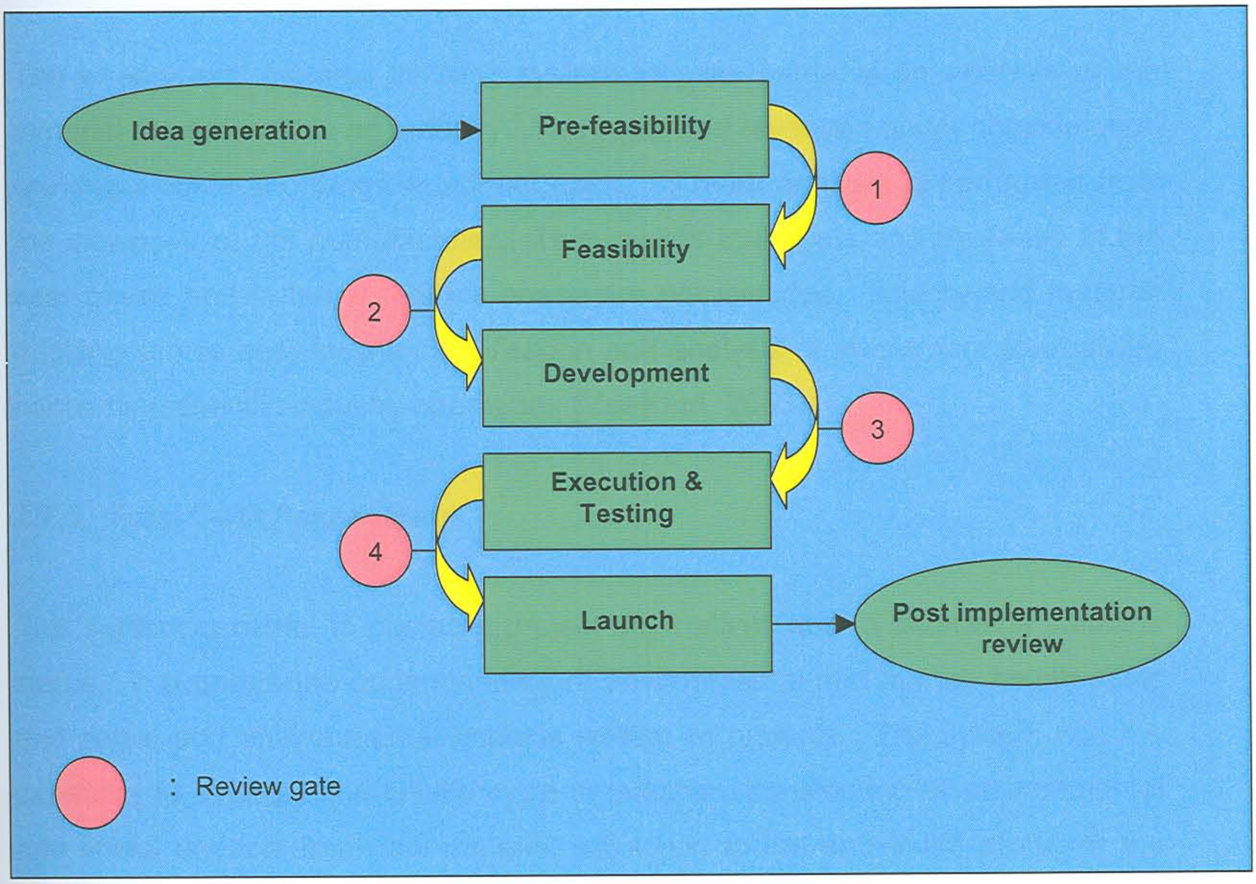

Figure 2.6 Project life cycle with gate reviews.

2.7 ENVIRONMENTAL ACCOUNTING SYSTEMS

Several systems have been developed for incorporating environmental costs and capital budgeting procedures into managerial decision making, based on product or project life cycle assessments. These include (Veefkind, 2003):

- Energy and Material Tracking (EMT),
- Total Cost Assessment (TCA),
- Life Cycle Costing (LCC), and
- Full Cost Assessment (FCA).

2.7.1 Energy and Material Tracking

The energy and material tracking system focuses primarily on analysis of the material streams within an industry. The costs and revenues under consideration are direct costs and tangible indirect costs. Stream analysis is performed from the viewpoint of the manufacturer. This implies that costs and revenues in the user phase and in the end-of-life phase are not included. Energy and material tracking serves best for the identification and analysis of investment alternatives concerning specific industry operations (Veefkind, 2003).

2.7.2 Total Cost Assessment

This system is useful to compare project alternatives and to determine baseline status. It supports the understanding of environmental and human health costs and social and environmental impacts related to projects. The system has the capability to evaluate the full life cycle in question, considering all environmental and social aspects from raw material extraction to the end-of-life phase of the product or process. Total cost assessment (TCA) is not designed to replace existing capital project and product development cost estimating practices, but rather to enhance these costing exercises by focusing attention on the potentially hidden environmental, human health and external costs (Little, 2000).

The TCA methodology is based on a life cycle approach and is designed for internal managerial decision making. When a corporation must decide between alternative projects, all potential environmental and human health costs should be fully considered. This methodology provides the framework for that decision process, as well as the framework for estimating baseline costs that have a much broader and potentially longer timeframe. Potential user groups of this system include (Little, 2000):

- product or process engineers in the design stage of new products and processes,
- engineers in the assessment of environmental projects, and
- business managers and analysts in developing product and business strategies.

The TCA methodology consists of six steps of analysis with a final step being a feedback loop providing input into the company's main decision process (Little, 2000). The purpose of the first three steps is to clearly define what aspects of the project or alternatives are important enough to carry forward and to fully evaluate. Once the first three steps have been completed, the financial inventory is developed for each project or alternative. The steps are as follows:

- *Goal and scope definition*: clearly identifies and defines the project and purpose of the total cost assessment.
- *Streamlining the analysis*: refines the first step by connecting the objectives and other elements of the decision at hand to sustainability metrics and impact categories and provides for the incorporation of life cycle information.
- *Identification of risks*: evaluates the relative importance of the impact categories and the current feasibility of expressing the costs for each attribute of an alternative or project.
- *Conducting the financial inventory*: with the focus on acquiring company specific environmental costs.
- *Impact assessment*: revision of costs to determine the largest cost contributors for each category and to assess how that information may be best incorporated into the overall decision making process.

- *Feedback to company's main decision loop*: feedback to the main decision making process within the company, recognising that the total cost assessment is only one element or input to an overall decision making process that includes many types of information.

The total costs assessment system does not advise a method of valuing internal intangible and external costs. As these costs are subjective, an objective framework to evaluate and determine cost factors involved in the development of these costs is important. Another weakness of applying the system is the availability of data for some materials and processes as input into the system. Divergence in inventory data is inevitable due to many factors, including (Little, 2000):

- the differences in unit operations among alternative systems,
- the overall quality of the data (for example, completeness and representativeness), and
- the complexity of environmental and social processes.

2.7.3 Life Cycle Costing

Life cycle costing (LCC) entails a number of economic assessment models, all of which considers the money flows that are related to the existence of a project or product (Dhillon, 1989). Life cycle costing has a cradle to grave approach based on the output of a quantitative life cycle assessment with all costs and revenues being accounted for on equal percentages (Kirk and Dell'Isola, 1995). This valuable information is used to account for the full impacts of decisions, especially those that occur outside of the site that are directly influenced by the selection of a product or process (Yarwood and Eagan, 1998).

Life cycle assessment (LCA) data are often directly applied to existing life cycle costing models. The focus of LCA models is on environmental objectives, whereas LCC models focus on cost structures and economical implications of a product, process or system (Labuschagne, 2002). The differences between LCA and costing models are summarised in Table 2.2 (Norris, 2001). Important life cycle costing characteristics include (Fabrycky and Blanchard, 1991):

- costs and revenues being allocated to individual products instead of lumping them into an overhead costs category,
- large time horisons are applicable, and
- economic equivalent financial indicators determine benefits of investments.

Table 2.2 Differences between LCA and LCC models.

Features	LCA	Costing models
Purpose	Compare relative environmental performance of alternative product systems for meeting the same end-use function, from a broad, societal perspective.	Determine cost-effectiveness of alternative investments and business decisions, from the perspective of an economic decision maker such as a manufacturing firm or a consumer.
Activities which are considered as part of the life cycle	All processes casually connected to the physical life cycle of the product, from pre-usage supply chain to processes supplying end-of-life steps.	Activities causing direct costs or benefits to the decision maker during the economic life of the investment, as a result of the investment.
Flows considered	Pollutants, resources and inter-process flows of materials and energy.	Cost and benefit monetary flows impacting decision maker.
Units for tracking flows	Primarily mass and energy; occasionally volume or other physical units.	Monetary units (for example, $, R).
Time treatment and scope	Timing of processes and their releases or consumption is traditionally ignored although the impact assessment can address a fixed time window. Future impacts are however generally not discounted.	Timing is critical. Present value of costs and benefits. A specific time horison scope is adopted and any cost or benefits that occurs outside that scope is ignored.

Although the objectives of different LCC models vary from each other, the goal is the same - intending to reduce the total cost of a product, project or asset. Life cycle costing models available in the world market include (Senthil *et al.*, 2002a):

1. The LCC model of Dahlen and Bolmsjo.
2. The LCC model of Woodward.
3. The Activity Based Costing model.
4. The LCC model of Fabrycky and Blanchard.
5. The Economic Input-output LCA model.
6. The Design to Cost model.
7. The Product Life Cycle Cost Analysis model.
8. The Life Cycle Environment Cost Analysis model.

2.7.3.1 The LCC model of Dahlen and Bolmsjo

Dahlen and Bolmsjo's LCC model is also referred to as 'Life cycle cost analysis of the labour factor' (Labuschagne, 2002). It widens the field of application for LCC by focusing on the cost of an employee over the entire employment cycle, that is from recruitment to retirement (Dahlen and Bolmsjo, 1996). The model carries out an analysis of investments done when raising the production factor of labour (Senthil *et al.*, 2002a).

Dahlen and Bolmsjo (1996) distinguished between three types of labour cost categories, with their classification, in a cost of labour breakdown structure. These are presented in Table 2.3. The benefit of the model is that it assists with industrial decision making through the inclusion of labour related costs in the LCC methodology. It qualifies and assists the verification process related to the following labour related decisions (Labuschagne, 2002):

- Who is to be employed?
- How much can be invested in the education and training programmes for a new employee?
- What is the correlation between costs and the shape of the work tasks and the working environment?
- What should be the ratio between production capital and labour capital to achieve the most cost effective production system?

Cost drivers for labour related costs could be labour hours, the number of employees, absenteeism or the number of work injuries. This leads to a wider allocation basis where labour costs are directly related to activities that cause the costs.

The weakness of the model relates to the costs being grouped according to the original cause of the costs. Only thereafter can all the costs be allocated to the cost unit on a proper allocation basis (Senthil *et al.*, 2002a).

Table 2.3 Cost of labour breakdown structure.

Cost of labour		
Employment costs	**Operation costs**	**Work environment costs**
Recruitment costs	Wages	Absence costs
Interviews	Employee salary	- Quality related costs
Information	Payroll taxes	Rejects
Advertisements	Overhead	Reworks
Administration	Manufacturing overhead	- Productivity loss
Additional production costs	Factory overhead	Overtime
Learning curve		Over staffing
Controls		Stand-ins
Rework		- Administration
Education costs		Foreman
Instructors		Planner
External education		Central admin.
		Sickness benefits
		Sick pay
		Payroll taxes
		Vacation benefit
		Rehabilitation costs
		Equipment
		Training
		Investigations
		Disability pension costs

2.7.3.2 *The LCC model of Woodward*

This model emerged from the objective of essentially planning and monitoring assets throughout their entire life cycle from the development or procurement stage through to disposal of waste (Senthil *et al.*, 2002a). The methodology is based on Kaufmann's formulation to establish life cycle costing (Woodward, 1997) and calculates the net present value of a product, process or system's life cycle cost (Labuschagne, 2002).

The model is concerned with optimising the value of money in the ownership of physical assets by taking into consideration all the cost factors relating to assets during their operational life (Senthil *et al.*, 2002a). Optimising the trade-off between these cost factors will give the minimum life cycle cost of the asset (Woodward, 1997). The LCC model of Woodward (1997) comprises eight steps of analysis:

1. Establishment of operation profiles to qualify the periods when the equipment will operate.
2. Establishment of utilisation factors to establish how the equipment will operate within the periods determined above.
3. Identification of cost elements.
4. Determination of critical cost parameters that may include energy use rate, mean time between failures, mean time to repair and the time period for scheduled maintenance.
5. Calculation of costs at current prices.
6. Escalation of costs at assumed inflation rates.
7. Discounting costs to present values.
8. Summing of discounted costs to establish a net present value.

The model has its strength in estimation of costs of assets, based on the whole life cycle of assets before making a choice to purchase a specific asset from a list of alternative assets. This encourages a long-term outlook of a company's investment decision making process. The model aims at establishing investment options to be more effectively evaluated considering the impact of all costs, rather than only initial capital costs, assisting in the effective management of completed projects and facilitating the choice between competing alternatives.

The success of this model depends on accurate, relevant and timely information. The restriction of this model lies in the optimisation of the value of money in asset ownership. It aims to optimise the total cost of asset ownership by identifying and quantifying all significant net expenditures that may arise during the ownership of an asset (Woodward, 1997).

2.7.3.3 *The Activity Based Costing model*

The activity based costing model can be applied to determine the life cycle cost of a product or project and has the best potential for effective cost assessment in the context of life cycle design (Senthil *et al.*, 2002a). This model is generic and can be applied whenever the activities are described in detail. The model has the capability of dealing with uncertainty and applies Monte Carlo simulation for such purposes (Labuschagne, 2002). The model consists of six steps (Bras and Emblemsvag (1996), as cited by Senthil *et al.*, 2002a):

- Creation of an activity hierarchy and network that will ensure that all activities in the part of the life cycle are considered.
- Identification and ordering of all the necessary cost drivers and consumption intensities.
- Identification of relationships between cost drivers and design changes.
- Determination and minimisation of the cost of the consumption activities, that use an optimisation algorithm where the design parameters serve as the source variable and the total cost as the response variable.
- Evaluating the solution.
- Iteration.

When dealing with environmental issues, uncertainty must be included due to the predominant lack of hard data. The inclusion of Monte Carlo simulation in conjunction with the above mentioned steps provide the capability to identify the project and product design aspects and uncertainty that contribute most to the costs (Society of Management Accountants of Canada, 1996). The activity based costing model for the assessment of external environmental and social impacts and costs, however, still needs more rigour in its development and functionality before it can be applied as a standalone decision making tool (Labuschagne, 2002).

2.7.3.4 The LCC model of Fabrycky and Blanchard

Fabrycky and Blanchard (1991) presented an LCC model that addresses detailed cost analysis of all the costs concerned with the entire life cycle of any product. The excellence of the model lies in its detailed cost breakdown structure. The methodology of the model is presented in Figure 2.7.

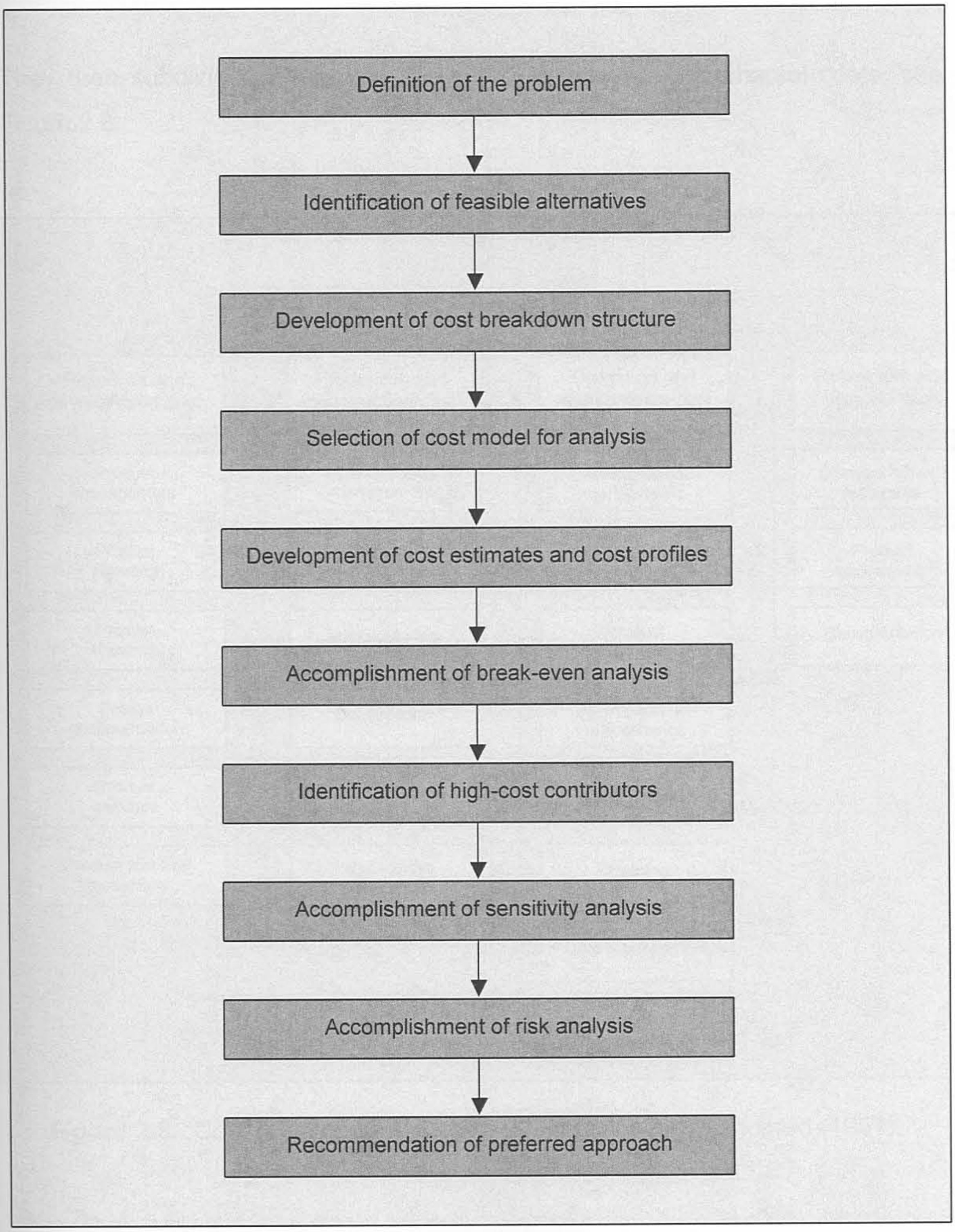

Figure 2.7 The LCC methodology of Fabrycky and Blanchard.

Fabrycky and Blanchard (1991) divide the total cost of a product or a system into four categories that include:

- research and development costs,
- production and construction costs,
- operation and maintenance costs, and
- retirement and disposal costs.

They then subdivided each cost category into relevant incremental costs, see Figure 2.8.

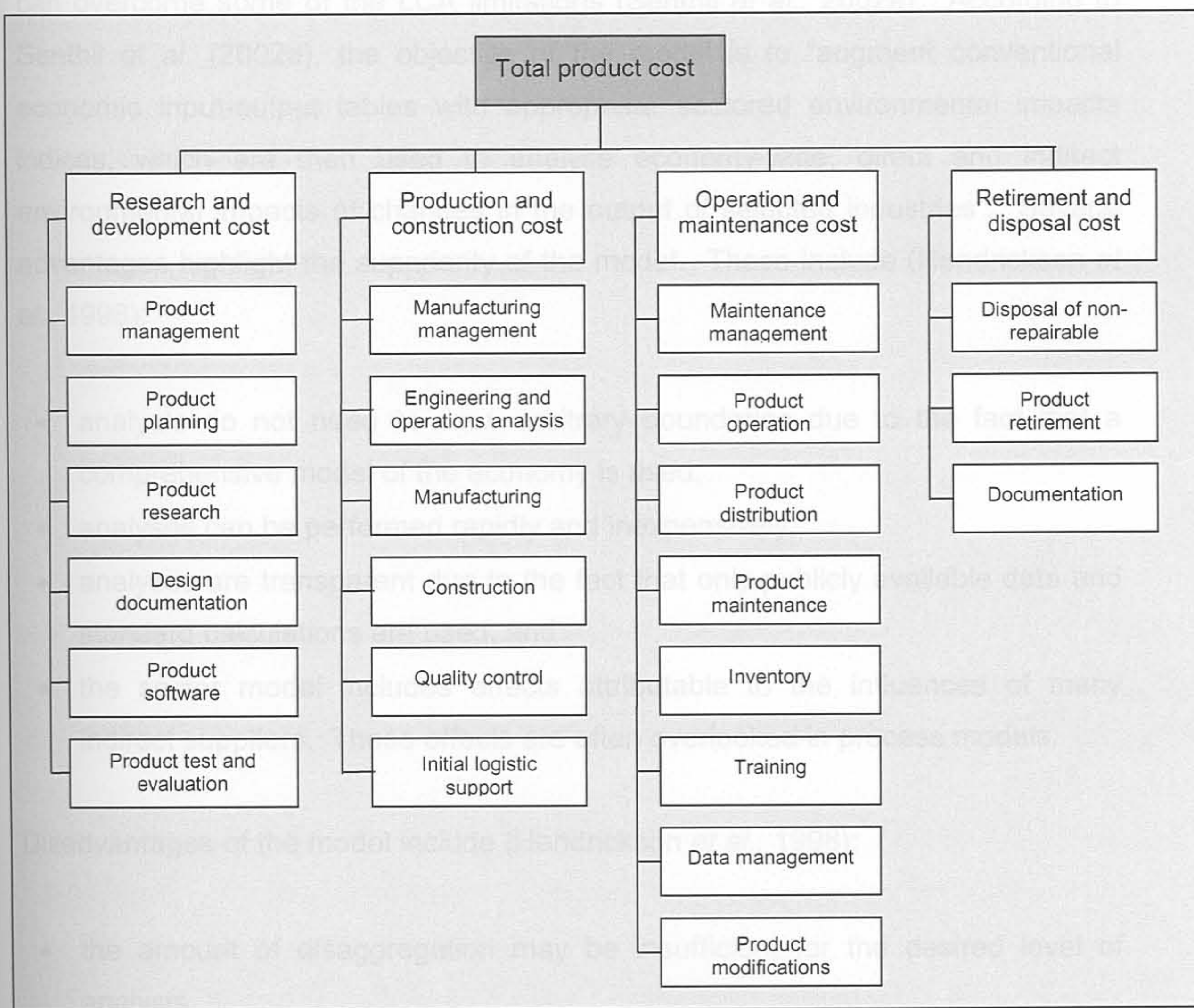

Figure 2.8 Cost breakdown structure of Fabrycky and Blanchard (1991).

The model can be implemented to address a wide variety of high cost factors at different stages of a new product or project's life cycle (Asiedu and Gu, 1998). It also assists in the assessment of high-cost contributors and costly problem areas of existing products or projects. However, the accomplishment of life cycle cost analysis using this model is iterative and must be tailored to specific applications. Given its generality though, the model can easily be extended to include more recent costs into its cost breakdown structure for different applications.

2.7.3.5 The Economic Input-Output LCA model

The model complements conventional life cycle assessment (LCA) procedures and can overcome some of the LCA limitations (Senthil *et al.*, 2002a). According to Senthil *et al.* (2002a), the objective of the model is to "augment conventional economic input-output tables with appropriate sectored environmental impacts indices, which are then used to analyse economy-wide, direct and indirect environmental impacts of changes in the output of selected industries". Several advantages highlight the superiority of the model. These include (Hendrickson *et al.*, 1998):

- analysts do not need to draw arbitrary boundaries due to the fact that a comprehensive model of the economy is used,
- analyses can be performed rapidly and inexpensively,
- analyses are transparent due to the fact that only publicly available data and standard calculations are used, and
- the sector model includes effects attributable to the influences of many indirect suppliers. These effects are often overlooked in process models.

Disadvantages of the model include (Hendrickson *et al.*, 1998):

- the amount of disaggregation may be insufficient for the desired level of analysis,
- it includes sectors of the economy rather than simple processes and the sectors can be too heterogeneous to correctly reflect a particular process,
- it cannot be used to refect the environmental impacts arising from product use and disposal, and

- it can interpret environmental impacts of products only in cumulative cost terms.

Despite the disadvantages of the model, it offers the ability to examine a product and suppliers in detail and so provides calculations of all of the indirect economic activity and environmental discharges.

2.7.3.6 *The Design to Cost model*

This model presents a generic methodology to combine cost modeling and quality function deployment (QFD) in order to assess the potential trade-offs between the cost and performance of competing product alternatives (Senthil *et al.*, 2002a). The model consists of a procedure to select a system design and has three main functions (Senthil *et al.*, 2002a):

- derivation of system performance,
- evaluation of system costs, and
- presentation of results and decision making.

This model is only limited to the early stages of production systems design (Asiedu and Gu, 1998).

2.7.3.7 *The Product Life Cycle Cost Analysis model*

The aim of the model is to calculate the life cycle costs of capital goods like machines and it focuses on single processes connected to a product's life cycle (Labuschagne, 2002). Cost reductions in the different product and project life cycle stages are achieved through a "conception directed towards the needs of the use phase. Similar dependency arises in the disposal phase." (Senthil *et al.*, 2002a). Asiedu and Gu (1998) states that the limitation of the model lies in the fact that various techniques need to be used to calculate all cost elements in every life cycle phase of the product or project.

2.7.3.8 The Life Cycle Environment Cost Analysis (LCECA) model

The objective of the model is to include eco-costs into the total cost of a product and defines eco-costs as all direct and indirect costs resulting from environmental impacts caused by the product over its entire life cycle (Senthil *et al.*, 2002b). The methodology of the model comprise nine steps of analyses, as reflected in Figure 2.9 (Senthil *et al.*, 2002b):

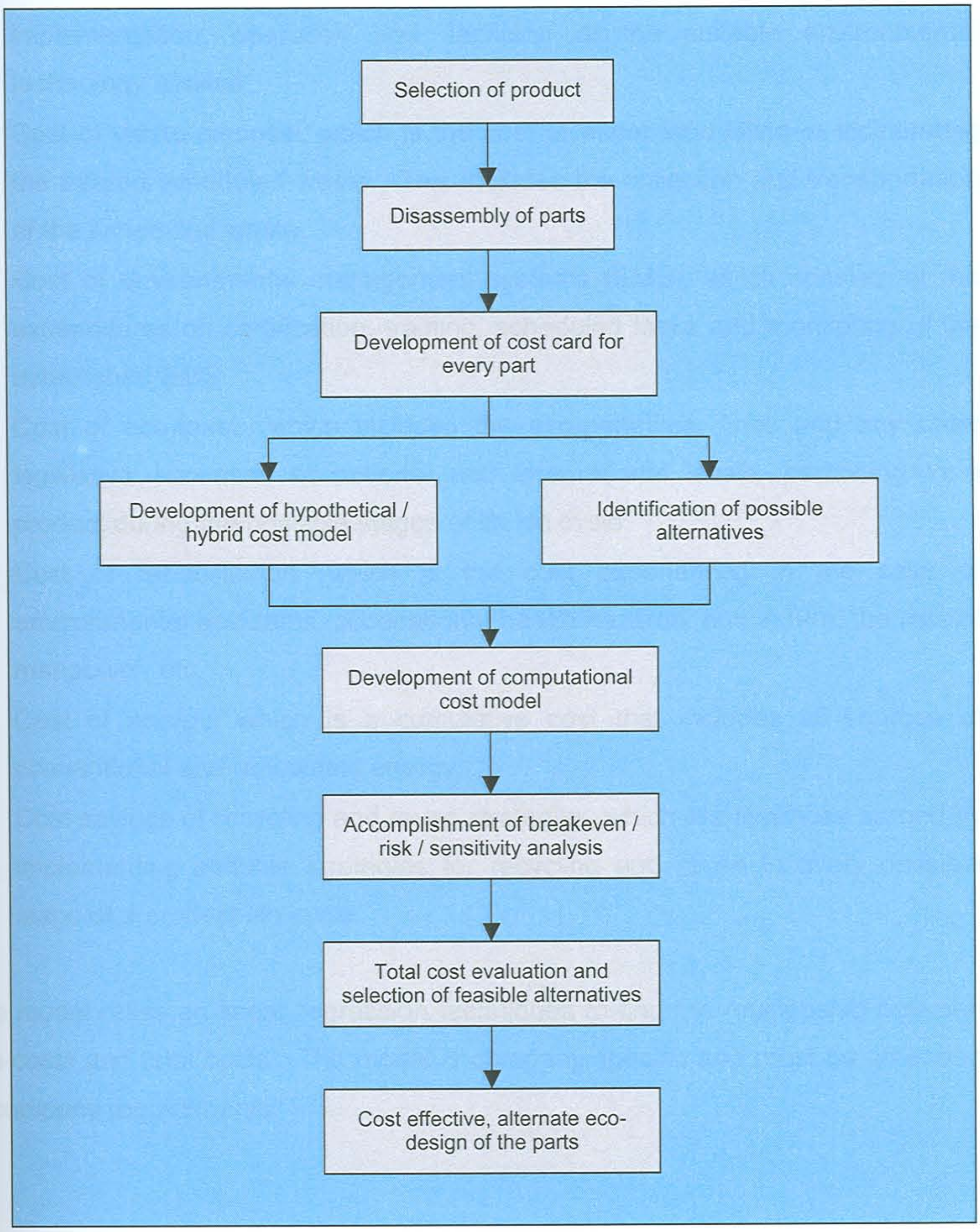

Figure 2.9 Methodology of the LCECA model.

The model introduces a new generic cost breakdown structure for eco-costs. This cost breakdown structure includes (Senthil *et al.*, 2002b):

- Cost of effluent/waste control, which is the expenditure incurred towards the in-process effluent control in suitable stages of a product life cycle. This includes the installation, operation and maintenance of effluent control systems throughout the process.
- Cost of waste treatment, which is the expenditure in treating the generated wastes at the end of each life cycle stage of a product. This includes the implementation, operation and servicing of the suitable environmental technology applied.
- Cost of waste disposal, which is the cost of either land filling or incinerating the treated scheduled waste. This includes the collection and transportation of the scheduled waste.
- Cost of environmental management systems (EMS), which consists of the expenditures on certification, training, scheduled tasks and monitoring of the established EMS.
- Cost of eco-taxes, which includes the eco-penalties, fines and any other legislative expenses at national and international levels, pertaining to a product during the possible stages of its life cycle.
- Cost of rehabilitation, which is the cost experienced in the case of environmental accidents, occupational health hazards, and in turn, the loss of manpower, etc.
- Cost of energy, which is a cumulative cost that includes all sources of conventional and renewable energy.
- Cost savings of recycling and reuse strategies, which are revenues earned by implementing suitable strategies for recycling and reuse in every possible stage of a product life cycle.

The model relies on linear regression techniques to find the relationship between eco-costs and total costs. The model is company specific and must be amended to company requirements.

Characteristics of these LCC models are presented in Appendix A, Table A.1. External costs are often not considered in most of the developed life cycle costing models. The estimation of external costs, using these models, is difficult and does not provide much informative value due to the low quality and inconsistency of available data; therefore usefulness of these models is limited at present for environmental accounting purposes.

2.7.4 Full Cost Accounting

The full cost accounting system is important for government agencies that represent a variety of interests when deciding how to allocate public funds and/or natural resources and to inform decision makers on the trade-offs intrinsic in proposed alternatives (Carter *et al.*, 2001). The objective of full cost accounting is to identify all of the costs associated with providing goods and services, both direct and indirect, regardless of the period in which the related disbursements or expenditures occur (Government Finance Officers Association, 2000). Full cost accounting involves four steps of analysis that include (Carter *et al.*, 2001):

- Identification of stakeholders and relevant values.
- Generation of project alternatives.
- Evaluation of the effects of each alternative on stakeholders.
- Tabulation, adjustment, and reporting of results.

2.7.4.1 Identification of Stakeholders and Relevant Values

The first step is to identify all stakeholder groups that have an interest in the project or product being considered. A thorough inventory of stakeholders includes those with direct and indirect market interests, as well as those who have a stake in the non-market aspects of the project or product. The indirect stakeholders are affected by changes in the activities of the direct stakeholders after the project is implemented or the product manufactured.

An effort should be made to identify the stakeholders whose interest in the project or product cannot be expressed as changes in market values. Such interests could relate to non-market environmental or cultural characteristics that may be affected by the project alternatives under consideration. A careful assessment of the stakeholders in the early stages of an analysis assists to clarify conflicting interests and reveal potential areas for compromise as the analysis progresses.

2.7.4.2 Generation of Project Alternatives

The next step is to create a list of feasible project or product alternatives based on recommendations by scientists and the stakeholders who are closely involved with the project subject matter. This list includes options that are feasible given the characteristics of the study area and the goals of the project. A complete list of alternatives also includes the 'no go' choice.

2.7.4.3 Evaluation of the Effects of Each Alternative on Stakeholders

The third step of analysis examines the potential direction and magnitude of each alternative's effect on the recognised stakeholders. First, the potential physical and environmental effects of each project alternative must be identified. Second, to the extent possible, these physical and environmental effects are translated into changes in stakeholder values and compared across alternatives.

Full cost accounting identifies and quantifies four levels of environmental costs (ICF Incorporated, 1996):

- direct costs such as labour, capital and raw materials;
- hidden costs such as monitoring and reporting;
- contingent costs including fines and remedial action; and
- intangible costs including public relations and goodwill.

Companies can use full cost accounting not only to determine the financial impact of their environmental activities, but also to find less costly alternatives by changing process or product design, increasing prices and developing an exit strategy to eliminate environmentally costly products.

Whilst full cost accounting can assist in corporate decision making, the model can not be applied solely for informed business decisions. Full cost accounting is not a standalone environmental accounting tool and must be developed and implemented as part of a larger environmental management system. This system usually relates to a company's environmental management framework for sustainable development.

A comparison of the features of the environmental accounting systems discussed above is presented in Appendix A, Table A.2. From the table it is evident that no system has been developed as such to be utilised as a sole decision making tool, except for the Total Cost Assessment system to some degree, and much research still needs to be done before this will be possible in near future. The systems are useful though when incorporated in a company's overall environmental management system. At present, the systems have the purpose to highlight information about a company's environmental expenditures and revenues, environmental impacts and social impacts. Without using these systems, this information could well be disregarded without company incentives to reduce possible environmental and social impacts and its associated costs.

The Total Cost Assessment system proves to be superior to the other environmental accounting systems available in the world market. This is primarily due to its ability to account for external costs, with sufficient data input it can be utilised as an exclusive decision making tool and due to its ease of application. It has a rigorous approach and can easily be amended for company and country specific purposes.

CHAPTER 3

Environmental accounting in South Africa

3.1 BACKGROUND

Corporate environmental and social impacts have significant and increasing influence on the financial performance of companies. Due to this financial influence, it is even more important for managers to use an information tool that will allow them to manage and control these impacts. Environmental accounting is that tool, both conceptually and in practice.

The United States Environmental Protection Agency (USEPA) was the first national government organisation in the world to establish a formal programme to promote the use of environmental accounting for managerial decision making (Savage, 2003a). The agency's early efforts in the 1980's focused on the use of corporate environmental accounting for pollution prevention efforts, but later broadened to include other environmental accounting applications, such as supply chain management and sustainable environmental management. Since the establishment of the agency's environmental accounting programme, extensive research in the United States and other first world countries have developed the understanding of environmental accounting principles and enhanced application of environmental accounting systems for worldwide corporate decision making (Savage, 2003b).

Environmental accounting has now become a well accepted and valuable corporate instrument and environmental best practice technique. Businesses and government organisations in more than 25 countries are at this stage promoting and implementing environmental accounting as part of their environmental management systems, including (UN, 2001): Argentina, Australia, Austria, Canada, Colombia, the Czech Republic, Denmark, Egypt, Finland, Germany, Guatemala, Italy, Japan, the Republic of Korea, the Netherlands, Nicaragua, Peru, the Philippines, Portugal, the Slovak Republic, Sweden, Tanzania, the United Kingdom, the United States, Vietnam and Zimbabwe.

In addition, regional and international governments are also promoting environmental accounting. These include the European Commission, the United Nations Environment Programme, and the United Nations Division for Sustainable Development (UN, 2001).

In the South African context, a large number of research projects have been conducted dealing with environmental accounting principles. These include, *inter alia*, the work of:

- Blignaut (1995), who researched the overall state of environmental accounting in South Africa;
- Van Horen (1996), who has done extensive research on externality costs;
- Winckler *et al.* (2001) and Blignaut and King (2002), whose research was directed at environmental accounting in especially the energy sector;
- Blignaut and De Wet (2002), who have established a forum for bridging the economic and environmental divide in South Africa; and
- Spalding-Fecher and Matibe (2003), who have valued electricity and electricity production factors in terms of external costs.

Unfortunately, South African companies do not have the incentives to employ a standalone corporate environmental accounting system and only subscribe to environmental accounting principles as part of their environmental management systems (Immink and Sephton, 2003). This is primarily due to the lack of available and adequate South African environmental accounting systems and environmental impact data, together with the requisite of awareness regarding legal requirements and the need of enforcement of applicable regulations in general (Hattingh, 2002).

KPMG South Africa has surveyed South Africa's 19 most influential companies regarding their environmental management systems. The findings of this survey suggest that there is a growing awareness of the significant financial implications of environmental performance and that environmental accounting practices are gradually increasing. The current application of corporate environmental accounting, however, remains at extremely low levels (KPMG, 2001).

Most of the South African companies measure environmental information relating to capital costs, operating costs, liabilities, donations and provisions. However, very few companies are reporting these in their annual financial statements, or even in their separate corporate environmental reports. Application of environmental accounting methods, especially the tracking of financial benefits relating to environmental programmes, further remains the exception rather than the rule. Consequently, there are also very few companies that can readily access information on their environmental costs and liabilities, or be in a position to disclose these costs in their annual reports.

Firm corporate environmental accounting systems therefore still needs to be promoted in South Africa. To promote environmental accounting in South Africa, it is needed to understand first the drivers of environmental accounting in a developing country, second the current state of corporate environmental awareness and thirdly the possible solutions to implementing corporate environmental accounting.

3.2 DRIVERS OF ENVIRONMENTAL ACCOUNTING

Drivers of environmental accounting are inevitably going to be different between first world and developing countries. In first world countries drivers for environmental accounting include the social demands and the significant international environmental legislation that has forced companies to undertake and participate in extensive sustainable environmental management.

Commensurate with the considerable growth in environmental regulation, organisations increasingly recognise the importance of addressing environmental issues effectively. For example, firms are adopting environmental policies and introducing ecological quality controls to enhance social and environmental compliance. Moreover, a firm's poor environmental performance may result in sanctions and penalties, as well as a reduction of its stock market capitalisation. There is also a growing expectation that firms that are strong environmental performers make better investments (Hattingh, 2002).

In South Africa though, drivers of environmental and social performance and adoption of corporate environmental accounting principles were largely incentive based up to now. Environmental reporting, for example, has primarily been by disclosures of financial statements addressing in particular the use of environmental disclosures to investors and other stakeholders, whereas environmental accounting principles were employed based on waste minimisation incentives and the encouragement to compare with international standards (Immink and Sephton, 2003).

This is primarily due to a lack of enforcement of applicable environmental and social regulations by governmental authorities. Yet, since reporting by firms of their environmental and social performance and responsibility has been legitimated, South African companies tend to give more attention to the environmental and social impacts of their operations. Drivers for environmental accounting now include the requirement to reduce reputational risks, potential fines and decreasing market interests.

Environmental and social compliance can also be profitable. This profitability may be linked to reduced costs through, *inter alia*, more efficient processes or reduced resource use. Should a company have the potential to reduce the emissions of greenhouse gases (GHG), for example, they could potentially benefit from international agreements around carbon credits. It is widely acknowledged that it will be financially attractive to invest in GHG mitigation projects in developing countries. Compared with international standards, countries such as South Africa have poor levels of energy efficiency and high pollutant levels. Therefore the cost to reduce GHG's could be lower (Immink and Sephton, 2003).

Another driver of corporate environmental accounting relates to sustainable biodiversity exploration. One of South Africa's greatest assets is its biodiversity. Biodiversity not only supports resources, but also a tourism industry that is responsible for a large percentage of South Africa's capital gain (Blignaut, 2004).

3.3 CORPORATE ENVIRONMENTAL ACCOUNTING

Most South African companies have formal environmental management systems and that include waste-, water-, air-, and energy management programmes. Also, these companies subscribe to sound environmental and social performance, but lack rigorous and standalone environmental accounting systems (Blignaut, 2004). The following are three South African companies that were surveyed about their environmental accounting principles, coupled to their respective environmental management systems:

- SASOL,
- ESKOM, and
- Anglo American PLC.

The surveys were conducted with each company's environmental health and safety representative (Goede, 2004; Lukas, 2004 and Ireton, 2004). The surveys only applied to the company's environmental accounting systems, if any, and entailed the following basic questions:

1. Does the company have an environmental accounting system?
2. Is it a standalone system or is the system coupled to a wider environmental management system?
3. What system is used for environmental accounting in the company?
4. What are the benefits and disadvantages of the system?
5. What is the scope of environmental costs represented by the system?
6. What influenced the company to develop and implement an environmental accounting system?
7. What results do the company get form the system and how is the results employed for informed business decisions?
8. Are the system matured or does it still need some refinement?

The results from the survey showed that all three companies have matured environmental management systems. Only ESKOM has an environmental accounting system, whereas the other two companies do have the incentive to record environmental costs in a standalone environmental accounting system.

3.3.1 SASOL

SASOL is South Africa's leading petroleum products industry with a large proportion of its individual companies being ISO 14001 certified (Goede, 2004). The company's main environmental goal is to move beyond compliance and integrate product stewardship into its business operations. The company's operations have impacts on both the natural environment and human health. At present, SASOL does not have a standalone environmental accounting system. The company only applies environmental accounting principles as such that environmental and human health impacts of operations and new developments can be quantified and converted to economic value. This is solely for budget distribution and finance recognition (Goede, 2004).

There is a definite need for a standalone corporate environmental accounting system and research is currently being financed to develop such a justifiable system, given the limitations of its current environmental management system. Limitations to SASOL's environmental management system at present include (Goede, 2004):

- only the costs of conventional financial accounting is addressed,
- the scope of the system can be set to range within compliance boundaries which is a convenient way to disregard non-compliance,
- the system is solely compliance driven at present,
- only water and waste management are properly addressed with a disregard of air management, and
- environmental cost savings are most often linked to waste recycling and water reductions and energy savings.

SASOL admits the simplicity of their environmental accounting principles and environmental management system and acknowledges its limited application compared to systems available in first world countries. Resistance to convert to a standalone environmental accounting system is primarily finance driven. Not only are there high costs involved in the development and implementation of such a system, but adjusting SASOL's environmental performance using an environmental accounting system to compare with first world standards will certainly not be financially justifiable (Goede, 2004).

The benefit of SASOL's current environmental accounting principles for corporate decision making only includes an incentive to minimise waste and water pollution through enhanced environmental and human health awareness (Goede, 2004).

3.3.2 ESKOM

ESKOM is the main supplier of electricity in South Africa. Its operations include coal fired, nuclear and hydro power stations, with associated impacts on both the natural environment and human health (Lukas, 2004). Being an ISO 14001 aligned company, it has a well matured environmental management system. ESKOM designed and implemented a fairly comprehensive environmental accounting system, which allows for the extraction of detailed management cost information relating to environmental issues. ESKOM measures environmental and social impact costs and reports its conventional costs as capital costs and operational costs using the SAP financial accounting system. ESKOM does not measure and report intangible and external costs as such, although periodical surveys are run to determine company image and performance (Lukas, 2004).

The environmental accounting system is not a standalone system. The benefit hereof is reduced costs due to only a single operational environmental management system and no costs involved in the development and implementation of a standalone environmental accounting system (Lukas, 2004).

3.3.3 Anglo American PLC

Anglo American PLC supplies coal, gold, platinum and diamonds, amongst other minerals, to the South African consumer market and for international export. The company is comprised of different business units, all with their own environmental management systems. Nearly 63% of these business units are ISO 14001 certified (Ireton, 2004). Generally, the company does measure tangible environmental costs, but reports them as conventional costs, liabilities and provisions in financial accounting systems. Liabilities and provisions primarily relate to land rehabilitation and future remediation due to its mining activities. The environmental management systems do not incorporate standalone environmental accounting systems at present, and the need therefore is being researched at present (Ireton, 2004).

3.4 RATIONALE FOR ENVIRONMENTAL ACCOUNTING IN SOUTH AFRICA

There are numerous reasons why corporate environmental accounting would make good business sense to implement in South African industries. For example, environmental accounting can (Blignaut, 2004):

- demonstrate the impact of financial issues on the income statement and balance sheet,
- facilitate financial planning, such as the creation of provisions for potential environmental liabilities,
- help to identify cost reduction and process improvement opportunities, such as in the areas of water management, energy efficiency, waste reduction and biodiversity exploration,
- assist with the prioritisation of environmental actions, namely to focus on those issues with potentially the largest financial impact,
- guide product decisions, such as product development, pricing and mix, where activity based costing allows environmental costs to be factored in,
- support existing environmental management systems and environmental managers,
- demonstrate transparency to stakeholders, through reporting of environmental financial information, and
- encourage the move towards sustainable development or the triple bottom line (Nganwa, 2002), which integrates economic, environmental and social performance.

3.5 POSSIBLE IMPLEMENTATION SOLUTIONS

To implement environmental accounting in South African industries requires some definite fundamentals. These include more pronounced government involvement, introduction of a well defined legal framework and resource accounts, establishment of a readily available national environmental and economic data inventory and development of an environmental accounting model that will support informed business decisions.

3.5.1 Government involvement

The government of South Africa must become more involved in corporate decision making and establish environmental standards comparable to first world standards. All stakeholders share interest in sustainable environmental management. However, government involvement in corporate environmental performance is a critical requirement for corporate accountability towards the environment. Governments must promote and enforce the use of environmental accounting systems as an addition to integrated environmental management systems.

3.5.2 Introduction of a legal framework and resource accounts

To implement corporate environmental accounting in South Africa, a legal framework should exist that supports both the concept and the system. A legal framework can establish the necessary transparency with regard to data requirements and environmental and economic information. Legislation is also needed to widen the scope of an environmental accounting system. Yet, once a legal framework is established, it needs to be sufficiently enforced.

Up to now the South African government lacked the ability to enforce legislation. However, the Department of Environmental Affairs and Tourism claims to have set aside funds to establish a directorate of regulatory affairs in order to tighten the enforcement of environmental regulations. This is in combination with training programmes within the department of justice aimed at empowering a large number of new inspectors and monitors for the new legislation. Training programmes are also being developed for both local government and the judiciary, to increase their awareness and understanding of environmental legislation (Immink and Sephton, 2003).

Apart from legislation, the South African government recently realised the need for South African environmental resource accounts. South African resources are inexpensive compared to first world countries, energy resources are over-exploited and biodiversity does not receive the conservation it deserves. The first document published in the series of these accounts is the Woody Accounts (Blignaut, 2004).

These accounts acknowledge the vulnerability of the South African indigenous forests and the value of timber as a national resource. The Water and Mineral Accounts that were published recently, to be proceeded by the Biodiversity and Energy Accounts in near future, followed this document (Blignaut, 2004). An Atmospheric Account still needs to be developed as South Africa's emission standards are far below international standards (Blignaut, 2004).

3.5.3 Inventory of national economic and environmental data

Monetary and physical data are necessary to implement a corporate environmental accounting model in South Africa. Monetary data consist mainly of national aggregates and are, to a very large extent, readily available. Problems with regard to nominal and constant values of certain aggregates may, however, exist, especially fixed capital stock values.

With regard to physical data, research has shown that huge data problems exist in South Africa (Blignaut, 1995). These data problems that add up to a data availability problem need to be addressed before an exercise to implement a standalone environmental accounting system can commence. The level of data availability can be categorised in three levels of (Blignaut, 1995):

- readily available data,
- classified or not readily disclosed data, and
- data that still needs to be developed.

Third level data must be developed and presented with second level data in a transparent inventory to deem it readily available, comparable to first level data, for inclusion in an environmental accounting model.

3.5.4 Development of an easily amendable environmental accounting model

South African environmental accounting principles and environmental management systems typically do not isolate environmental costs and information in a systematic fashion, yet there are benefits in developing methods and models for doing so.

By incorporating environmental costs into an activity-based environmental accounting model, South African organisations can identify more accurately those products and projects that are driving their environmental costs. Once identified, companies would then be better equipped to determine which products to eliminate, which materials to change and what processes to modify (Nganwa, 2002).

Companies can also achieve competitive advantage not only by being in compliance, but also by understanding environmental market opportunities and proactively using that knowledge to create markets in which they have sole or leadership positions. Such objectives are likely to be facilitated by the provision of an environmental accounting model with the South African drivers for environmental accounting incorporated. Due to the diverse range of industrial activities in South Africa, this model need to have a simplistic approach and must be easily amendable for company specific purposes (Hattingh, 2002).

Finally, environmental accounting should be seen as one of the ways to challenge the widely held perception of environmental management as only a generator of costs. In particular, a future focus on tracking the financial benefits should prove that there are significant returns on investments in environmental good practice (Savage, 2003b).

With the first three solutions to implementation of sustainable corporate environmental accounting in South Africa largely dependent on government involvement, only an environmental accounting model still needs to be developed or customised from systems available in the world market to address all these fundamentals to compare the South African national industrial economy with first world standards.

CHAPTER 4

Environmental Accounting Model

4.1 INTRODUCTION

In first world countries environmental accounting systems provide the framework for corporate evaluation of alternative projects and processes and for estimating economic and environmental performance. However, in South Africa industries generally do not have the incentive to account for environmental costs. This is primarily due to the lack of South African environmental accounting systems to support companies in effectively accounting for these costs. The EEGECOST model was developed to promote environmental accounting in South Africa. This model will assist companies in identifying, recording and accounting for environmental costs to enhance their corporate decision making processes.

4.2 A SOUTH AFRICAN SPECIFIC MODEL

Since the South African business community realised the requirements to achieve sustainable industrial operations and to reduce the global environmental impacts of their operations, the need for an environmental accounting model became evident. This is primarily due to considerable pressure from within these companies, global organisations, governments and public to design and produce products that are sustainable and eco-efficient, with negligible social impact. An environmental accounting model for South Africa was further conceived in recognition of some of the limitations of conventional accounting approaches for management decisions involving significant environmental costs and/or impacts. The EEGECOST model was developed for the purpose of environmental accounting in South Africa.

The EEGECOST model has its intent in tracking costs and revenues associated with sustainable environmental and social development within the South African business environment, based on the drivers of the South African national environmental accounting framework. Table 4.1 summarises these drivers that led to the development of the EEGECOST model.

The model focuses not only on cost information related to a company's environmental impacts, but also on information about the use and fate of biodiversity in South Africa. From a cost perspective, biodiversity accounting is important because biodiversity exploitation is a major cost driver in South Africa. From an environmental perspective, biodiversity accounting is important because of the natural resources lost due to waste, pollution and over-exploitation impacts associated with biodiversity use.

Table 4.1 Drivers of the EEGECOST model.

Driver	Description
Improved environmental cost management	Improves identification, allocation, tracking and management of environmental costs in each business unit of a company.
Environmental policy contribution	To contribute effectively to development of environmental standards.
Quality improvement	To establish optimal levels for reducing emissions, effluents and wastes with consideration for least costs to society.
Sustainable development	Provides a transition medium to sustainable production.
Cost avoidance	Improves the ability of companies to anticipate future environmental liabilities and costs and to implement corrective actions earlier.
Revenue enhancement	To recognise revenue enhancement opportunities through either technology innovations or strategic waste reduction probabilities.
Improved decision making	Aids companies to better integrate environmental, social and economical decision analyses.
Public reporting and stakeholder interest	Improves reporting initiatives.
Retail and export implications	Assists company image reporting to establish continuing retail and export markets for products and services.

The model is unique in the sense that it is an innovative concept developed for the South African market. It can be applied over the whole spectrum of South African industries and for governmental decision making. The model is not bound for application in South Africa only, and with country specific requirements incorporated, can be used for corporate decision making in other countries as well.

4.3 DEVELOPMENT OF THE MODEL

The EEGECOST model was developed based on an holistic approach with simplistic operation, sufficient data input requirement, distinct cost allocation and output that will ensure usability for informed business decisions the main criteria. The following steps outline the methodology followed in development of the model:

1. reviewing the *status quo* of environmental accounting in South Africa and within the corporate environment,
2. extracting the benefits most appropriate to an environmental accounting model for South Africa, from systems currently available in the world market,
3. defining the drivers of environmental costs and revenues,
4. determining environmental costs and revenues most applicable to South Africa,
5. determining the definitions of all environmental accounting terms to be used in the model,
6. creating guidelines for the allocation of environmental costs and revenues whilst correctly accounting for these entities,
7. determining the criteria for reporting and risk value analysis,
8. verifying the model using pilot data,
9. making modifications to the model until appropriate output is delivered, and
10. launching the model for corporate assessment.

The model was further based on the notion that companies would undertake various aspects of environmental accounting in phases. For example, most companies will begin with environmental capital expenditure, then focus on operating environmental costs, followed by environmental liabilities and lastly evaluate less tangible and external environmental costs. Therefore, the model was developed to be systematic in its approach.

A final objective of the methodology was to provide the user with a comprehensive environmental accounting tool that is flexible. The user is able to tailor the model to meet specific product and project requirements based on company specific operations.

4.4 THE EEGECOST MODEL

The goal of the EEGECOST model is to provide accurate and comprehensive environmental cost information to enable better decisions on corporate issues that impact on both a company's financial status and the environment. The model is particularly valuable for management initiatives with a specific environmental focus, such as pollution prevention, environmental supply chain management, environmentally preferable purchasing and waste management systems. The EEGECOST model is based on environmental accounting systems and methodologies currently available in the world market. These include:

- activity based costing,
- life cycle assessment,
- full cost accounting,
- total cost assessment,
- energy and material tracking,
- life cycle costing,
- cost discounting, and
- capital budgeting.

With these systems and methodologies incorporated, the EEGECOST model has the objective to fully understand the cost significance of environmental and human health related decisions, activities and consequences over the whole life cycle of a product or process; at present and especially for the future. The model brings focus to costs frequently not considered in fiscal accounting systems, such as contingent risks, internal intangible costs and costs associated with external impacts. Table 4.2 summarises the main aspects of the EEGECOST model.

Table 4.2 Aspects of the EEGECOST model.

Aspect	Description
Objective	• to be a standalone corporate decision making tool, and • to incorporate all internal and external impacts associated with a company's production processes and operation.
Relevance	• comparison of alternative project or product considerations, • economic, environmental and social performance evaluations, and • design and capital budgeting decisions.
Costs considered	• whole range of internal and external costs.
Cost categories considered	• remediation costs, • current environmental and social impact costs, and • future impact costs.
Functions	• modification, optimisation or decommissioning of processes or products. • long-range strategic planning, and • economical, environmental and social impact assessments.

The model can be used to assist corporate decision making through stages in the accounting process that include:

- the identification of the most significant environmental consequences of a company's business operations,
- comparison of these consequences with a company's sustainability metrics,
- valuation of the environmental, social and economic impacts of these consequences,
- promotion of measures to bring these consequences into range of national and international legislative standards, and
- consequent estimation of a company's environmental and social sustainability costs and profits.

4.5 IMPLEMENTATION OF THE EEGECOST MODEL

The following guidelines can assist companies in implementing the EEGECOST model as part of their environmental management framework:

- Modify the current environmental management system and accounting framework to incorporate the EEGECOST model.
- Augment the current financial evaluation framework.
- Support a research programme and establish a research team to implement the model.
- Initiate a training programme to successfully operate the model.
- Identify data requirements for internal and external company costs as model input.
- Identify how the results of the model will be applied in the environmental management framework for informed business decisions.

Cross-functional teams consisting of designers, chemists, engineers, production managers, operators, accountants, environmental health and safety managers and business managers must accomplish implementation of the EEGECOST model. Because the structure of the model is not solely based on accounting issues and information will be distributed among all of these professions, internal corporate communication is vital for successful implementation of the model. The structure of the model is given in Figure 4.1. The model consists of five steps for analysis that includes:

- Compiling an *objective statement and scope of analysis*.
- The second step entails conducting the *life cycle assessment* of the process or product being analysed.
- The third step involves the *cost inventory* where environmental costs are recorded and allocated to cost types (see Section 4.8).
- After the costs have been processed in the cost inventory, an *impact assessment* is completed to identify the high impact cost types.
- The final step is that of *documenting the results* of the model for use by stakeholders, enabling informed business decisions.

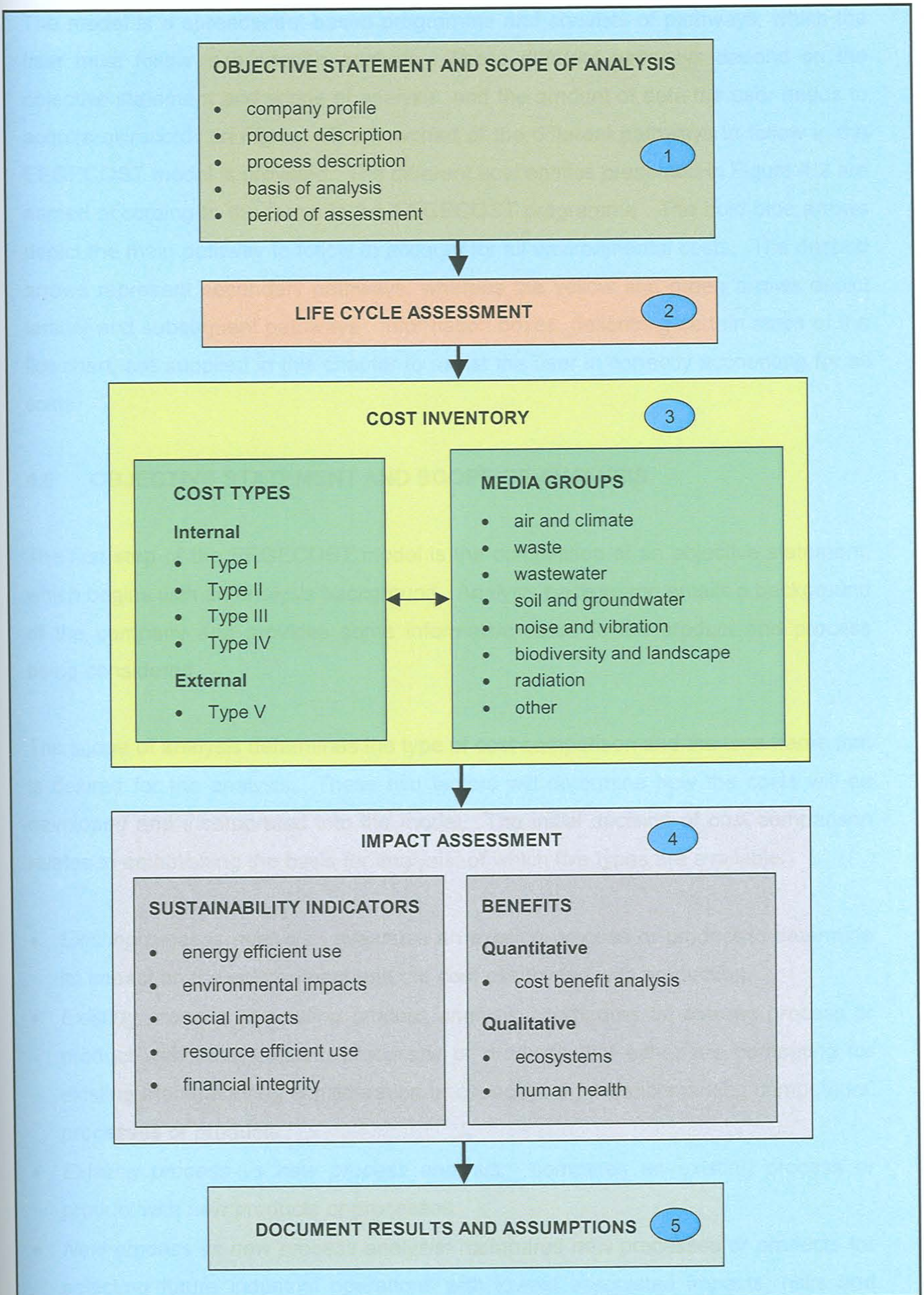

Figure 4.1 Structure of the EEGECOST model.

The model is a spreadsheet-based programme and consists of pathways, which the user must follow in a specific analysis. These different pathways depend on the objective statement and scope of analysis, and the amount of data the user needs to acquire or record. In Figure 4.2 a flowchart of the different pathways to follow in the EEGECOST model is provided. The different cost entities presented in Figure 4.2 are named according to the forms in the EEGECOST programme. The bold blue arrows depict the main pathway to follow to account for all environmental costs. The dashed arrows represent secondary pathways, whereas the yellow and green arrows depict tertiary and subsequent pathways. Information boxes, describing certain steps of the flowchart, are supplied in this chapter to assist the user in correctly accounting for all costs.

4.6 OBJECTIVE STATEMENT AND SCOPE OF ANALYSIS

The first step of the EEGECOST model is the compilation of an objective statement, which begins with an analysis background. Analysis background entails a background of the company and provides some informative value to the product and process being considered.

The scope of analysis determines the type of cost comparison and the time frame that is desired for the analysis. These two factors will determine how the costs will be developed and incorporated into the model. The initial decision of cost comparison relates to establishing the basis for analysis, of which five types are available:

- *Existing process analysis*: evaluates an existing process or product to determine its impact on the environment and the cost associated with production.
- *Existing process vs existing process analysis*: compares an existing process or product with other existing processes or products that either are competing for existing manufacturing consideration or capacity; or for benchmarking competitors' processes or products.
- *Existing process vs new process analysis*: compares an existing process or product with new products or processes.
- *New process vs new process analysis*: compares new processes or products for selecting future industrial operations with lowest associated impacts, risks and costs.
- *Capital budgeting analysis:* compares different investment alternatives.

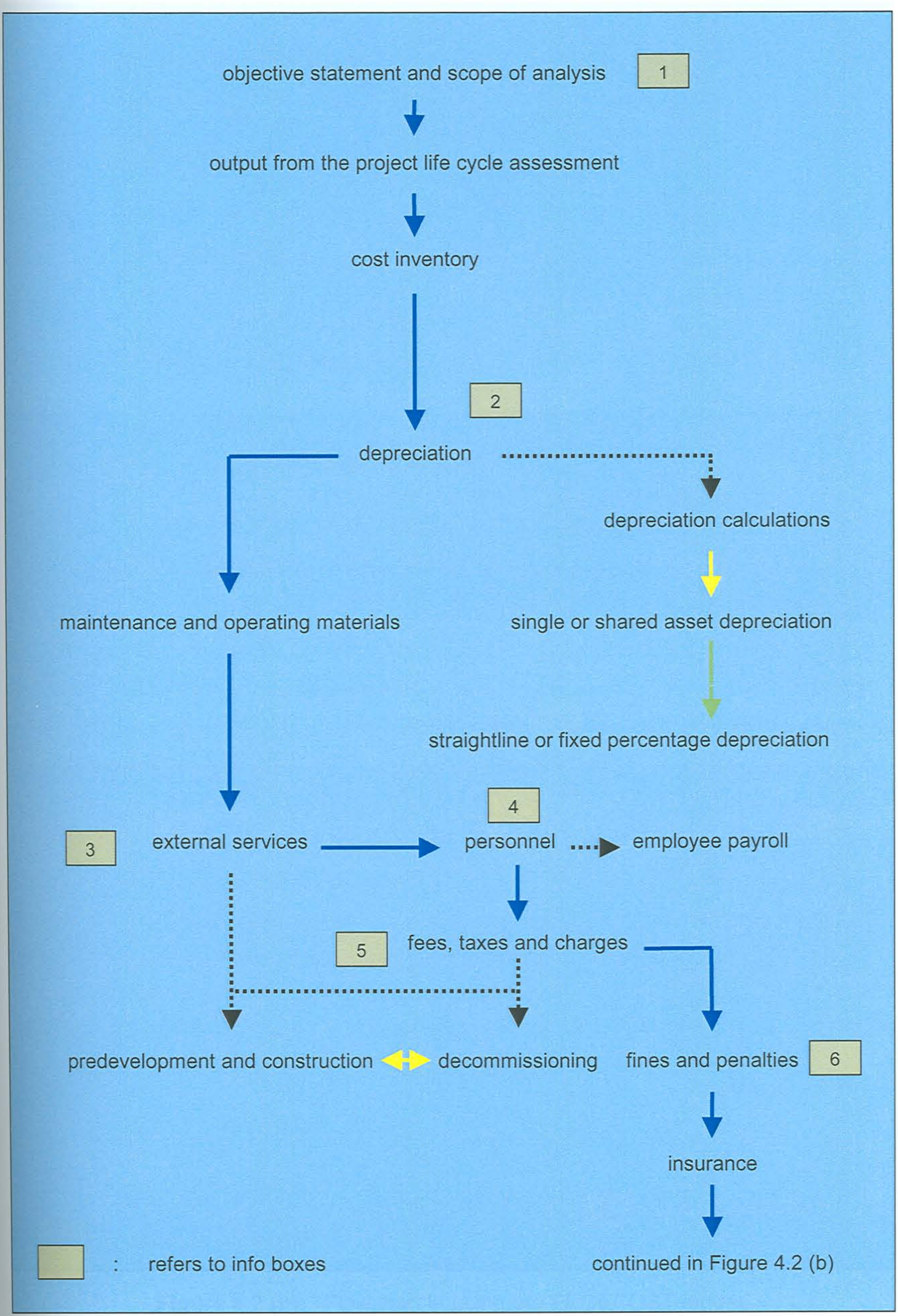

Figure 4.2 (a) Flowchart in using the EEGECOST model.

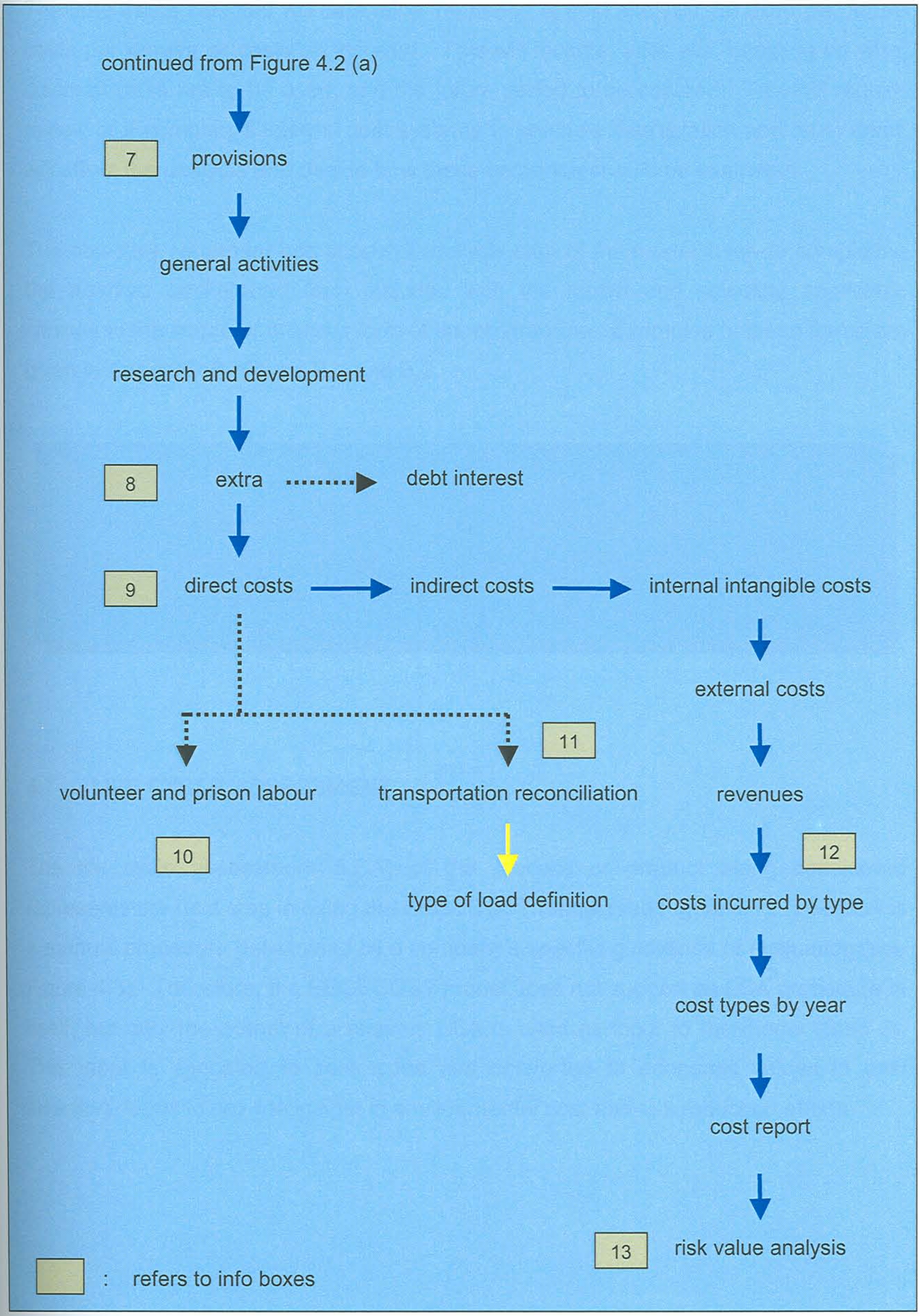

Figure 4.2 (b) Flowchart in using the EEGECOST model.

The time frame selected will determine the period of cost analysis, for example, future costs per annum or costs as incurred. This will include, *inter alia*, deciding on what discount rates are to be used, and the future period to be covered. This will require review of a company's internal cost systems to see how depreciation and other items will affect the analysis and decide how these decisions should be evaluated.

The objective statement and scope of analysis step of the model involves completing the *analysis background form* included with the model and selecting applicable choices in the *scope of analysis form* of the programme. Examples of these forms are given in Appendix B, Forms B.1 and B.2.

Info box 1

- In the *scope of analysis form*, make a selection for each decision in the form.
- Where two choices are accidentally selected for the same decision, only the first choice will be reported in the *cost report form* of the model.

4.7 LIFE CYCLE ASSESSMENT

The life cycle assessment (LCA) of the process or product being considered represents the next step in using the EEGECOST model (see Figure 4.1). The LCA is a manual procedure determined by a company's specific guidelines of evaluation (see Figure 4.3). Therefore, the EEGECOST model does not support an LCA procedure in itself, but only the output of a relevant LCA is used as input to the model (Step 3). This input is allocated to cost types and converted to economic values in *cost inventory forms* to provide insight in environmental cost and risk reduction efforts.

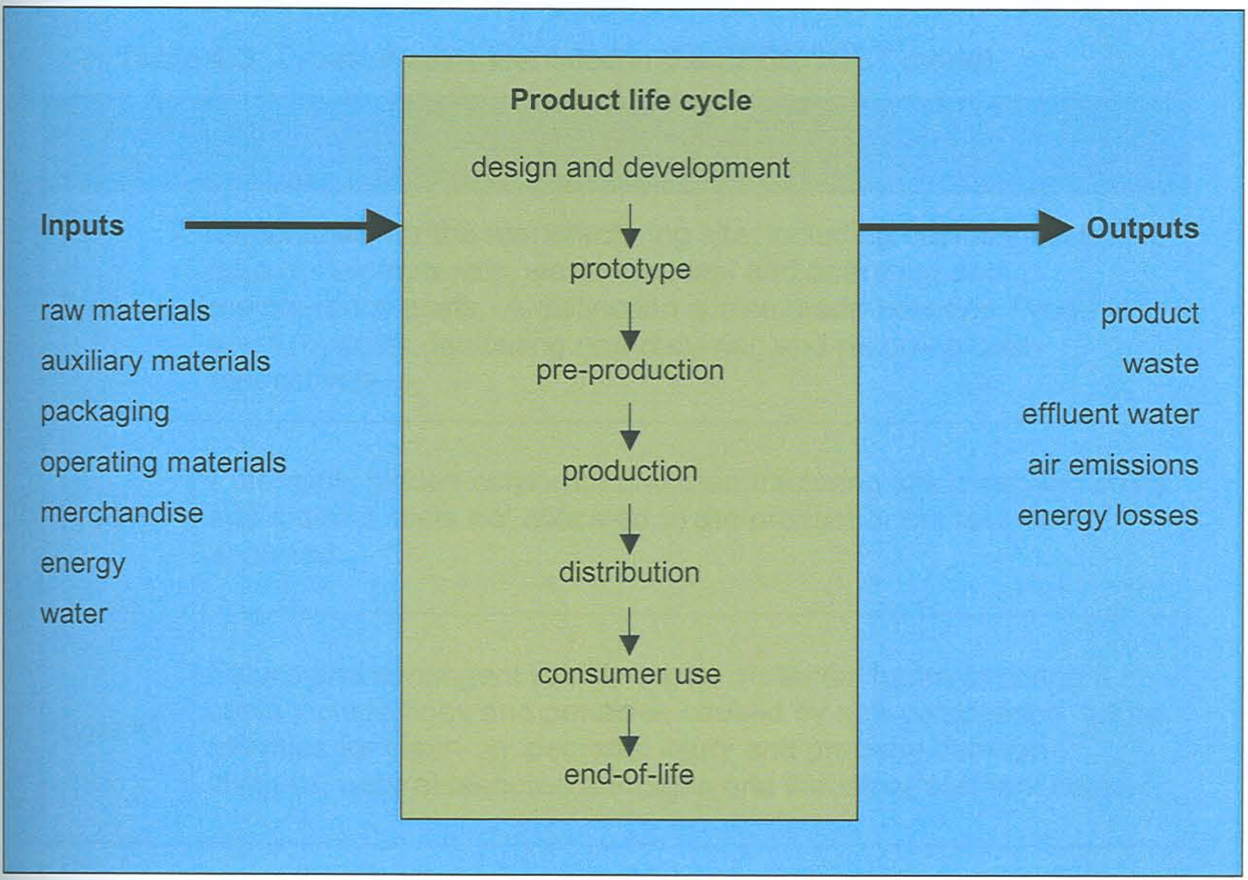

Figure 4.3 Product life cycle and material flows.

4.8 COST ALLOCATION TO COST TYPES

During the third step of the EEGECOST model, output from the LCA of the process or product analysed in Section 4.7 is allocated to cost types to be used in Section 4.10. The model allocates environmental costs to the following cost types:

- *Type I*: site costs,
- *Type II*: corporate costs,
- *Type III*: impact costs,
- *Type IV*: internal intangible costs, and
- *Type V*: external costs.

Full definitions of these costs are provided in Table 4.3. Some of the Types I and II costs can be allocated according to company determined regulations, whereas the model automatically allocates Types III to V costs.

Table 4.3 Types of costs identified in the EEGECOST model.

Type of cost	Cost definition
Type I	Direct costs for the manufacturing site, including capital investment, labour, raw materials, waste disposal and operating and maintenance costs. A distinction is also made between Type I (a) and I (b) costs, indicating non-recurring and recurring costs respectively.
Type II	Potentially hidden corporate and manufacturing site overhead costs and indirect costs not allocated to the product or process being analysed.
Type III	Future and contingent liability costs. Potential future contingent costs include fines and penalties caused by non-compliance, future liabilities for clean-up, personal injury and property damage lawsuits, natural resource damages and industrial accident costs.
Type IV	Present and future internal intangible costs. Costs that are paid by the company. Includes difficult to measure cost entities, including consumer acceptance, customer loyalty, worker morale, worker wellness, union relations, and corporate image and community relations.
Type V	Present and future external costs. Costs for which the company does not pay directly. Costs borne by society, including deterioration of the environment by pollutant dispersions that are currently in compliance with applicable regulations.

4.9 COST DISCOUNTING

Future costs are discounted to present values as part of the third step of the EEGECOST model. It is recommended that different discount rates be used for Types I to IV costs, internal to a company, and Type V costs, which are external to a company. Several groups suggest that a 3% discount rate is useful for Type V (external) costs, while others regard a zero or very low discount rate to be appropriate (Little, 2000). Another approach can involve escalating the Type V costs more aggressively than the other costs and using a common discount rate for the project.

From the *scope of analysis form* (Appendix B, Form B.2), a link directs the user to the *discount rates form* (Appendix B, Form B.3). Discount rates entered on this form are used for all possible future costs in Step 3 of the EEGECOST model, and discounted automatically for a period of up to 5 years.

4.10 ENVIRONMENTAL COST INVENTORY

After allocation to cost types, the output from the LCA of the process or product analysed in Section 4.7 is translated to an economic value. Economic values are calculated by recording/entering all relevant present and future environmental costs and revenues in *cost inventory forms*. These forms are categorised into the following environmental media groups:

- air and climate,
- waste,
- wastewater,
- soil and groundwater,
- noise and vibration,
- biodiversity and landscape,
- radiation, and
- other costs which do not fit into any of the above categories.

A *cost inventory form* for the air and climate media group is presented in Appendix B, Form B.4. These *cost inventory forms* are subdivided into environmental cost groups that include:

- treatment, operation and prevention,
- general and beyond, and
- environmental revenues.

The total cost of each group is added together to provide the total cost associated with an environmental media group.

4.11 TREATMENT, OPERATION AND PREVENTION

This environmental cost group addresses the treatment of wastes, pollution and hazard prevention procedures, and ordinary plant operation and production processes. The group is further subdivided into the following cost categories (see Appendix B, Form B.4):

- depreciation costs;
- costs for maintenance and operating materials;
- costs for external services;
- personnel costs;
- costs related to fees, taxes and charges;
- costs of fines and penalties;
- insurance cost; and
- cost of provisions for environmental management.

Each of these categories is accessed from the *cost inventory form* by selecting the relevant category from the link column (indicated by red buttons in the forms).

4.11.1 Depreciation of related assets

Depreciation is the process by which the price of acquiring an asset is systematically allocated as cost (that is, depreciation expense) over an asset's useful life. This cost category includes assets like, for example, collection containers, vehicles and air pollution control equipment. When this cost category is selected from the *cost inventory form*, the *depreciation form* is opened. The *depreciation form* for the air and climate media group is shown in Appendix B, Form B.5. An asset register is created in this form and the depreciation of each asset calculated by using *depreciation calculation forms*.

The model allocates depreciation costs as Type II costs and investments in environmental related assets can be calculated in terms of years, machine hours or machine mileage; using either of two methods:

- straightline depreciation, or
- fixed percentage depreciation.

For straightline depreciation a constant amount is depreciated for a certain number of years, machine hours or machine mileage. If, for example, the usable life of an investment is 10 years, then one tenth of the value of the capital investment is depreciated annually, or after a fixed number of machine hours or mileage. In the case of fixed percentage depreciation, a constant percentage of the net depreciable value of the capital investment is depreciated annually; or after a number of machine hours or mileage. Company regulations determine which method of depreciation is to be used.

The EEGECOST model also provides for two options in terms of allocating assets. In the first option depreciation is calculated for an asset related to only one environmental media group (EMG). By selecting the relevant link in the *depreciation form*, the *single asset depreciation forms,* B.6 and B.7 in Appendix B, can be used for straightline and/or fixed percentage depreciation calculations.

For assets shared between environmental media groups, for example a vehicle, depreciation is allocated as a percentage contribution to each relevant environmental media group in the *shared asset depreciation forms.* Examples of these forms are shown in Appendix B, for the *shared assets depreciation (straightline) form* (see Form B.8), the *percentage* (Form B.9) and *monetary* (Form B.10) *allocation forms* respectively. Forms B.6 to B.10, used for the actual depreciation calculations, are common to all environmental media.

Info box 2

- Assets are listed and numbered in the *depreciation form* of the model.
- Once the asset is identified and numbered, the depreciation calculations can be performed in the *depreciation calculation forms*. The asset number and all relevant information pertaining to the asset are entered in this form, in either the *straightline depreciation* or the *fixed percentage depreciation* sections, relevant to the applicable method of annual, hour or mileage depreciation to be used.
- The depreciation value will automatically be transferred to the *depreciation form* of the model.

In the case of assets shared between environmental media, for instance a vehicle, the *shared assets depreciation forms* must be used.

- A link from the *depreciation form* directs the user to the *shared assets depreciation forms.*
- Enter the asset number and description in either the *straightline depreciation* or the *fixed percentage depreciation* sections, relevant to the applicable method of annual, hour or mileage depreciation.
- Once identified, and the depreciation calculated, the depreciation value can be allocated as percentages in the *percentage allocation form* to the relevant environmental media groups. Enter the allocation to each environmental media group as a fraction. All fractions added must equal 1.
- The model automatically performs the monetary allocation to environmental media, with the depreciation value reported as a total per EMG.
- The depreciation value will automatically be transferred to the *depreciation form* of the model.

4.11.2 Maintenance and operating materials

The maintenance and operating materials link in the *cost inventory forms* directs the user to the *maintenance and operating materials form*. The air and climate form for maintenance and operating materials is given in Appendix B, Form B.11. The model allocates maintenance and operating materials costs as Type II costs.

Maintenance and operating materials are not part of the product, but are necessary for production and administrative processes. They may be used in laboratories or workshops and contain harmful and toxic substances, which often have to be disposed of separately as hazardous wastes. Cost drivers often include oils, lubricants, chemicals, paints, varnishes, diluting agents, glues and cleaning agents. Repair materials and spare parts are also normally recorded in this category.

Usually companies do not have separate accounts for maintenance and operating materials, with the costs of these materials disappearing into overhead accounts. It is therefore advised to record and classify, to the extent possible, at least those materials related to hazardous waste disposal and other waste flows.

4.11.3 External services

External service providers can be contracted for a variety of environmental management functions. Possible cost drivers may range from site construction to legal aid and functional management. All external services for environment-related consultations, training, inspections, audits and communication should be accounted for, and as far as possible, allocated to the relevant environmental media. An example of an *external services form* for the soil and groundwater media group is presented in Appendix B, Form B.12.

Although external services can be allocated to all the respective environmental media groups, only the *external services form* for soil and groundwater is shown as an example due to the site specific cost drivers *predevelopment and construction* and *decommissioning* contained in this form. External services can be contracted either for the complete development and decommissioning of sites, or for selective activities such as fencing of a site.

The *predevelopment and construction form* and the *decommissioning form* are given in Appendix B, Forms B.13 and B.14 respectively. A link from these forms directs the user to the *indirect costs form* (Form B.31 in Appendix B). Indirect costs that can be allocated to these site specific cost drivers in the *indirect costs form*, are automatically displayed in the *predevelopment and construction form* and the *decommissioning form* respectively.

External service costs can be allocated to Types I or II costs, using company defined criteria. External services costs would typically be allocated as Type I (a) costs for a new site developed, as these costs are not recurring in the near future. Where external services involve weekly maintenance of the site gardens, for example, these costs would be allocated as Type I (b) costs. External services would be allocated as Type II costs for the case where research and development, for instance, is contracted to another company.

Info box 3

- For selective services, enter the costs directly in the *external services form*.
- For the case where the whole development or decommissioning phases of a site are contracted to external services, enter the costs in the *predevelopment and construction* and *decommissioning forms* respectively.
- Indirect costs for predevelopment and construction and decommissioning are entered in the *indirect costs form* (Form B.31 in Appendix B).
- From the *predevelopment and construction* and *decommissioning forms*, the costs must be transferred to the *external services form*.

Both the *external services form* and the *fees, taxes and charges form* (see Appendix B, Form B.17) account for these site related costs in the soil and groundwater environmental media group. If these forms are required for external services, enter the number "1" in the *number of units* column in the external services form.

4.11.4 Personnel

This cost category accounts for all in-house personnel, ranging from operating personnel to management. The personnel link in the *cost inventory forms* directs the user to the *personnel form* (Form B.15, Appendix B). From the *personnel form* the *employee payroll form* (Form B.16) is accessed where all employee particulars are entered, from where only the contribution to media values of each employee is transferred to the *personnel form*. The model allocates personnel costs as Type II costs.

Info box 4

- Enter the employees' particulars in the *employee payroll form*, and allocate their relative media contributions as a factor.
- In the *personnel form*, enter the employee's number according to the number entered in the *employee payroll form*, in all of the environmental media groups the employee contributes to and according to his/her post description.
- The employee's salary, wage and overtime will automatically be displayed in this form.

4.11.5 Fees, taxes and charges

Fees and taxes may include cost drivers, for example, disposal and effluent fees, costs for specific licenses and environmental taxes and permit fees for air emissions and wastewater discharges. Charges are recorded as cost when another division, within the same company, for which charges must be paid, provides services. This may include, for example, maintenance services, waste management services or site development services. Appendix B, Form B.17, presents the *fees, taxes and charges form* for the soil and groundwater environmental media group. The user can allocate fees, taxes and charges costs to cost Types I or II, according to company definitions.

Although fees, taxes and charges can be allocated to all the respective environmental media groups, only the *fees, taxes and charges form* for soil and groundwater is shown as an example. (This is to illustrate the use of the site specific cost drivers, predevelopment and construction and decommissioning, contained in this form; see also Section 4.11.3).

Info box 5

- For selective services, enter the costs directly in the *fees, taxes and charges form*.
- For the case where the whole development or decommissioning phases of a site are contracted to another business unit, within the same company, enter the costs in the *predevelopment and construction* and *decommissioning forms* respectively (see Appendix B, Forms B.13 and B.14).
- From these forms, the costs must be transferred to the *fees, taxes and charges form*.
- Enter the number "1" in the *number of units* column in the *fees, taxes and charges form*.

It is also possible for a company to conduct its own site development or decommissioning activities. Should this be the situation, the same scenario prevails as if the activities were contracted to another business unit within the same group of companies, that is, as a charge (see Info box 5). It is important to account for all cost drivers relevant to these activities and allocate the costs to the appropriate cost categories in the *cost inventory forms*. These costs may include, for example, salaries or fines.

4.11.6 Fines and penalties

In cases of no compliance to environmental regulations, fines and penalties are charged. These may include cost drivers like illegal discharges to the environment, or releases to the environment above permitted quantities. Appendix B, Form B.18, presents an example of the *fines and penalties form* for the air and climate media group. Fines and penalties are allocated as Type III costs.

Future expense risk analysis scenarios, related to possible fines and penalties in the future, can be created in this instance to enhance project feasibility studies. Risk analysis scenarios are created in the *risk scenario form*, presented in Appendix B, Form B.19 as an example. These future risk scenarios are manually transferred to the *risk scenarios summary form*, given in Appendix B, Form B.20. These scenarios are incorporated into the model, in the *fines and penalties form*, for the number of years depicted in the *objective statement and scope of analysis forms* (see Appendix B, Forms B.1 and B.2).

In the *fines and penalties form*, the implication of an occurrence is entered to improve risk value analysis. The implication of occurrence refers to the effect of an impact on a company, related to an occurrence. This value is entered as a number between 1 and 5, based on the scale of impact determined by the user of the model. The value of the cost of the impact is then converted to a risk value and classified in a risk category. This is for purposes of risk analysis subsequent to cost accounting (see Section 4.15).

Info box 6

If the cost inventory is performed for costs already incurred, the exact expenses are entered in the *fines and penalties form*, without the creation of risk analysis scenarios:

- Complete the form with existing data.
- The costs will be reported in the *Year 1* column.
- Enter zero's in the *Year 2* to *Year 5* columns.

If future costs are predicted, enter the *implication of occurrence, probability of occurrence, number of incidents per year,* and the *cost per incident* in the columns provided in the *fines and penalties form*, from the *future risk scenarios summary form*.

- The weighted cost will be displayed.
- For each future year, a discounted value of the weighted cost will be displayed, except for the first year, as this value portrays exactly the weighted value of the cost.
- Where no expense is foreseen in a specific upcoming year, enter a zero in the form according to the specific year where no expense is predicted.
- If, for example, an expense is predicted only in the third year of analysis, then enter the number zero in the applicable space of the first and second years, as well as the fourth and final fifth year. Thus, only the year, in which the expense is predicted, must have a displayed value in the same row of the weighted cost.
- The model automatically assigns the cost to a risk category and risk value (see Section 4.15).

4.11.7 Insurance for environmental liability

Possible cost drivers could include the annual contributions to insurance against traditional damage to persons, goods and biodiversity caused by dangerous and potentially dangerous activities that should be recognised and accounted for in an accounting model. This cost category also includes insurance of transportation of hazardous materials. The insurance link in the *cost inventory forms* directs the user to the *insurance form* (see Appendix B, Form B.21). The model allocates these costs as Type II costs.

4.11.8 Provisions for environmental management

This form provides for cost drivers with possible future expenses related to, for example, remedial activities, equipment repairs and governmental and public hearings that can result due to the following accidental events:

- groundwater contamination,
- surface water contamination,
- air emissions due to breakdown of control equipment,
- radioactive emissions, and
- soil contamination.

Form B.22 in Appendix B is an example of the *provisions form* for the air and climate media group. Provisions are allocated as Type III costs. Risk analysis scenarios are performed in this form to account for possible future expenses. Forms B.19 and B.20 present the *risk scenarios forms* used to compile future expense risk scenarios.

Info box 7

- Risk analysis for provisions are compiled following the same algorithm as for possible future fines and penalties. Where no expense is foreseen in a given year, enter a zero in the form according to the specific year.

4.12 GENERAL AND BEYOND

General and beyond refers to costs impacting directly on the company as well as those costs (Types IV and V costs) considered beyond ordinary financial accounting costs (typically Types I and II costs). This environmental cost group includes the following cost categories (see Appendix B, Form B.4):

- general environmental management activities;
- research and development;
- extra expenditure for cleaner technologies;
- general direct costs;

- general indirect costs;
- internal intangible costs; and
- external costs.

4.12.1 General environmental management activities

This cost category includes general environmental management activities, not directly related to emissions management or the treatment of wastes. Work hours for training programmes, including travel expenses, discussion sessions of environmental management activities and projects, audits for compliance and external communication should be reported here and evaluated with the respective work hour costs. Form B.23 in Appendix B presents the *general activities form* for the air and climate media group, with examples of possible cost drivers. These costs can be allocated as either Type I and/or II costs.

4.12.2 Research and development

Research and development accounts for extra expenses related to internal environmental related research and development projects. These costs should be quoted separately from general environmental management activities, as their amounts can sometimes be substantial. The *research and development form* for research and development costs is presented in Appendix B, Form B.24. Examples of possible cost drivers for the air and climate and waste environmental media groups are also provided in From B.24.

Research and development costs can be allocated as Type I or II costs. These costs could be allocated, for example, as Type I (a) costs for new site development, Type I (b) costs for existing site upgrades and relevant research, and Type II costs for production research, process and system upgrades.

4.12.3 Extra expenditure for cleaner technologies

Extra expenditure for cleaner technologies includes cost drivers like, for example, integrated pollution prevention measures as part of the ordinary production process, and interest expense on debt related to sustainable environmental management.

Interest is the cost of renting money and therefore should be recognised as a cost over the benefiting period (that is, the period during which the debt is outstanding). For purposes of environmental accounting, care must be taken in calculating the effects of long-term debt. Principal repayments should not be considered a cost. The cost of the assets purchased or constructed with debt proceeds is accounted for through depreciation. However, the interest associated with debt issuances should be identified as a cost in an accounting model.

The *extra form* (Form B.25 in Appendix B) is accessed from the *cost inventory forms.* Selecting the link in the *extra form*, the *debt interest form* for debt interest calculations is opened (Appendix B, Form B.26). Extra expenditure for cleaner technologies is allocated as either Type I or II costs.

Info box 8

- Interest calculations are performed in the *debt interest form.*
- In this form, allocation to environmental media is requested.
- The results are automatically transferred to the *extra form.*

4.12.4 General direct costs

Direct costs represent direct capital outlay. The material purchase cost is the most important direct cost factor. Cost drivers could include:

- raw materials that constitute the major part of a product;
- auxiliary materials that become part of the product, but are not its main components for example, glue in a table or shoe;
- packaging that leaves the company with the product;
- energy that includes electrical energy purchased and fuels; and
- water that comprises the sum of all fresh water purchased or obtained from surface and groundwater sources.

Although direct costs can be allocated to all the respective environmental media groups, only the *direct cost form* of the other environmental media group is presented as an example (Form B.27 in Appendix B).

Direct costs can be allocated to either Type I or II costs, depending on company specific definitions.

Info box 9

- Enter the direct costs per unit in the *direct cost form* for each environmental media group respectively.
- Enter a number in the *number of units* column.
- The direct costs will automatically be displayed.

If the volunteer and prison labour link is selected in the *direct cost form,* the *volunteer and prison labour form* (Form B.28, Appendix B) is accessed. Some companies have the benefit of volunteer and prison labour in their operations. This labour is used by the production functions and its value should be costed during the periods that benefit from the labour as a direct cost. Volunteer and prison labour can be allocated as either Type I or II costs in the *direct cost form* of the other environmental media group.

Info box 10

- Enter the costs in the *volunteer and prison labour form*.
- Allocate the percentage contribution of the labour to the respective environmental media groups.
- The costs will be reported in the *direct cost form* in the other environmental media group for allocation to cost types (see Appendix B, Form B.27).
- The costs are automatically reported as *direct costs* in the *cost inventory forms* (see Appendix B, Form B.4).

From the *direct cost form* the transportation reconciliation link opens the *transportation reconciliation form* (Form B.29). From the *transportation reconciliation form,* selecting the type of load definition link will access the *type of load definition form* (Form B.30). A transportation register is structured in the *type of load definition form*. The total transportation cost value is reported as a direct cost in the *direct cost form*, from where the costs can be allocated as either Type I or II costs.

Info box 11

- Define the type of load in the *type of load definition form.*
- Enter the unit of load-measurement in the *unit* column of the *type of load definition form* using the pre-defined codes supplied in this form, that is, weight, volume or distance.
- Enter the cost per unit of each load in the *type of load definition form.*
- In the *transportation reconciliation form*, enter the freight details in the columns supplied.
- In the *type of load* column, enter the load number, according to the load number as defined in the *type of load definition form.*
- Enter the *number of units* being transported.
- The transportation costs are directly reported in the *direct cost form* of the other media group for cost allocation to cost types (see Appendix B, Form B.27).
- The costs are automatically reported as *direct costs* in the *cost inventory forms* (see Appendix B, Form B.4).

4.12.5 General indirect costs

Indirect costs are capital outlay over the whole spectrum of operations and environmental media, including cost drivers such as advertising and telephone costs. Unlike direct costs, only a portion of indirect costs is attributable to environmental management activities. The *indirect costs form* (Form B.31 in Appendix B), with examples of possible cost drivers, is accessed from *cost inventory forms.* In the *indirect costs form*, the respective budget sections are entered, from which the media allocations are calculated. The results of this form are automatically transferred to the *cost inventory forms.* The model allocates indirect costs as either Type I or Type II costs.

4.12.6 Internal intangible costs

This category can include cost drivers for annual environmental report costs, community relations activities, costs incurred voluntarily for environmental activities (such as tree planting), and costs incurred for pollution prevention award or recognition programmes. In addition, some costs are associated with subjective, though measurable perceptions of management, customers, employees, communities and regulators, including for example worker mortality and morbidity costs that are also regarded cost drivers of intangible costs.

Form B.32 in Appendix B presents the *internal intangible costs form* for the air and climate media group. Risk analysis scenarios can be created in the form to account for possible future costs. Where no expense is foreseen in a given year, enter a zero in the form according to the specific year. Internal intangible costs are allocated as Type IV costs.

4.12.7 External costs

This cost category includes costs of a company's impacts on the environment and society for which the business is not financially responsible. External costs must incorporate environmental and human health costs to the extent quantifiable. As for internal intangible costs, future risk analysis scenarios can be created in the form. Where no expense is foreseen in a given year, enter a zero in the form according to the specific year. Selecting the external costs link in the cost inventory forms opens the *external costs form*, portrayed in Appendix B, Form B.33 for all environmental media groups. Examples of possible cost drivers for all environmental media groups are also provided in Form B.33. External costs are allocated as Type V costs in the EEGECOST model.

4.13 ENVIRONMENTAL REVENUES

Environmental revenues include earnings from recycled materials and subsidies. Capital investments for environmental protection and projects for environmental management may enjoy subsidies, tax exemptions or other advantages. Subsidies, tax exemptions and non-fiscal advantages should be calculated when determining the cost savings arising from investments and projects and entered in the *subsidies, rewards and earnings form*, as they mean actual income.

Companies can also receive external awards for their activities. When the prize is money, the revenue should be recorded. Other possible earnings could, for example, derive from sharing the capacity of a wastewater treatment plant. The *subsidies, rewards and earnings form,* accessed from the *cost inventory forms,* for the air and climate environmental media group is presented in Appendix B, Form B.34.

4.14 CROSS-BALANCE AND REPORTING

As a consistency check and cross-balance, the *total expense* entry at the end of the *cost inventory forms* of the model must equal the *cost incurred by type* form's total presented in Appendix B, Form B.35. Equal, it means all costs incurred have successfully been allocated to cost types.

The final report can be compiled according to company specific regulations, incorporating the reported value/s as given in the *costs incurred by type form* (Form 35), the *cost types by year form* (Form 36) and the *cost report form* (Form B.37) of the model. In addition, some graphs were pre-developed for incorporation into reports. These are presented in the *cost report form* of the model and include:

- costs incurred by media,
- future costs by type,
- revenue received by media,
- costs incurred by type,
- interactive costs incurred by media graph, and
- interactive cost types by year graph.

Figures B.1 to B.3 in Appendix B present a pre-developed graph-set for *costs incurred by media,* based on hypothetical data, and subsequently an example of an interactive graph of *costs incurred by media*, based on hypothetical data.

Info box 12

- For an itemisation of costs incurred by type, that is, for the first accounting year only, the *costs incurred by type form* is referred to.
- The value of future costs is displayed in the *cost types by year form*. Should no future costs be foreseen, types I to V costs would automatically be reported as zero values in future years, from the relevant accounting forms of the model.
- The user has the option to choose a future year's cost display from the drop-down menu in the *cost types by year form*.
- When the all choice is selected from this drop-down menu, the costs displayed are the sum of the pre-calculated present values of all cost types over all years.
- In the *cost report form*, the scope of analysis will be displayed.
- The drop-down menu in this form can be utilised to reflect specific environmental expenditure relevant to environmental media groups.
- The drop-down menus in the *cost types by year form* and *cost report form* are tables preserving previously stored data. **Every time new data is read into the model, or if data is altered, the tables must be updated, otherwise distorted data will be presented in these tables.** To update these tables, right-click with the mouse button on any *total* value in the table, and choose the refresh option. The data will now reflect updated values.

4.15 RISK VALUE ANALYSIS

Risk value analysis enables informed business decisions regarding the priority of environmental and social impact cost reductions. The model assigns impacts to high, medium and low risk categories and couples a risk value to impacts. Risk values are determined by the magnitude of an impact based on three parameters; including the probability of occurrence, implication of occurrence and cost of the impact. The three risk parameters are interrelated and evaluated together. A high probability of an occurrence does not always mean the occurrence will have a significant implication on a company. Also, the high cost of an occurrence does not warrant a high value risk scenario, and has to be weighted together with the implication that the occurrence will have on a company and the probability of the occurrence taking place.

Probability of occurrence is designated to weigh less in risk value analysis as compared to the other two risk parameters. This decision is not biased and seems to be largely company specific. High probability of an occurrence taking place, for example, does not always render a risk high priority, given the other two risk parameters reflect insignificant contribution. Therefore, the user needs to weigh the parameters based on own experience and purpose of evaluation. The user has the ability to adjust the scale of magnitude and effect of these three parameters in the *risk value form* of the model, as presented in Appendix B, Form B.38. This form is accessed with the risk value link in the *cost report form*.

Based on the three risk parameters, all Types III to V costs are converted to risk values and classified by risk category in the respective accounting forms (see Appendix B, Form B.18 as an example of the fines and penalties form). These risks are sorted in a *management priority table.* This table summarises all risks by priority or importance of risk management based on risk value. Appendix B, Form B.39 presents the *management priority table* of the EEGECOST model.

Info box 13

- In the *risk value form*, define the scale of magnitude and effect of the three parameters probability, cost and implication.
- In the *provisions, fines and penalties, external costs* and *internal intangible costs forms*, the costs entered previously into these forms are displayed in terms of a risk value.
- For every risk an automatic number is assigned.
- In the *management priority table* of the *risk value form,* enter the number of every risk from the forms mentioned above.
- The risks will be displayed, sorted by category and risk value.
- In this table, the data can manually be sorted by priority, ranging from high priority, high risk value impacts to low priority, low risk value impacts.

4.16 CAPITAL BUDGETING

Apart from accounting for environmental costs and revenues, benefits of environmental investments can be determined in the *capital budgeting form* of the model. Capital budgeting improves the overall management and decision making process regarding environmental investments and helps to change the widely held perception that environmental investments only imply costs, with little or no financial returns. Capital budgeting for environmental investments will prove to companies that, through environmental cost savings, cost avoidance, revenues and liability reduction, significant financial benefits can accrue from investing in pollution reduction technologies and sound environmental management systems.

This form is accessed with the capital budgeting link in the *scope of analysis form.* The *capital budgeting form* is subdivided into an *investment database form* and a *net present value calculations form.* Examples of the *investment database form* (Form B.40) and the *net present value calculations form* (Form B.41) are presented in Appendix B.

The investments, and subsequent savings anticipated, are numbered in numerical order in the *investment database form*, after which only the investment number is entered in the *net present value calculations form.* The payback period in months will automatically be calculated and displayed. Calculation of the net present value (NPV) is somewhat of a trial-and-error approach. The internal rate of return (IRR) is entered as a fraction where after the NPV will be displayed. The NPV must be zeroed, by adjusting the IRR fraction.

4.17 MODEL COMPARISON

The EEGECOST model was developed using some of the finer qualities of other environmental accounting systems currently available in the world market. These systems mainly include the Full Cost Accounting (FCA) system, the Total Cost Assessment (TCA) environmental accounting system and the Activity Based Costing (ABC) life cycle costing system. This provides for a unique model that compares with the other systems, but delivers enhanced environmental accounting attributes.

Table 4.4 presents a comparison of the EEGECOST model with the models mentioned above. The model is unique in the sense that:

- the set of cost and benefit items included are diverse in nature,
- risk and uncertainty are dealt with in a systematic fashion,
- the model assists in quantifying items that are usually left un-quantified (intangibles and externalities), and
- traditional overhead items are assessed and allocated to specific cost drivers (a cost driver is the actual activity or reason for a cost to occur) of a project or process.

The benefits and disadvantages of the model itself are discussed in Section 4.18.

4.18 BENEFITS AND DISADVANTAGES OF THE MODEL

The EEGECOST model conforms to the collection, analysis, reporting and use of cost information for corporate decision making. The model especially focuses on cost information related to the environmental and social impacts of a company's operations. Table 4.5 summarises some of the direct benefits of the EEGECOST model. Another benefit of the EEGECOST model relates to cost allocation. The model allocates costs to environmental media and to types of costs. This allows companies to identify the high cost contributors of their operations to make informed business decisions regarding corrective or preventative measures. The model reports its output in graphs and tables for inclusion in management reports. Some of these graphs and tables are user interactive. This allows the user to make choices of the type of output that is needed for decision making with an immediate programme response.

Unique about the model is its cross-balance function, its risk value analysis function and the capital budgeting function. The cross-balance function is a consistency check to determine whether all costs incurred has been allocated to cost types. The user must be careful in allocating costs. Incorrect allocation of costs from environmental media to cost type will result in a distorted cross-balance between the total of costs incurred by environmental media and the total of costs incurred by type.

Table 4.4 Comparison of the EEGECOST model with existing models.

		Environmental Accounting Systems			
No	**Features**	**EEGECOST**	**TCA**	**FCA**	**ABC**
1	Objective	Stand-alone decision making tool	Incorporates all environmental and social impact costs	Analyses of costs related to public goods and services	Enhances decision making for cost reduction
2	Sustainability and eco-efficiency checklists	X	√	X	X
3	Costs considered				
3.1	Conventional costs	√	√	√	√
3.2	Hidden costs	√	√	√	√
3.3	Contingent costs	√	√	√	√
3.4	Image and relationship costs	√	√	X	X
3.5	Environmental degradation costs	√	√	√	√
3.6	Human impact costs	√	√	X	X
4	Cost breakdown structure	√	√	√	√
5	Cost allocation				
5.1	By cost type	√	√	X	X
5.2	By environmental media	√	X	√	X
6	Total cost determination	√	√	√	√
7	Cross balance and consistency check	√	X	X	X
8	Determination of high costs contributors	√	√	√	√
9	Pre-developed reporting aids	√	X	X	X
10	Risk value analysis	√	X	X	X
11	Capital budgeting feature	√	X	X	X
11	Primary limitation	LCA data and external cost estimation	**No defined method of valuing intangible and external costs and lack of actual input data**	Not a sole decision making system	Not a sole environmental accounting system

The risk value analysis function is a direct management benefit that allows for informed decision making regarding the priority of corporate environmental and social cost reductions. The model classifies risks by category and by risk value and sorts these risks in a management priority table. The table allows for easy reference regarding high priority impacts that need immediate corrective or preventative measures, to low priority impacts that can gradually be adjusted.

The purpose of the capital budgeting function is to report the payback period and calculate the internal rate of return on investments related to environmental management systems. Capital budgeting improves the overall management and decision making process regarding environmental investments and helps to change the widely held perception that environmental investments only imply costs, with little or no financial returns.

A shortcoming of the EEGECOST model is its lack of generating life cycle analysis (LCA) data. LCA data is used to create scenarios upon which an environmental accounting assessment can be performed. Since the EEGECOST model is a support tool for making informed decisions regarding environmental health and safety improvements, having a detailed understanding of the pollutants generated and the human health exposure effects for a product or process is essential. LCA data must be generated manually and then transferred to the model where they are translated to economic values. Generating these data manually can be cost and time intensive. However, as LCA data is company, product and project specific, intended users are advised to create their own specific data and incorporate it into the model.

Another disadvantage of the model is the creation and valuing of external impacts and costs. There are two main approaches currently being used by industry and governments to place monetary values on external impacts. These include (Society of Management Accountants of Canada, 1996): (1) the cost of control approach and (2) the damage function approach. The cost of control approach uses the cost of installing and operating environmental control techniques as a proxy of the monetary value of actual damages, whereas the damage function approach uses site-specific data and modeling techniques combined with economic methods to estimate external impacts and costs.

Table 4.5 Benefits of the EEGECOST model.

Feature	Benefit
Facility layout and location	The EEGECOST model can assist with facility layout and location decision making. Especially shipping costs have a definite influence in this decision.
Project alternatives	Output of the EEGECOST model can assist corporate decision making to select between project alternatives regarding pronounced economic, environmental and social corporate benefits and performance.
Product combination	The model can be beneficial regarding product combination selections. A company can use the output from the model to adjust their product combinations to maximise environmental and social performance whilst adhering to economic integrity and maximum profitability.
Product pricing	Output form the model can reflect the real production price of products to assist companies in making price adjustments.
Materials selection	Understanding the costs implication regarding hazardous materials, a company can use the output from the model to choose to purchase less hazardous input materials, and from companies that subscribe to sustainable environmental and social management principles.
Process adjustments	The EEGECOST model will highlight which manufacturing processes impact most on the environment and society. This will assist in decisions whether to modify current processes or to upgrade to new technologies.
Benchmarking	The model can assist benchmarking surveys regarding corporate economic, environmental and social performance.
Environmental standards	Integrated environmental management systems can benefit from the results of the EEGECOST model regarding, for instance, ISO 14001 certification.
Social impacts	A company's operational impacts on society directly reflect on company image. Understanding the cost implication of a negative societal company image can assist companies in making corrective decisions.
Logistics	Employing 'cradle-to-grave' sustainable environmental management implies that companies are aware of the products leaving the company boundary and the cost magnitude of the impact of these products on the environment and society. These products usually include packaging material, by-products and waste. The EEGECOST model can assist with determining the value of these impacts.
Training	Operational training is easier to motivate if the benefits of better environmental and societal management and awareness can be quantified.
Pollution management	A better understanding of the environmental cost structure of a company can lead to more informed decisions regarding pollution prevention expenditures and alternative waste handling opportunities.
Emission markets	The EEGECOST model will highlight cost reductions of better pollution management systems. It also assists with establishing the value of emission rights.

The model does not advocate which approach to use. This can lead to inconsistent results obtained by different users within the same company and working on the same project. However, the objective of the EEGECOST model does not require absolute or complete valuing of external impacts. The model has its purpose to provide information necessary for informed business decisions and to amend processes and products with costly environmental and social impacts. Therefore, whilst it is acknowledged that a model is only as good as its inputs and uniform quantification of external costs is desirable where possible, the success of environmental accounting lies in the ability to consider all environmental and social impacts in planning and decision making, whether or not impacts can always be quantified consistently.

CHAPTER 5

Case study

5.1 INTRODUCTION

The application of the EEGECOST environmental accounting model was tested in a case study conducted at the cigarette manufacturing facility of British American Tobacco Manufacturers; situated in Heidelberg, South Africa.

5.2 BACKGROUND TO CASE STUDY

5.2.1 Company profile

British American Tobacco Manufacturers (BATM) Heidelberg is a wholly owned subsidiary of British American Tobacco South Africa (BATSA). BATSA currently has an approximate 93% share of the domestic market with the Heidelberg factory manufacturing approximately 20 billion cigarettes per annum (British American Tobacco, 2002). The personnel complement at the Heidelberg site is approximately 750 persons consisting of process and machine operators, technical support artisans and technicians, administrative staff and the factory management team (British American Tobacco, 2003).

5.2.2 Product description

Notwithstanding variants introduced to provide a differentiated product range for a discerning consumer market, a typical filter cigarette is made up of components as illustrated in Figure 5.1 (Brown and Williamson, 2003).

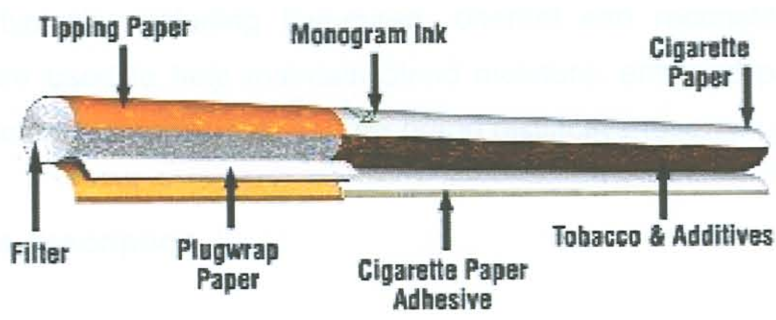

Figure 5.1 A typical filter cigarette.

A brief explanation of these components is given below:

- *Tipping paper*: The outer paper that wraps around the filter rod and is used to attach the filter rod to the tobacco section. Suppliers apply colourants and coatings (for example, lip release agents) via gravure printing to the paper. Various backgrounds, lines and logos may be incorporated into the tipping design.
- *Monogram ink*: A small amount of ink may be applied to the cigarette paper via a letterpress operation to provide a distinctive brand mark to the product.
- *Cigarette paper*: The tobacco section of the cigarette is enclosed with a strong lightweight paper made from flax or other cellulose fiber. Cigarette paper usually contains fillers and other additives to provide whiteness, improve ash appearance and assure burn uniformity.
- *Cigarette paper adhesive*: Also known as seam adhesive, this is used to secure the cigarette paper around the tobacco section.
- *Plug wrap paper and filter rod*: The filter rod is the major component of the filter section of a cigarette. Most conventional filter rods are comprised of four components – filter tow, plasticiser, plug wrap paper and adhesive. Filter tow is a band of cellulose acetate fibers that are bundled together into a cylindrical shape to form a filter after application of a plasticiser. The plasticiser helps provide acceptable filter firmness by bonding the fibers to each other. The plug wrap holds the shape of the filter rod while the plasticiser hardens the filter. The plug wrap is attached to the rod by a thin line of adhesive.

- *Tobacco and additives*: The tobacco is comprised of a blend of many different tobaccos, typically including flue-cured, oriental and reconstituted tobaccos. Additives are used to help maintain blend moisture, enhance pack aroma and taste character, and provide flavour for brand distinctiveness.

5.2.3 Process description

The broader manufacturing process is depicted in the flow chart contained in Figure 5.2. The core cigarette production process begins with the primary processing, cutting and blending of pre-threshed tobacco leaf and stem. Thereafter the cigarettes are manufactured and packed on high speed manufacturing and packing machines and transferred to the bonded dispatch stores in cases of 8 000 and 10 000 cigarettes.

Ancillary manufacturing processes include the making of filter rods, metallised paper, and Laube boxes for one of the three packaging variants, which consist of soft-packs, hinged-lid packs and Laube boxes. Utilities supporting the manufacturing process include electricity supply at 11kV, steam from four John Thompson Afripac coal-fired boilers, compressed air at 6 bar, chilled water from the refrigeration plant for air conditioning in all production areas and process water supplied by the local municipal authority (Buissine, 2003).

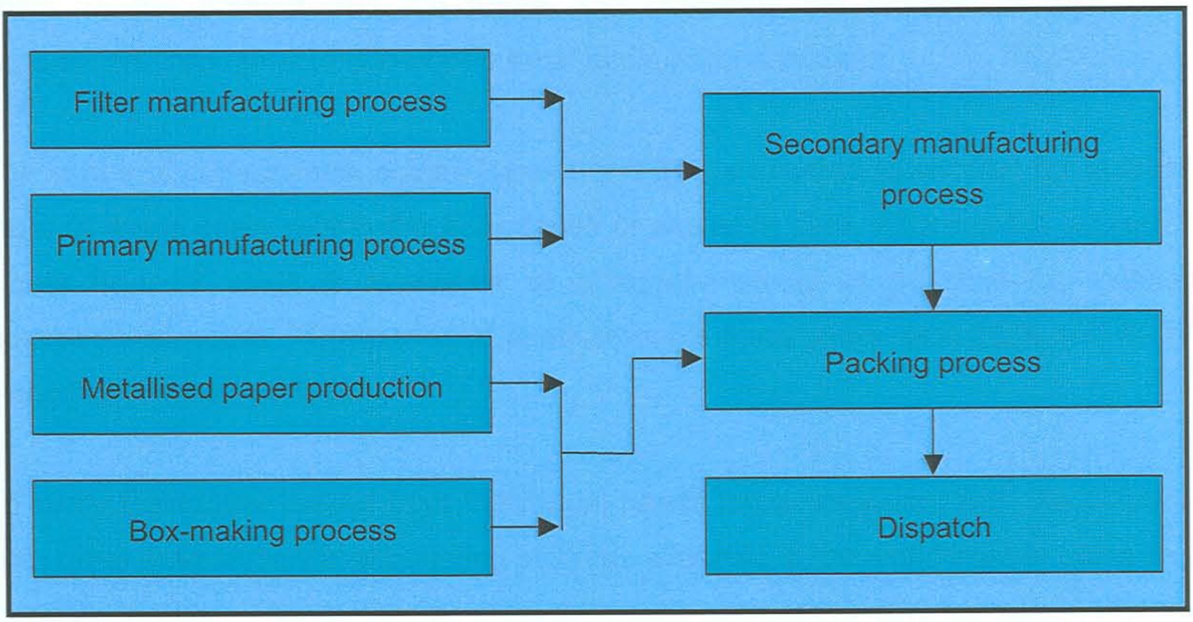

Figure 5.2 The core cigarette production process.

5.2.4 Objective statement and scope of analysis

The objective of the case study is to demonstrate the application of the EEGECOST model in obtaining a more comprehensive picture of environmental cost accounting than that presented by traditional financial accounting methods, for both current and future activities, as well as identifying impacts and prioritising interventions and corrective actions that will result in overall environmental performance improvement. The results of the case study will be used to verify the model.

This will be done by first determining the present production costs based on a production volume of 1 million cigarettes. These costs (Types I and II) are only partially categorised for conventional fiscal accounting purposes and do not incorporate less tangible costs, future costs and costs external to the company (Types III to V costs). Then, after incorporation of Types III to V costs in the EEGECOST model, with costs being properly allocated to cost types, a better representation can be created of the highest cost contributors of the manufacturing process. These costs are based on future costs and risk scenarios. These costs are prioritised to assist decision making regarding interventions and corrective actions.

Then, after prioritisation of the highest cost contributors and implementation of possible interventions and corrective actions, the model will be amended with the newly acquired data incorporated, to prove the effect of accounting for all types of costs, in the present and the future and mitigating the impacts of high cost contributors through sound environmental accounting principles.

The scope of conventional costs (Types I and II) is evaluated to account for at least most of these costs, within the boundaries of available data, whereas the scope of Types III to V costs is evaluated as comprehensively as possible for reliable illustration purposes. The period of assessment is three years, with 2004 and 2005 being the forecast periods.

To verify the model, output from the model needs to be compared with the outputs from other environmental accounting systems available in the world market using the same input data. The verification protocol entails comparable and consistent results that support the objective of the model based on a diverse range of input data.

5.3 LIFE CYCLE ASSESSMENT OF THE PRODUCTION PROCESS

The life cycle assessment (LCA) of the cigarette manufacturing process was based on the actual performance data collected during the 2003 financial year from January to December 2003. The LCA of the cigarette production process reveals the environmental resources used for the production of a functional unit of cigarettes and its accompanying emissions to air, effluents to water and wastes to landfill and hazardous waste treatment sites. The functional unit is one million cigarettes. For purposes of this life cycle assessment, outputs to the environment due to consumption of the product are not considered. Also, the assessment only considers the life cycle of the cigarette production process within the boundaries of the site, with the exemption of transportation, freight and air travel; which are included in the LCA due to contributive fuel consumption and related air emissions. Therefore, tobacco agriculture and related inputs and outputs were excluded. Table 5.1 is a summary of the LCA for the cigarette production process. Appendix C, Table C.1 presents the comprehensive LCA of the cigarette production process (Buissine, 2003).

Table 5.1 LCA for the cigarette production process.[1]

Functional unit					
One million cigarettes					
Input	**Unit**	**No. of units**	**Output**	**Unit**	**No. of units**
Energy	GJ	25,20	Air emissions	ton CO_2 eq	2,59
Water	kl	14,22	Wastewater	kl	8,25
			Total dissolved solids	kg	1,62
			Chlorine	kg	0,25
			Total waste[2]	kg	78,20

Notes

1 Data from Buissine (2003).

2 Total waste includes the following:

a) Waste to landfill, which is mixed non-hazardous waste.
b) Waste for recycling (off-site), which includes paper, card, metal and tobacco fines.
c) Hazardous waste for removal, which includes oil, glue and plastic.

5.4 COST ALLOCATION AND ENVIRONMENTAL COST INVENTORY

5.4.1 Actual expenditure (2003)

Table 5.2 reflects the actual expenditure for 2003, categorised in terms of the various cost types presented in the model and based on a functional unit of 1 million cigarettes (Buissine, 2003).

Table 5.2 Conventional costs measured by the company.

Conventional costs	Cost per functional unit	Type of cost
Remuneration	R 6 206,61	Type II
Maintenance	R 1 823,71	Type II
Depreciation	R 1 347,27	Type II
Utilities	R 783,30	Type II
Rentals	R 69,69	Type II
Environmental health and safety	R 119,23	Type II
Meals and refreshments	R 28,24	Type II
Recruitment costs	R 11,78	Type I
Service contracts	R 191,60	Type I
Traveling	R 28,70	Type II
Communications	R 35,06	Type II
Training	R 51,39	Type I
Insurance	R 249,49	Type II
Vehicles	R 65,05	Type II
Other	R 77,80	Types I and II
Total	**R 11 088,92**	

5.4.2 Environmental cost inventory and impact assessment (2003)

Table 5.3 shows the consolidated results for the period including impact costs arising out of the manufacturing activities not included in the traditional financial accounting data. At present, the company does not measure and report Type III to V costs, nor are these costs included into the corporate decision making process.

Table 5.3 Results of the impact assessment for 2003.

Cost type	2003
Type I (a)	R 232,64
Type I (b)	R 31,04
Type II	R 10 825,25
Type III	R 0,00
Type IV	R 0,00
Type V	R 0,00
Totals	**R 11 088,92**

5.4.3 Preliminary environmental cost inventory (forecast for 2004-2005)

5.4.3.1 Scenarios

Although not exhaustive, a number of likely scenarios were identified to illustrate the application of the model to future business periods. These scenarios are summarised in Appendix D, Form D.1. Appendix D, Forms D.2 to D.8 presents the detail pertaining to the future expense risk scenario summary form.

5.4.3.2 Preliminary cost inventory and impact assessment

The scenarios presented in Appendix D, Form D.1, resulted in the preliminary cost inventory and impact assessment as contained in Table 5.4, sorted in order of overall significance for 2004 and 2005 in Tables 5.5 and 5.6 respectively.

Table 5.4 Results of the cost inventory for 2004 and 2005.

Cost type	2004	2005
Type I (a)	R 233,21	R 233,79
Type I (b)	R 69,03	R 70,92
Type II	R 10 825,25	R 10 863,23
Type III	R 16,94	R 10,81
Type IV	R 9,38	R 14,75
Type V	R 502,91	R 1 025,36
Totals	**R 11 656,72**	**R 12 218,86**

Table 5.5 Results of the impact assessment for 2004.

Risk no	Description	Cost	Cost type	Risk category	Risk value
7	Global warming effect	R 502,91	V	H	37
2	Cost effect of AIDS	R 2,68	VI	M	30
5	Electricity supply interruption	R 16,88	III	M	28
6	Noise and odour pollution	R 6,70	VI	M	26
3	Increasing draw on COID fund	R 0,07	III	L	13

Table 5.6 Results of the impact assessment for 2005.

Risk no	Description	Cost	Cost type	Risk category	Risk value
7	Global warming	R 1 025,36	V	H	39
2	Cost of AIDS	R 4,78	VI	M	30
6	Noise and pollution complaints	R 9,96	VI	M	28
5	Electricity supply interruption	R 10,76	III	M	23
3	Increasing draw on COID fund	R 0,05	III	L	11

5.4.3.3 Preliminary budget expenditure

The anticipated fiscal requirements in terms of budget expenditure for the scenarios presented in Appendix D are reflected in Table 5.7.

Table 5.7 Fiscal requirements for 2004 and 2005.

Cost type	2004	2005
Type I (a)	R 233,21	R 233,79
Type I (b)	R 69,03	R 70,92
Type II	R 10 825,25	R 10 863,23
Totals	**R 11 127,49**	**R 11 167,94**

5.4.4 Amended environmental cost inventory (forecast for 2004-2005)

5.4.4.1 Interventions and corrective actions

Possible interventions and corrective actions aimed at delivering a more acceptable situation with respect to environmental impacts and costs were identified as listed in Appendix E, Forms E.2 to E.8. Form E.1 of Appendix E presents a summary of the amended expenditures for 2004 and 2005, resulting from these interventions and corrective actions.

5.4.4.2 Amended environmental cost Inventory and impact assessment

The amended cost inventory and impact assessment that is expected to result from the successful execution and implementation of the interventions and corrective actions are reflected in Tables 5.8, 5.9 and 5.10 respectively.

Table 5.8 Results of the amended cost inventory for 2004 and 2005.

Cost type	2004	2005
Type I (a)	R 233,58	R 233,03
Type I (b)	R 69,78	R 49,21
Type II	R 10 832,10	R 10 870,10
Type III	R 16,94	R 10,81
Type IV	R 8,04	R 5,18
Type V	R 502,91	R 99,37
Totals	**R 11 663,35**	**R 11 267,70**

Table 5.9 Results of the amended impact assessment for 2004.

Risk no	Description	Cost	Cost type	Risk category	Risk value
7	Global warming	R 502,91	V	H	37
2	Cost of AIDS	R 1,34	VI	M	28
5	Electricity supply interruption	R 16,88	III	M	28
6	Noise and pollution complaints	R 6,70	VI	M	26
3	Increasing draw on COID fund	R 0,07	III	L	13

Table 5.10 Results of the amended impact assessment for 2005.

Risk no	Description	Cost	Cost type	Risk category	Risk value
2	Cost of AIDS	R 1,20	VI	M	24
5	Electricity supply interruption	R 10,76	III	M	23
7	Global warming	R 99,37	V	M	20
6	Noise and pollution complaints	R 3,99	VI	M	19
3	Increasing draw on COID fund	R 0,05	III	L	11

5.4.4.3 *Amended budget expenditure*

The anticipated fiscal requirements in terms of budget expenditure incorporating the execution and implementation of the identified interventions and corrective actions are reflected in Table 5.11.

Table 5.11 Amended fiscal requirements for 2004 and 2005.

Cost type	2004	2005
Type I (a)	R 233,58	R 233,03
Type I (b)	R 69,78	R 49,21
Type II	R 10 832,10	R 10 870,10
Totals	**R 11 135,46**	**R 11 152,34**

5.5 DOCUMENTATION OF RESULTS

The costs developed in the risk scenarios given in Appendix D were calculated to a total present value cost based on the production of 1 million cigarettes over a two-year evaluation period. Types I to IV costs were discounted to present day using a 12% discount rate, while Type V costs were discounted with a 3% discount rate. The choice of discount rate here is purely arbitrary and is not intended to imply any statement on the appropriateness of either value.

Table 5.3 presents conventional costs measured by the company. Comparing the total expenditure value of this table, with the total expenditure values for 2004 and 2005, as presented in Table 5.4, it becomes evident the impact that Types III to V costs have on a company's financial status. These costs can, in effect, increase expenditures per annum up to 10%, depending on the individual cost magnitudes contributing to the total expense value of every individual year. Therefore, knowledge of the impact of possible future risk and cost scenarios, to identify high cost contributors, can assist the process of identifying interventions and corrective actions.

The effect of no intervention and corrective actions for high contributing environmental impacts and costs is reflected in Table 5.4. The total expense value of 2005 is 4,6% more than the 2004 value. Should corrective actions not be employed, this financial effect can have a cumulative negative impact on a company's financial status in future years.

Table 5.8 shows the effect of interventions and corrective actions. The total expenditure value for 2004 is higher than without interventions and corrective actions. However, the 2005 total expenditure value is significantly lower (see Table 5.4). Implementing interventions and corrective actions seemingly result in higher capital expense. This is evident from the results of Tables 5.7 and 5.11 that indicate increased budget expenditure as compared with the total expense value of 2003.

The positive effect of these interventions and corrective actions, however, is displayed through a lowered total expense value of Types III to V. Figure 5.3 shows the preliminary expenditures of 2005 without interventions and corrective actions. Comparing this figure with Figure 5.4, which displays the amended 2005 expenditures with interventions and corrective actions incorporated, the difference is distinct. Without interventions and corrective actions, Types III to V costs contribute 8% of expenditure per functional unit, whereas implemented, this contribution decreases to only 1%.

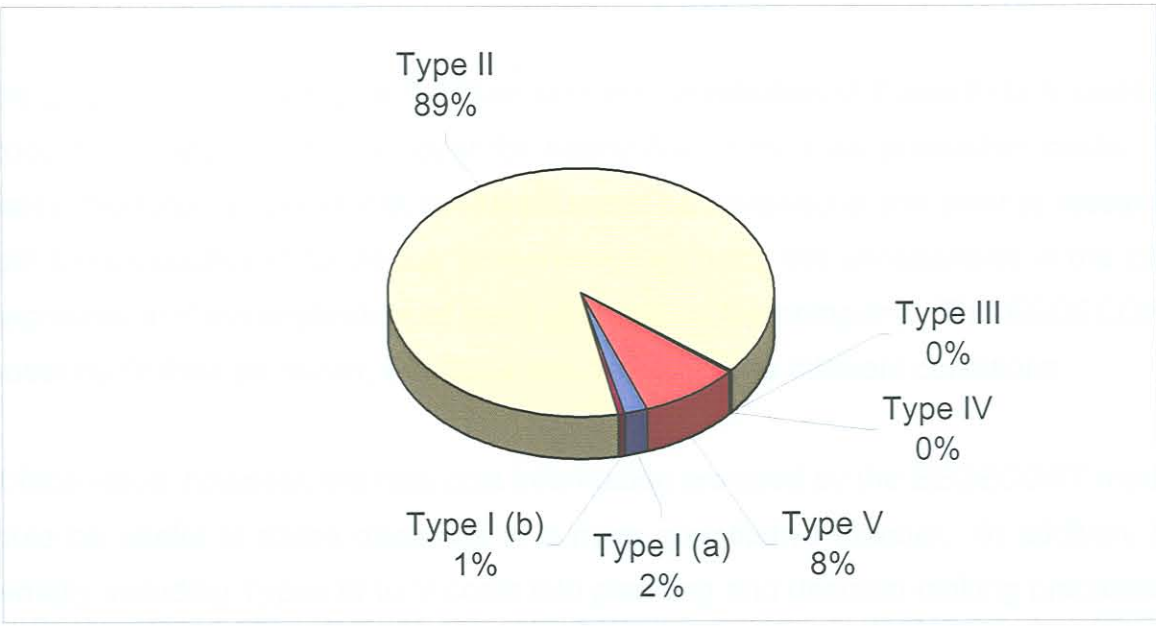

Figure 5.3 Preliminary expenditure for 2005.

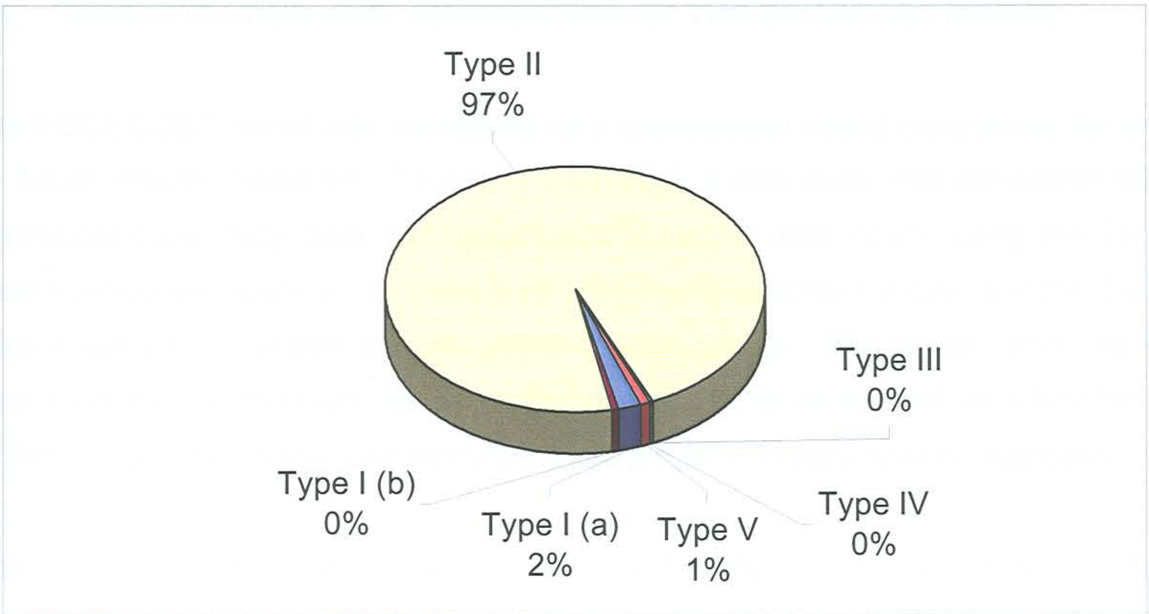

Figure 5.4 Amended expenditure for 2005.

Notwithstanding financial benefits, implementing interventions and corrective actions also decreases the risk significance of future expenditures. Table 5.6 presents the management priority table of 2005. With interventions and corrective actions implemented, the overall risk priority changes, whereas the overall trend in risk values is a decrease from the preliminary expenditure scenarios to the amended expenditure scenarios. Table 5.10 presents the amended management priority table for 2005, based on the amended expenditures scenarios with interventions and corrective actions implemented.

The graph depicted in Figure 5.3 illustrates the contribution of Types III to V costs to production costs that can account for nearly 8% of the total production costs. In reality, the future expense risk scenarios would be reviewed at this point to reassess both the probability of future risk scenario occurrences, the uncertainties in the cost magnitude and the implication of each scenario on the company. The EEGECOST model could then be re-run, with the application of these different conditions.

At face value, however, the new cost information provided by the EEGECOST model could be useful to frame decisions in a more quantitative manner. In addition, by formally including Types III to V costs into planning and decision making processes, improved management and communication of risks can result. Feedback from BATM on the use and observation of the EEGECOST model is given in Appendix F.

5.6 QUALIFICATION AND VERIFICATION OF THE EEGECOST MODEL

The EEGECOST model was developed as a spreadsheet based programme for use by South African industries. To qualify the model, a pilot study was conducted with theoretical case study data and hypothetical industrial data inputs, using the Total Cost Assessment system. Outputs from both the EEGECOST model and the Total Cost Assessment system are presented in Appendix G. The EEGECOST model was adjusted and finalised, based on the pilot study, to be applied as a functional tool for corporate use that can easily be improved for company specific purposes.

Then, to verify the model as a sole decision making tool for corporate use, the results of the model, based on the case study results from BATM, were weighted against the objective of the model as being compared to the objectives of the Total Cost Assessment (TCA) and the Full Cost Accounting (FCA) systems with the same case study inputs (see Table 5.12).

Verifying the model, it became clear that the model has some shortcomings and that the model is only as good as its data input. However, the process also revealed the direct corporate benefits achievable when implementing the model. The results from the verification process highlighted the benefits of the EEGECOST model through:

- the value added to corporate decision making as compared to no model,
- the ability of the model to withstand corporate application,
- the usability and credibility of the model, and
- the ability of the model to be consistent with its results as being compared to the objective of the model.

Table 5.12 Comparison of the EEGECOST model with the TCA and FCA systems.

Values	EEGECOST model	TCA	FCA
Objective	To be a standalone decision making tool	To incorporate all environmental and social impact costs	To analyse costs related to public goods and services
Cost allocation to type	√	√	X
Cost allocation to environmental media	√	X	√
Future risk assessment	√	√	X
Risk valuation	√	X	X
Iterative operation	√	√	X
Reporting support	√	X	X

CHAPTER 6

Conclusions and recommendations

Environmental accounting is a best practices technique for improved corporate management and reporting, however, the current application of environmental accounting in South Africa remains at low levels. This is primarily due to the lack of available and adequate South African environmental accounting systems and environmental impact data, together with the requisite of awareness regarding legal requirements and the need of enforcement of applicable regulations in general. The following are concluded about environmental accounting in South Africa:

- Environmental accounting is currently not being practiced in South African industries as a standalone decision making tool although the principles of environmental accounting are incorporated in some industries' overall environmental management and fiscal accounting systems.
- Environmental accounting must be implemented in South Africa to promote the integration of environmental and business best practices in the South African context of sustainable environmental management and business development. This is necessary to demonstrate the benefits of understanding the environmental impacts and costs associated with business activities and the potential for reductions in future environmental and social risks and liabilities.
- Valuing internal and external costs highlights those business activities where it is possible to exert most influence and obtain positive results for enhanced environmental and social best practices. There are many environmental, economic and competitive benefits that will be realised by those companies that explicitly value these costs in monetary terms. However, environmental accounting does not focus explicitly on exact values of external costs, but rather use relative costs to measure performance and highlight cost and risk reduction potential.
- Developing and implementing environmental accounting involves a gradual process of extensive data collection because the process of identifying and quantifying environmental and social impacts is so data intensive.

- The process of changing corporate culture and attitude is important to foster support and commitment to implementing environmental accounting in South Africa. The challenge here is especially to develop an appreciation for the benefits obtainable by implementing environmental accounting for informed business decisions.

The EEGECOST model was developed to promote environmental accounting in South Africa. The model has two functions; an accounting function, using a cost inventory to allocate environmental costs to specific cost types and cost drivers for informed business decisions and risk analyses; and a capital budgeting function, for investment appraisal. The EEGECOST model allocates environmental costs to Types I to V costs, categorised in environmental media groups. Within the environmental media groups, these costs are further allocated to specific cost drivers that cause the costs. Therefore, no costs are simply allocated to overhead accounts, which is usually the shortcoming of traditional fiscal accounting systems. Possible future risk and cost scenarios can be created in the model for up to four years. These future risks/costs are discounted to present values to create a basis for comparison between different years and for effortless risk valuation and analyses. The results of the EEGECOST model are summarised in report forms. These forms contain interactive graphs and tables for easy inclusion in management reports and presentations. The capital budgeting function of the model can calculate return on investment periods and internal rates of return on investments.

The EEGECOST model was used in a case study, based on the life cycle assessment of the cigarette production process. The case study has illustrated both the application of the model in providing a more complete picture of environmental costs and liabilities, and by including a routine that allows automatic ordering of defined future risks and costs according to user selected probability and consequence parameters, its use as a management decision making tool.

The case study proved the importance of accounting for all environmental costs, both internal as well as external and allocating these costs to cost types and cost drivers in a structured environmental accounting model. The case study revealed that Types III to V costs, usually not considered in traditional fiscal accounting systems, can contribute up to 8% of the total production costs of one million cigarettes.

Through implementation of suitable identified interventions and corrective actions, however, this contribution can be decreased to as low as 1%.

The EEGECOST model provides the framework for corporate evaluation of alternative projects and processes and for estimating economic and environmental performance in the present and especially the future. The model can assist South African industries in identifying, recording and allocating environmental costs within environmental media groups, using cost types and cost drivers, to enhance their corporate decision making processes. Implementing and applying the EEGECOST model as a standalone corporate decision making tool enhances risk analyses, corporate reporting and capital budgeting. The following conclusions are made regarding the EEGECOST model:

- The EEGECOST model assists environmental accounting in South Africa.
- Successful implementation of the EEGECOST model requires a team approach, with input from a wide variety of professionals in a company. These may include scientists, engineers, accountants and managers.
- The EEGECOST model is not solely an accounting system. It is a framework that can be used to consider the broader financial and environmental implications of business.
- The EEGECOST model considers both internal and external costs. The boundary between these costs need not always be static, but at times can be rather dynamic; given the rate of change in company policies and governmental regulations.
- Capital investment decisions are usually made within the financial sector of companies at present. However, if investment proposals are to be considered on more than just internal costs, there must be communication and collaboration between the financial and environmental decision makers in the company. The model therefore also attempts to relate financial and environmental investment decision making.

Direct benefits are therefore obtainable by implementing corporate environmental accounting and especially implementing the EEGECOST model in South African companies. The following guidelines will assist in successful implementation of the model:

- Establishment of company specific research teams and research programmes to evaluate the model and to implement it in the environmental management framework.
- Modification of a company's current environmental management framework and fiscal accounting system to incorporate the EEGECOST model.
- Initiation of internal communication and training programmes to support the model.
- Reporting the benefits of implementing the model to promote national environmental accounting initiatives.

The following recommendations will expand the model to enhance its credibility and increase its functionality as an environmental accounting tool:

- Further development of the model with respect to providing a clearer distinction between costs involving actual expenditure, provisions for contingency and external costs or virtual expenditure, as well as between income and expenditure items reflecting business performance and balance sheet items reflecting business conditions.
- Multiple case studies addressing a wider variety of industrial and/or manufacturing activities, as well as the application of the model during actual company planning and performance measuring cycles.
- Development of a database incorporating environmental media and social impact costs with extractable data that can easily be amended for company specific purposes.
- Advancement of the programme to a software tool for streamlining data input, increasing usability and enhancing output reporting and risk analyses.
- Augmenting the programme to support life cycle analyses and to estimate surrogate data for data not readily available.
- Enlarging the programme to support simultaneous analyses for comparison purposes and enhanced corporate decision making.
- As Type V costs are subjective, it is recommended that further research be conducted to structure an objective framework to evaluate and determine cost factors involved in the development of Type V costs.

The EEGECOST model was developed based on an holistic approach with simplistic operation, sufficient data input requirement, distinct cost allocation and output that will ensure usability for informed business decisions the main criteria. The user is able to tailor the model to meet specific product and project requirements based on company specific operations. The model succeeds in providing accurate and comprehensive environmental cost information to enable better decisions on corporate issues that impact on both a company's financial status and the environment. The model is valuable for management initiatives with a specific environmental focus, such as pollution prevention, environmental supply chain management, environmentally preferable purchasing and waste management systems. The model particularly brings focus to costs frequently not considered in fiscal accounting systems, such as contingent risks, internal intangible costs and costs associated with external impacts.

CHAPTER 7

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APPENDIX A

COMPARISON OF EXISTING ENVIRONMENTAL ACCOUNTING SYSTEMS

Table A.1 Comparison of LCC methodologies.

Life Cycle Cost Analysis Methodologies									
No	**Features**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	Objective	LCC of labour	LCC of assets	Cost alternatives	Cost reduction	EIO Analysis	Cost evaluation	LCC estimates	Eco-design
2	Identification of alternatives	A	A	A	A	NA	A	NA	A
3	Cost breakdown structure	E	E	E	E	G	G	G	E
4	Identification of suitable cost model	G	G	E	E	A	A	A	E
5	Generation of cost estimates	E	E	E	E	NA	A	NA	G
6	Availability of cost profiles	A	A	G	A	NA	A	NA	G
7	Break even analysis	A	A	A	A	NA	NA	NA	A
8	Determination of high cost contributors	NA	NA	A	A	A	NA	NA	A
9	Total cost determination	A	A	A	A	A	A	A	A
10	Incorporation of eco-costs	NA	NA	NA	NA	NA	NA	NA	G
11	Correlation with design changes	NA	NA	NA	A	NA	A	A	A
12	Implementation of design solution	NA	NA	NA	A	NA	A	A	A
13	Quality aspects	NA	NA	NA	NA	NA	A	E	NA
14	Inclusion of supplier relationships	NA	NA	NA	NA	E	NA	NA	A
15	Trade-offs	NA	E	NA	A	A	A	A	A
16	Employment cycles	E	NA	NA	NA	A	NA	NA	NA
17	Sensitivity analysis	A	A	A	A	NA	NA	NA	A
18	Risk analysis	A	A	A	A	NA	A	A	A
19	De-manufacture concept	NA	NA	NA	A	NA	A	A	A
20	Any special feature	Human factor	Asset model	Holistic model	Uncertainty	LCA upgrading	Product system design	Redesign	Eco-design
A: Available; NA: Not Available; G: Good; E: Excellent; LCC: Life Cycle Cost; EIO: Economic input-output									

Table A.2 Comparison of environmental accounting systems

Environmental Accounting Systems					
No	**Features**	**EMT**	**TCA**	**LCC**	**FCA**
1	Main objective	To analyse material streams and related money flows	To analyse environmental and social impacts and costs	To reduce the total cost of a product, project or asset	To identify costs related to providing goods and public services
2	Costs considered				
2.1	Conventional costs	Y	Y	Y	Y
2.2	Hidden costs	N	Y	N/A	Y
2.3	Contingent costs	N	Y	N/A	Y
2.4	Image and relationship costs	N	Y	N	Y
2.5	Environmental degradation costs	N	Y	N	N
2.6	Human impact costs	N	Y	N	N
3	Cost estimates	Y	Y	Y	Y
4	Probability analysis	N	Y	S	N
5	Risk analysis	Y	Y	S	Y
6	Determination of high cost contributors	Y	Y	S	Y
7	Total cost determination	N	Y	Y	Y
8	Stand-alone decision making tool	N	Y*	N	N
9	Special features	Good for identification and analysis of investment alternatives	Good for identification and analysis of investment alternatives and to determine baseline status	A cradle-to-grave approach considering definite money flows based on the output of life cycle analysis data	All costs are identified regardless of the period in which the expenditures occur
10	Trade-off	Costs and revenues in the end-of-life and user phases are not included	No defined method of valuing intangible and external costs and lack of actual input data	The costs considered are limited for use as a stand-alone environmental accounting system	This system must be implemented as part of a larger environmental management system
Y: Yes; N/A: Not available; N: No; S: Some systems; Y*: To some degree.					

APPENDIX B

THE EEGECOST MODEL

Form B.1 Analysis background form.

Project title:	
Company:	
Department:	
Prepared by:	
Date completed:	

Product description:

Process description:

Objective statement:

Go to Capital budgeting

SCOPE OF ANALYSIS

Go to Discount rates

Project phase (Insert the number [1] in the required block.)

Concept initiation	Concept analysis	Validation	Development	Implementation	Production

Type of analysis (Insert the number [2] in the required block.)

Existing process analysis	Existing vs existing process analysis	Existing vs new process analysis	New vs new process analysis	Capital budgeting analysis

Range of operations (Insert the number [3] in the required block.)

Import	Production	Export	Research	Development	Not applicable

Siting (Insert the number [4] in the required block.)

New	Exisiting site

Site location (s) (Insert the number [5] in the required block.)

Johannesburg	Pretoria	Durban	Cape Town	Port Elisabeth	Other

Site stage (Insert the number [6] in the required block.)

Predevelopment & development	Decommisioning	Not applicable

Life cycle stage (Insert the number [7] in the required block.)

Raw material extraction	Manufacturing	Filling & packaging	Distribution	Use, reuse & maintenance	End-of-life	All stages

Range of costs (Insert the number [8] in the required block.)

Types I & II	Type III	Type IV	Type V	Costs and revenues	All by media	Future costs

Type of assessment (Insert the number [9] in the required block.)

Life cycle	Period

Period

From	To

Functional unit

Form B.3 Discount rates form.

DISCOUNT RATES

Discount rates	
	For type I to IV costs
	For type V costs

Return to Scope of analysis

Go to Cost Inventory

Return to Discount rates

COST INVENTORY

Go to Cost incurred by type

1	Air and climate	Total	Link	Comments
1.1	*Treatment, prevention and operation*			
1.1.1	Depreciation of related assets		Go to Depreciation	
1.1.2	Maintenance and operating materials		Go to Maintenance and operating materials	
1.1.3	External services		Go to External services	
1.1.4	Personnel		Go to Personnel	
1.1.5	Fees, taxes and charges		Go to Fees, taxes and charges	
1.1.6	Fines and penalties		Go to Fines and penalties	
1.1.7	Insurance for environmental liabilities		Go to Insurance	
1.1.8	Provisions for environmental management		Go to Provisions	
1.2	*General and beyond*			
1.2.1	General environmental management activities		Go to General activities	
1.2.2	Research and development		Go to Research and development	
1.2.3	Extra expenditure for cleaner technologies		Go to Extra	
1.2.4	General direct costs		Go to Direct costs	
1.2.5	General indirect costs		Go to Indirect costs	
1.2.6	Internal intangible cost		Go to Internal intangible cost	
1.2.7	External costs		Go to External costs	
1.3	*Environmental revenues*			
1.3.1	Subsidies, rewards and earnings		Go to Subsidies, rewards and earnings	
	Total			

Form B.5 Depreciation form.

Return to Cost Inventory

DEPRECIATION OF RELATED ASSETS

Go to single asset depreciation
Go to shared asset depreciation

Air and Climate			
Unit no.	**Type of unit**	**Unit description**	**Total**

Return to Depreciation

DEPRECIATION OF SINGLE ASSETS

STRAIGHTLINE CALCULATION

Go to Fixed percentage depreciation

Capital assets depreciated in years

No	Description	Asset No	Acquisition date	Total valuation	Depreciable life	Current period	Current period depreciation	Depreciation to date	Years to date	Depreciation years to date

Total current depreciation __________

Form B.7 Single asset depreciation (fixed percentage) form.

Return to Depreciation

DEPRECIATION OF SINGLE ASSETS

FIXED PERCENTAGE CALCULATION

Go to Straightline depreciation

Capital assets depreciated in years

No	Description	Asset No	Acquisition date	Total valuation	Percentage %	Current period	Current period depreciation	Depreciation to date	Years to date	Depreciable value to date

Total current depreciation ______

Form B.8 Shared assets depreciation (straightline) form.

Return to Depreciation

DEPRECIATION OF SHARED ASSETS

STRAIGHTLINE CALCULATION

Go to Fixed percentage depreciation

Go to Allocation

Shared assets depreciated in years

No	Description	Asset No	Acquisition date	Total valuation	Depriaciable life (Years)	Current period (Year)	Current period depreciation	Depreciation to date	Years to date	Depreciable years left

Shared assets depreciated in machine hours

No	Description	Asset No	Acquisition date	Total valuation	Depriaciable life (Hours)	Current period (Hours)	Current period depreciation	Depreciation to date	Hours to date	Depreciable hours left

Shared assets depreciated in machine mileage

No	Description	Asset No	Acquisition date	Total valuation	Depriaciable life (Mileage)	Current period (Mileage)	Current period depreciation	Depreciation to date	Mileage to date	Depreciable mileage left

Return to Depreciation

Return to Depreciation of shared assets

Percentage allocation to media

STRAIGHTLINE CALCULATION

Go to Monetary allocation

Shared assets depreciated in years

No	Description	Asset No	Environmental media								
			1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	Total %

Shared assets depreciated in hours

No	Description	Asset No	Environmental media								
			1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	Total %

Shared assets depreciated in machine mileage

No	Description	Asset No	Environmental media								
			1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	Total %

Return to Depreciation of shared assets
Return to Allocation of shared assets

Monetary allocation to media

STRAIGHTLINE CALCULATION

Shared assets depreciated in years

No	Description	Asset No	Environmental media								
			1 R	2 R	3 R	4 R	5 R	6 R	7 R	8 R	Total R

Shared assets depreciated in hours

No	Description	Asset No	Environmental media								
			1 R	2 R	3 R	4 R	5 R	6 R	7 R	8 R	Total R

Shared assets depreciated in machine mileage

No	Description	Asset No	Environmental media								
			1 R	2 R	3 R	4 R	5 R	6 R	7 R	8 R	Total R

Form B.11 Maintenance and operating materials form.

Return to Cost Inventory

MAINTENANCE AND OPERATING MATERIALS

Air and Climate					
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**

Form B.12 External services form.

Return to Cost Inventory

EXTERNAL SERVICES

Soil and groundwater												
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**	**%**	**Type I(a)**	**%**	**Type I(b)**	**%**	**Type II**	**Total**
Legal aid												
External consultation												
External analysis												
External testing, contol and												
monitoring costs												
Metrics cost												
External inspections												
Training												
Literature												
Information material												
Site preparation	Demolotion											
	Selective clearing											
	Earthmoving											
	Herbicide reduction											
	Building											
	Fencing											
	Aesthetic appeal											
	Roads											
	Go to Predevelopment and construction											
Site decommisioning	**Go to Decommisioning**											
Maintenance and operation												
Other												
Equipment cost and installation												
Feasibility studies												
Stormwater management												

Form B.13 Predevelopment and construction form.

Return to External services

Go to Indirect costs
Go to Fees, taxes and charges

PREDEVELOPMENT AND CONSTRUCTION COSTS

Site information

Location name:	
Address:	
Legal description:	
Number of hectares:	
Other descriptive information:	

Facility predevelopment cost

	Account code	Cost
Public hearings		
Public outreach and education		
Land acquisition		
Legal fees		
Licensing and permit fees		
Engineering		
Design		
Environmental studies		
Testing		
Other		
Indirect costs		

Subtotal ______

Construction cost

	Account code	Cost
Scale system installation		
Monitoring or office facilities		
Equipment storage facilities		
Roads		
Landscaping		
Engineering		
Earthwork		
Other		
Indirect cost		

Subtotal ______

Total ______

Form B.14 Decommissioning form.

Return to External services
Return to Fees, taxes and charges

Go to Indirect costs

DECOMMISSIONING COST

Site information

Location name:	
Address:	
Legal description:	
Number of hectares:	
Other descriptive information:	

Decommissioning

	Account code	Cost
Public hearings		
Public outreach and education		
Raze buildings		
Dismantling and disposal		
Landscaping		
Remediation		
Site survey		
Post closure care		
Other		
Indirect costs		

Subtotal ______

Closure and postclosure

Any relevant costs	Account code	Cost
Indirect costs		

Subtotal ______

Total ______

Return to Cost Inventory

PERSONNEL

Go to Employee payroll

Air and Climate						
No	**Name**	**Salary / Wage**	**Benefits**	**Overtime**	**Total**	**Description**
	Totals					

Form B.16 Employee payroll form.

Return to Personnel

EMPLOYEE PAYROLL

No	Name	ID number	Account code	Salary / Wage	Overtime wage	Media group								Total allocation %
						1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														
11														
12														
13														
14														
15														
16														
17														
18														
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
#														

Grand total wages

Form B.17 Fees, taxes and charges form.

Return to Cost Inventory

FEES, TAXES and CHARGES

Soil and groundwater					
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**
Compliance costs					
Site preparation	Demolotion				
	Selective clearing				
	Earthmoving				
	Herbicide reduction				
	Building				
	Fencing				
	Aesthetic appeal				
	Roads				
	Go to Predevelopment and construction				
Site decommissioning	Go to Decommisioning				
Maintenance and operation					
Other					
Permit costs					

Form B.18 Fines and penalties form.

Return to Cost Inventory

FINES AND PENALTIES

Air and Climate															
Cost driver	Description	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no

FUTURE EXPENSE RISK SCENARIO NUMBER			
DESCRIPTION		TYPE OF COST	
BACKGROUND, PROBABILITY, ASSUMPTIONS, IMPLICATION AND COST			
Sources			

Form B.20 Risk scenarios summary form.

SCENARIO	DESCRIPTION	IMPLICATION	PROBABILITY	COST	COST TYPE

Return to Cost Inventory

INSURANCE

Air and Climate					
Cost driver	Description	Unit	No of units	Cost / unit	Total

Return to Cost Inventory

PROVISIONS FOR ENVIRONMENTAL MANAGEMENT

Air and Climate														
Cost driver	Description	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / incident	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no

Form B.23 General activities form.

Return to Cost Inventory

GENERAL ACTIVITIES COST

Air and Climate					
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**
Meetings					
Internal audits and control cost					
Administration					
Operational training					
Planning					
Filing and record keeping					
Conferences					
Symposiums					
Travel costs					
Accommodation expense					
Other					

Form B.24 Research and development form.

Return to Cost Inventory

RESEARCH and DEVELOPMENT

TYPE OF COST

Air and Climate						Air and Climate						
Cost driver	Description	Unit	No of units	Cost / unit	Total	%	Type I(a)	%	Type I(b)	%	Type II	Total
Emission prevention measures												
Prevention energy conversion loss												
Meteorological forecasting												
Dispersion modelling												
CFC studies and phaseout												
Global warming studies												
Other												
Feasibility studies												

Waste						Waste						
Cost driver	Description	Unit	No of units	Cost / unit	Total	%	Type I(a)	%	Type I(b)	%	Type II	Total
Waste prevention measures												
Advanced waste treatment												
Dust management												
Ash management												
Chemical, oil and toxic												
substance management												
Organic waste management												
Waste fuel management												
Reclamation optimization												
Other												
Feasibility studies												

Return to Cost Inventory

EXTRA EXPENDITURE FOR CLEANER TECHNOLOGIES

Air and Climate					
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**
Energy efficiency improvements					
Other					
Debt interest	Go to Debt Interest				

Waste					
Cost driver	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**
Special prevention measures					
Other					
Debt interest	Go to Debt Interest				

Return to Extra

DEBT INTEREST ACCUMULATION

No	Dept issue or capital lease description	Account code	Total interest expense	Environmental media group								Total allocation %
				1 %	2 %	3 %	4 %	5 %	6 %	7 %	8 %	
1												
2												
3												
4												
5												
6												
7												
8												
9												
10												
11												
12												
13												
14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												

Grand total

Form B.27 Direct cost form.

Return to Cost Inventory

DIRECT COSTS

Other						
No	**Cost driver**	**Description**	**Unit**	**No of units**	**Cost / unit**	**Total**
#	Volunteer and prison labour		Go to Volunteer and prison labour			
##	Transportation: Raw material, co-product, product and waste		Go to Transport reconciliation			

Form B.28 Volunteer and prison labour form.

Return to Direct costs

VOLUNTEER AND PRISON LABOUR

Volunteer labour				
Name	Identification number	Hours worked	Wage / hour	Value of labour

Total ______

Prison labour				
Name	Identification number	Hours worked	Wage / hour	Value of labour

Subtotal ______

Cost of law enforcement supervision ______

Total cost of prison labour ______

Environmental media	Allocation percentage		Volunteer labour	Prison labour
	Volunteer labour	Prison labour		
Air and climate				
Wastewater				
Waste				
Soil and groundwater				
Noise and vibration				
Biodiversity and landscape				
Radiation				
Other				
Total				

Form B.29 Transportation reconciliation form.

Return to Direct costs

TRANSPORTATION AND SHIPPING COSTS

Go to Type of load definition

Departure		VIN	Vehicle description	Company	Type of load	Description	Unit		No of units	Cost / unit	Total
Date	Time										

Total ______

TYPE OF LOAD DEFINITION

	Type of load	Unit	Description		Cost / unit
1	Product				
1.1		#	-	-	
1.2		#	-	-	
1.3		#	-	-	
1.4		#	-	-	
1.5		#	-	-	
1.6		#	-	-	
1.7		#	-	-	
1.8		#	-	-	
1.9		#	-	-	
1.10		#	-	-	
1.11		#	-	-	
1.12		#	-	-	
1.13		#	-	-	
1.14		#	-	-	
1.15		#	-	-	
#	None				
2	Waste				
2.1		#	-	-	
2.2		#	-	-	
2.3		#	-	-	
2.4		#	-	-	
2.5		#	-	-	
2.6		#	-	-	
2.7		#	-	-	
		#	-	-	
		#	-	-	
3	Raw material				
3.1		#	-	-	
3.2		#	-	-	
3.3		#	-	-	
3.4		#	-	-	
3.5		#	-	-	
3.6		#	-	-	
3.7		#	-	-	
3.8		#	-	-	
3.9		#	-	-	

Unit		
1	Weight	ton
2	Volume	m^3
3	Distance	km.
#	-	-

Form B.31 Indirect costs form.

Return to Decommisioning
Return to Predevelopment and construction
Return to Cost Inventory

GENERAL INDIRECT COSTS

Cost driver	Account codes	Description	Cost
Telephone			
Billing			
Budgeting			
Training support costs			
Production space rent			
Land use opportunity cost			
Marketing support cost			
Medical surveillance cost			
Spill response support			
Advertising			
		Total	

Total budget - All funds			
Total budget indirect costs - All funds			
Total budget Net of central service providers			
Total budget for operations			
Total budget Net of central service providers			
Allocation ratio			
Allocable indirect costs			

Environmental media	Budget per media	% of Individual media to total	Allocated costs
Air and climate			
Wastewater			
Waste			
Soil and groundwater			
Noise and vibration			
Biodiversity and Landscape			
Radiation			
Other			
Predevelopment cost			
Site construction cost			
Decommisioning cost			
Closure & Postclusure care costs			
Total			

Return to Cost Inventory

INTERNAL INTANGIBLE COSTS

Air and climate

Unit	Cost driver	Description	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Staff																
Market share																
Licence to operate																
Relationships																
Other	Habitat and wetland protection															
	Support to environmental groups															
	Environmental projects															
	Environmental report															
	Environmental hearings															
	Pollution prevention programs															

Return to Cost Inventory

EXTERNAL IMPACT COSTS

Air and climate

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Pollutant discharges	Global warming	tons of CO_2 eq.														
	Acidification	tons of SO_2 eq.														
	Photochemical smog	tons of C_2H_6 eq.														
	Groundlevel ozone	tons of O_3 eq.														
	Stratosperic ozone depletion	tons of CFC-11 eq.														

Wastewater

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Pollutant discharges	Eutrophication	tons of PO_4 eq.														
	Aquatic toxicity	Eq. Tons														

Soil and Groundwater

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Pollutant discharges	Land use	Eq. Tons														
	Resource depletion	Ratio														
	Terrestrial toxicity	Eq. Tons														

Form B.33 External costs form (continued).

Noise and Vibration

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Pollution	Noise pollution	Decibels														

Other

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no
Human health effects	Migration															
	Morbidity															
	Fertility															
	Mortality															
	Thermal discharge	Eq. BTU's														
	Visibility															
	Odour															

Form B.33 External costs form (continued).

Radiation

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no

Waste

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no

Biodiversity and Landscape

Cost driver	Description	Unit	Implication of occurrence (1 - 5)	Probability of occurrence	Frequency of events / year	Cost / event	Weighted cost	Year 1	Year 2	Year 3	Year 4	Year 5	Present value	Risk Category	Risk Value	Risk no

Return to Cost Inventory

SUBSIDIES, REWARDS AND EARNINGS

Air and Climate					
Description		Unit	No of units	Value / unit	Total

Form B.35 Costs incurred by type form.

Return to Cost Inventory

Go to Cost types by year

COSTS INCURRED BY TYPE

Type	Description	Total
I (a)	Non-recurring site costs	
I (b)	Recurring site costs	
II	Corporate costs	
III	Impact costs	
IV	Internal intangible costs	
V	External costs	
Total		

Form B.36 Cost types by year form.

Return to Cost incurred by type | Go to Cost Report

COST TYPE ASSESSMENT BY YEAR

Year	Year 1

Cost type	Total
I (a)	
I (b)	
II	
IV	
V	
Grand Total	

Return to Cost Types by year

Go to Risk Value

REPORT FORM

			Description		
1	Project phase				
2	Type of analysis				
3	Range of operations				
4	Siting				
5	Site location				
6	Site stage				
7	Life cycle stage				
8	Range of costs		for year/s		
9	Type of assessment			to	
10	Functional unit				

Expenditure	General activities

Environmental media	Total
Air and climate	
Biodiversity and landscape	
Noise and vibration	
Other	
Radiation	
Soil and groundwater	
Wastewater	
Grand Total	

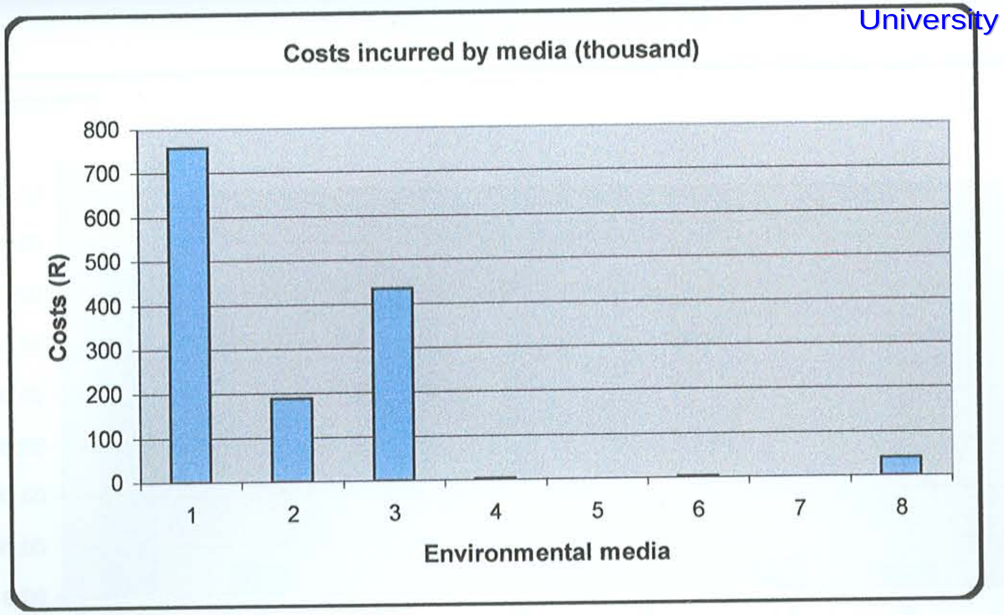

Figure B.1 Costs incurred by media.

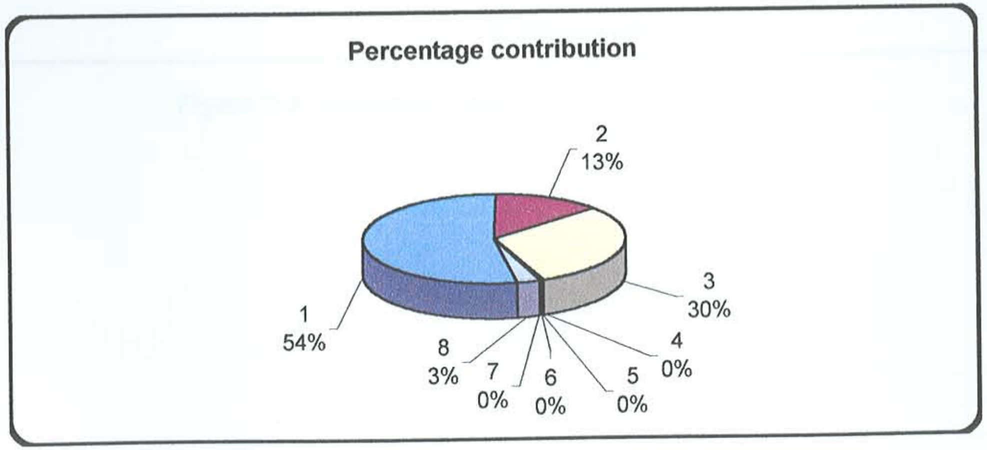

Figure B.2 Percentage cost contibution.

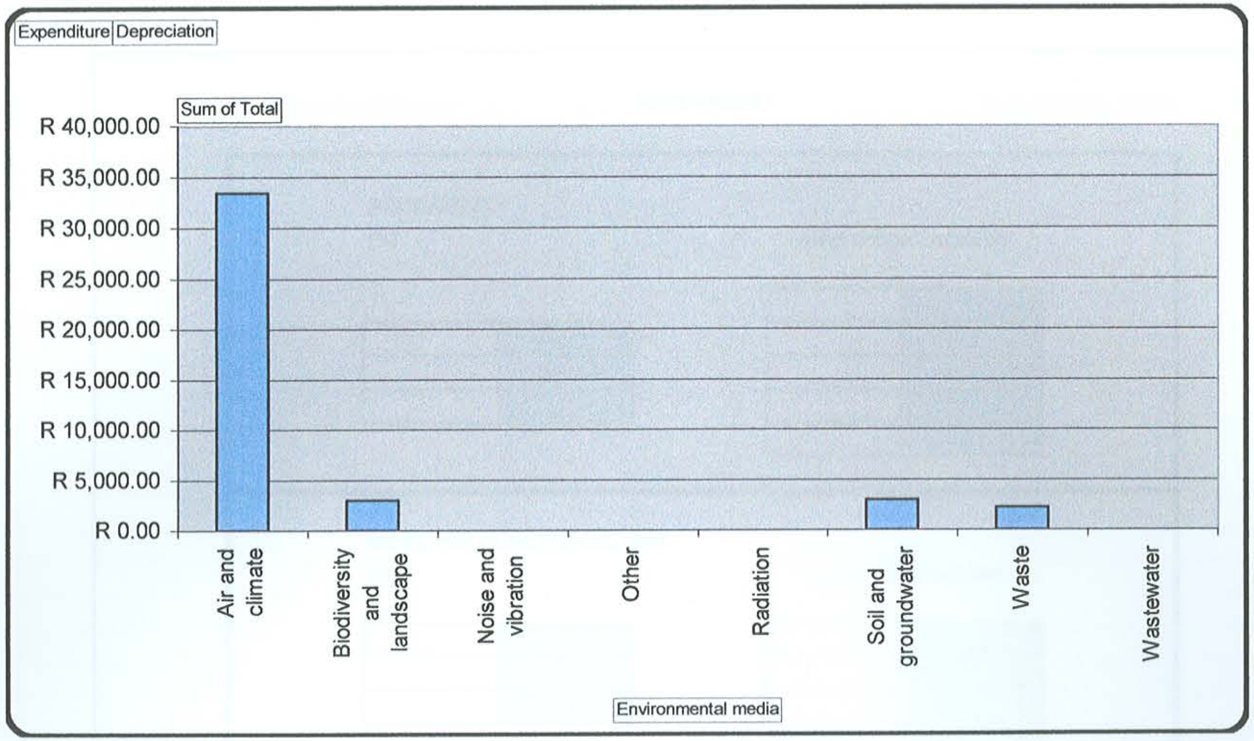

Figure B.3 Interactive *Costs incurred by media* graph.

Form B.38 Risk value form.

Return to Cost Report | RISK VALUE | Go to Priority Table

PROBABILITY
[%]

	L
	M
	H

User defined valuation

	2
	4
	6
	8
	10

COST PER FUNCTIONAL UNIT
[R]

	L
	M
	H

User defined valuation

	5
	10
	15
	20

IMPLICATION
[1-5]

2	L
3	M
4	H

User defined valuation

1	0
2	5
3	10
4	15
5	20

Form B.39 Management priority table.

Return to Risk Value

MANAGEMENT PRIORITY TABLE

RISK NO	DESCRIPTION	COST	TYPE OF COST	RISK CATEGORY	RISK VALUE

Form B.40 Investment database form.

Return to Scope of analysis

INVESTMENT DATABASE

Go to Net present value calculations

Air and climate

No	Description	Investment total	Average monthly savings	Savings per annum				
				Year 1	Year 2	Year 3	Year 4	Year 5

Wastewater

No	Description	Investment total	Average monthly savings	Savings per annum				
				Year 1	Year 2	Year 3	Year 4	Year 5

Waste

No	Description	Investment total	Average monthly savings	Savings per annum				
				Year 1	Year 2	Year 3	Year 4	Year 5

Form B.41 Net present value calculations form.

Return to Investment database

NET PRESENT VALUE CALCULATIONS

No	Description	Payback period (months)	Net Present value value	IRR

APPENDIX C

COMPREHENSIVE LCA OF THE CIGARETTE PRODUCTION PROCESS

Table C.1 Comprehensive LCA of the cigarette production process.*

Functional unit: 1 million cigarettes					
Inputs	**Unit**	**No. of units**	**Outputs**	**Unit**	**No. of units**
Tobacco	ton	1,50	Air emissions	ton CO_2 eq	2,59
Cigarette paper	g	10,65	Total waste	kg	78,20
Packaging materials	g	23,93	Waste to landfill	kg	36,16
Total energy	GJ	25,20	Waste for recycling	kg	40,12
Electricity	KW-hr	1 980,96	Hazardous waste for removal	kg	1,92
	GJ	7,13	Water[2]	kl	8,25
Coal	ton	0,61	Total dissolved solids[3]	kg	1,62
	GJ	17,07	Chlorine[3]	kg	0,25
LP-gas	kg	4,20			
	GJ	0,20			
Diesel	l	4,10			
	GJ	0,16			
Transportation fuel[1]	GJ	0,64			
Water	kl	14,22			

Notes

1 Transportation fuel includes fuel usage for passenger kilometres, freight kilometres and air travel.
2 Because the water effluent flow rate is not measured, it is assumed 42% of the input water is consumed within the factory (Buissine, 2003).
3 Total dissolved solids and Chlorine are measured on site as 196 mg/l and 30 mg/l respectively (Buissine, 2003).

* Data from Buissine (2003).

APPENDIX D

FUTURE EXPENSE RISK SCENARIOS

Form D.1 Risk scenario summary.

Scenario[1]	Description	Cost[2] (per million of cigarettes)	Implication	Probability	Cost type
1	Higher utility costs due to tariff increases.	• R 37,99 in 2004 • R 39,89 in 2005	-	100%	I (b)
2	Employee replacement resulting from mortality due to HIV/AIDS.	• R 3,00 in 2004 • R 6,00 in 2005	5	100%	IV
3	Increase in COID assessment arising from industrial accidents.	• R 0,15 in 2004 • R 0,15 in 2005	2	50% 40%	III
4	Higher waste disposal costs due to tariff increases.	• R 0,58 in 2004 • R 1,15 in 2005	-	100%	I (a)
5	Losses due to electricity supply interruption.	• R 27,00 in 2004 • R 27,00 in 2005	3	70% 50%	III
6	Negative impact of noise and odour pollution on community relations.	• R 25,00 in 2004 • R 25,00 in 2005	4	30% 50%	IV
7	External environmental impact of emissions to air.	• R 5 180,00 in 2004 • R 5 439,00 in 2005	4	10% 20%	V

Notes:

1 Refer upcoming forms for a detailed report on each scenario.

2 For calculation purposes, an average production rate of 20 billion cigarettes per annum was applied.

FUTURE EXPENSE RISK SCENARIO NUMBER			1
DESCRIPTION	Higher utility costs due to tariff increases.	TYPE OF COST	I (b)

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

The cost of utilities was R 783,30 in 2003, based on the production of one functional unit[1]. A 5% per annum increase in tariffs is anticipated for electricity, coal and water supply, for the years 2004 and 2005[2] that converts to R 37,99 in 2004 and R 39,89 in 2005 per functional unit. The probability of occurrence is 100%.

Sources

1 **BUISSINE B (2003)** Background to the Tobacco Industry in South Africa, *Environmental Health and Safety Department publication,* British American Tobacco Manufacturers, Heidelberg.
2 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			2
DESCRIPTION	Employee replacement resulting from mortality due to HIV/AIDS.	**TYPE OF COST**	IV

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

HIV/AIDS is a growing concern in the South African middle income economy[1]. To replace middle-income deceased individuals in the cigarette manufacturing business costs the company on average R 4 000,00 per individual due to operational training and an additional R 4 000,00 due to recruitment exercises per individual[3]. Therefore, it costs the cigarette manufacturing business on average R 8 000,00 to replace a middle-income individual. Medical costs related to treating illnesses, over the extent of these peoples' life span, are not easily quantified and only the baseline replacement cost will be considered.

It is known the company employs 750 individuals[2]. Of these, it is assumed 1% and 2% in 2004 and 2005 need to be replaced annually due to death of AIDS[3]. This equates to R 3,00 and R 6,00 extra expenditure per functional unit in 2004 and 2005 respectively with a 100% probability of occurrence. To replace deceased has a high overall implication on the company, therefore an implication value of 5 is assigned to this scenario.

Sources

1 **BRITISH AMERICAN TOBACCO (2002)** Social Report 2002. *British American Tobacco publication*, Heidelberg.
2 **BRITISH AMERICAN TOBACCO (2003)** Social Report 2003. *British American Tobacco publication*, Heidelberg.
3 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			3
DESCRIPTION	Increase in COID assessment arising from industrial accidents.	**TYPE OF COST**	III

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

Increasing draw on the Compensation of Occupational Injury and Diseases fund is expected to result in increases in the assessment rates of 2% annually for 2004 and 2005[1]. The probability of occurrence is assumed 50% and 40% in 2004 and 2005 respectively. The implication is assigned a value of 2, given the relative low overall impact this risk scenario will have on the company. The scenario will result in costs of R 0,15 per functional unit for both years in the forecast period[1].

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			4
DESCRIPTION	Higher waste disposal costs due to tariff increases.	**TYPE OF COST**	I (a)

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

Anticipated increase of 5% annually for 2004 and 2005 of landfill tariffs[1]. The probability of occurrence is 100% resulting in additional costs of R 0,58 in 2004 and R 1,15 in 2005 per functional unit.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			5
DESCRIPTION	Losses due to electricity supply interruption.	**TYPE OF COST**	III

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

Anticipated losses due to electricity supply interruption – one day per year for the forecast period of 2004 to 2005[1]. The cost of plant interruption is estimated at R 0,54 million per day, converted to a cost of R 27,00 per functional unit. The probability of occurrence is estimated as 70% in 2004 and 50% in 2005. It is assumed that in 2005, enhanced technology and increased service quality will result in a lower probability of electricity failures. Due to reserve stock, the impact of one day's production losses only results in an implication value of 3.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			6
DESCRIPTION	Negative impact of noise and odour pollution on community relations.	**TYPE OF COST**	IV

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

A negative impact on the company can result from community complaints due to noise and odour emissions on night production shifts[1]. The probability of occurrence is assumed 30% and 50% in 2004 and 2005 respectively. The implication value on the company is assumed 4. If it is assumed the company compensates the complaints and the value of these compensations result in R 500 000,00 per annum, it converts to a cost impact of R 25,00 per functional unit per annum on the company.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

FUTURE EXPENSE RISK SCENARIO NUMBER			7
DESCRIPTION	External environmental impact of emissions to air.	**TYPE OF COST**	V

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

Global climate change, the economy and changes in the exposure to the health risk of people are inextricably linked[1]. The spectrum of global environmental and social health hazards includes global climate change due to the accumulation of greenhouse gasses in the lower atmosphere[1]. The emission of greenhouse gasses causes considerable social and environmental damage with accompanying costs[3]. In South Africa, these costs are not borne by the polluting industries as of yet. In future though, legislation may force polluting industries to internalise these costs[1]. It is assumed the probability of legislation forcing South African industries to internalise these costs are 10% for 2004 with a slightly higher probability of 20% in 2005. Should these costs be internalised, the impact on the company will be severe, therefore an implication value of 4 is assigned to this scenario.

The company only monitors and reports CO_2 emissions[2]. Therefore, only the cost of CO_2 emissions will be determined, without reference to sulphur dioxide, ash and volatile matter. Given these omissions, the value presented here reflects a lower bound estimate of the costs of air emissions.

The current price of CO_2 is set at R 2,00 per kg[3]. The company emits 2,59 tons of CO_2 eq in total for the production of 1 million cigarettes. This is due to coal combustion processes[4]. The cost impact converts to R 5 180,00 per functional unit in 2004, whereas if it is anticipated a 5% increase in the price of CO_2 will result in 2005, the cost impact of this scenario will be R 5 439,00 in 2005.

Sources

1 **BLIGNAUT JN AND KING NA (2002)** The externality cost of coal combustion in South Africa. *Bridging the economics/environment divide, Forum for economics and the environment, First annual conference*, Cape Town, February 2002.

2 **BRITISH AMERICAN TOBACCO (2003)** Social Report 2003. *British American Tobacco publication*, Heidelberg.

3 **ABSA (2003)** *Economist Projections for the 2004-2005 financial year*, 2003.

4 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

APPENDIX E

INTERVENTIONS AND CORRECTIVE ACTIONS

Form E.1 Risk scenario summary (inclusive of interventions and corrective actions).

Scenario[1]	Description	Cost[2] (per million of cigarettes)	Implication	Probability	Cost type
1	Higher utility costs due to tariff increases.	• R 37,99 in 2004	-	100%	I (b)
		• R 18,18 in 2005			
2	Employee replacement resulting from mortality due to HIV/AIDS.	• R 3,00 in 2004	5	50%	IV
		• R 6,00 in 2005		25%	
3	Increase in COID assessment arising from industrial accidents.	• R 0,15 in 2004	2	50%	III
		• R 0,15 in 2005		40%	
4	Higher waste disposal costs due to tariff increases.	• R 0,20 in 2004	-	100%	I (a)
		• R 0,39 in 2005			
5	Losses due to electricity supply interruption.	• R 27,00 in 2004	3	70%	III
		• R 27,00 in 2005		50%	
6	Negative impact of noise and odour pollution on community relations.	• R 25,00 in 2004	4	30%	IV
		• R 25,00 in 2005		20%	
7	External environmental impact of emissions to air.	• R 5 180,00 in 2004	4	10%	V
		• R 5 271,00 in 2005	3	2%	

Notes:

1 Refer upcoming forms for a detailed report on each scenario.

2 For calculation purposes, an average production rate of 20 billion cigarettes per annum was applied.

Form E.2 Risk scenario number 1 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			1
DESCRIPTION	Higher utility costs due to tariff increases.	TYPE OF COST	I (b)

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

A project is proposed to reduce electrical energy consumption by 3% by installing variable speed motor drives on both supply and return air fans on 30 air handling units at an approximate capital cost of R 30 000,00 per air handling unit[1]. These drives are depreciated by straightline depreciation over a period of 10 years. Due to the project, the amended expenditures are R 37,99 and R 18,18 for 2004 and 2005 respectively with a 100% probability of occurrence. A decrease in expenditure is only observed for 2005, anticipated that the drivers would only be functional at the end of 2004.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.3 Risk scenario number 2 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			2
DESCRIPTION	Employee replacement resulting from mortality due to HIV/AIDS.	**TYPE OF COST**	IV

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

R 25 000 per annum will be spent in the clinic to increase awareness of modes of HIV transmission and the provision and training of peer educators[1]. A cumulative decrease of 50% per annum in the probability of occurrences of deaths related to HIV/AIDS in the company is anticipated.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.4 Risk scenario number 3 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			3
DESCRIPTION	Increase in COID assessment arising from industrial accidents.	**TYPE OF COST**	III

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

A reduction in the number and consequences of industrial accidents is anticipated related to a project of R 30 000,00 per annum expenditure aimed at reducing the frequency of accidents[1]. This expenditure will result in an expected R 30 000,00 rebate in 2005. Although a fiscal expenditure, no amendments are made to the risk scenarios for 2004 and 2005. This is due to the fact that the COID is a national fund, over which the company has no control in increases of assessments[1].

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.5 Risk scenario number 4 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			4
DESCRIPTION	Higher waste disposal costs due to tariff increases.	**TYPE OF COST**	I (a)
BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION			
A project will be implemented from the beginning of 2004, regarding an agreement with a brick manufacturer to remove boiler coal ash free of charge to be used as a fill material[1]. The project will result in amended expenditures of R 0,20 and R 0,39 in 2004 and 2005 respectively.			

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.6 Risk scenario number 5 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			5
DESCRIPTION	Losses due to electricity supply interruption.	**TYPE OF COST**	III
BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION			
No intervention or corrective action can be anticipated to decrease the probability or costs of electricity supply failures[1].			

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.7 Risk scenario number 6 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			6
DESCRIPTION	Negative impact of noise and odour pollution on community relations.	**TYPE OF COST**	IV

BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION

A project is proposed to install automatic combustion controls on each of four coal fired boilers at an approximate capital investment of R 55 000,00 per boiler aimed at improving combustion efficiency to reduce coal consumption and associated CO_2 emissions by 3%[1]. It is assumed for illustration purposes these units will decrease noise and odour pollution due to newer technology innovations. The amended probabilities of community complaints are 20% for 2005. It is assumed the equipment will only be functional from end 2004.

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

Form E.8 Risk scenario number 7 (inclusive of interventions and corrective actions).

FUTURE EXPENSE RISK SCENARIO NUMBER			7
DESCRIPTION	External environmental impact of emissions to air.	**TYPE OF COST**	V
BACKGROUND, PROBABILITY, ASSUMPTIONS, COST AND IMPLICATION			
A project is proposed to install automatic combustion controls on each of four coal fired boilers at an approximate capital investment of R 55 000,00 per boiler aimed at improving combustion efficiency to reduce coal consumption and associated CO_2 emissions by 3%[1]. An amended probability of 2% and implication value of 3 in 2005 is anticipated due to lower CO_2 emissions that will decrease the probability of being forced by legislation to internalise the external cost of CO_2 emissions.			

Sources

1 **BUISSINE B (2004)** Environmental Accounting at BATM, *personal communication,* Environmental Health and Safety Department, British American Tobacco Manufacturers, Heidelberg, (016) 341 5141 [9 February 2004].

APPENDIX F

BRITISH AMERICAN TOBACCO MANUFACTURERS' FEEDBACK

BRITISH AMERICAN TOBACCO
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10 February 2004

Mr PJ de Beer
Environmental Engineering Group
Department of Chemical Engineering
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0002

Dear Mr de Beer

EEGECOST Model Case Study

As a responsible company, manufacturing and distributing a controversial product in a free market environment, and being committed to continuous improvement in the areas of economic performance, social upliftment, and environmental sustainability, British American Tobacco Manufacturers welcomes the opportunity to participate in this case study illustrating the application of the EEGECOST model to some of the manufacturing activities of its Heidelberg site, and to deliver comment on its functionality and usefulness as an environmental accounting management tool.

Due to both time constraints and that it was not possible to synchronize this exercise with actual company planning cycles, the future scenarios presented in the case study are few in number and, although based on identified aspects of our operations, are largely hypothetical in content and timing. It is also important to note that inclusion of aspects pertaining to product lifecycle beyond the boundaries of the manufacturing process would of necessity require the inclusion of comprehensive data pertaining to a very much broader scope of activities including research and development, product design, materials selection and sourcing, agricultural sustainability, marketing, and corporate social investment on a global company scale.

Notwithstanding the above, the exercise has illustrated both the application of the model in providing a more complete picture of environmental costs and liabilities, and by including a routine that allows automatic ordering of defined issues according to user selected probability and consequence parameters, its use as a management decision making tool.

Further development of the model with respect to providing a clearer distinction between costs involving actual expenditure, provisions for contingency, and external costs or virtual expenditure, as well as between income/expenditure items reflecting business performance and balance sheet items reflecting business condition, will considerably enhance its functionality.

Multiple case studies addressing a wider variety of industrial or manufacturing activities as well as the application of the model during actual company planning and performance measuring cycles will also result in a more comprehensive test of its usefulness and reliability as an environmental accounting management tool.

In conclusion, the overall view is that the exercise has been worthwhile and that there is definite benefit to be derived from further research and development of the EEGECOST model.

Yours faithfully,

BA Buissinne
EHS Manager : Africa and Middle East Region

APPENDIX G

PILOT STUDY

G.1 INTRODUCTION

To qualify the EEGECOST model, its outputs were compared to that of the Total Cost Assessment (TCA) system. The same input data was used, based on a case study presented in the Total Cost Assessment literature (Little, 2000). The case study data is hypothetical, however, it still proves to be comparable and representative of actual data to provide information regarding the functionality of the EEGECOST model for corporate decision making, with the main intent to show how the results of the EEGECOST model compares with that of the TCA system.

G.2 THE CASE STUDY

The objective of the case study is to determine the priority of two waste streams for research and development (R&D) funding. In this hypothetical example, a company has articulated several goals aimed at reducing waste generation from its industrial processes. The main question is how to decide which waste stream will receive priority for R&D funding in the implementation of the company's waste reduction strategy. The case study is a baseline assessment of the manner in which the wastes are currently being treated. The waste treatment options and their evaluations would be developed as part of the R&D assessment activities that presumably would occur later in the decision-making process.

Relying on conventional cost data (that is, total Types I and II costs, or Types I and II costs presented as per ton disposed values) indicates that waste stream 1 (liquid hazardous waste) is consistently more expensive than waste stream 2 (aqueous sludge) for the company. Thus, the company could reasonably be expected to prioritise R&D funding towards reducing the more costly waste stream. The potential value in applying environmental accounting is to determine how the cost profile and possibly the prioritisation decision may change when Types III, IV, and V costs are considered. By incorporating these costs into the environmental accounting system will assist the initial comparison of the costs associated with the management and disposal of the two waste streams.

G.3 METHOD

The first step is to determine the average annual operating costs for managing and disposing of each waste stream. It is assumed that waste stream 1 is incinerated onsite and waste stream 2 is landfilled offsite. Tables G.1 and G.2 present the Types I and II costs associated with the management and disposal of each waste stream.

Table G.1 Waste stream 1 conventional costs.

DESCRIPTION	COST
Corporate overheads	R 290 000,00
Depreciation	R 1 230 000,00
External services	R 130 000,00
Internal services	R 850 000,00
Labour	R 300 000,00
Utilities	R 600 000,00
Raw materials	R 600 000,00
Total	R 4 000 000,00

Table G.2 Waste stream 2 conventional costs.

DESCRIPTION	COST
Corporate overheads	R 50 000,00
Depreciation	R 100 000,00
External services	R 2 200 000,00
Internal services	R 250 000,00
Labour	R 150 000,00
Utilities	R 50 000,00
Raw materials	R 200 000,00
Total	R 3 000 000,00

After annual costs are forecasted using readily available data, the next step is to identify the cost driver or the overall cost on a per mass basis. For example, if the amount of waste stream 1 (liquid waste) incinerated annually is roughly 25 000 tons, then the cost per ton would be:

R 4 million/25 000 = R 160,00 per ton.

Similarly, if 20 000 tons of aqueous sludge was disposed of annually, the associated cost would be:

R 3 million/20 000 = R 150,00 per ton.

Using these, an initial evaluation of the Type I and II costs associated with each disposal option would lead the decision-maker to make the judgement that waste stream 1 is more costly than waste stream 2 per ton.

Environmental accounting are subsequently applied to assess how the above results could change by looking at the additional Types III, IV, and V costs. The case study uses similar data as a starting point but also incorporates additional costs, which include the following (see Table G.3):

Table G.3 Additional costs for environmental accounting.

DESCRIPTION	COST CATEGORY
Future compliance cost	Type III
Future contingent liabilities	Type IV

Incorporating Types III and IV costs into the analysis, allows consideration of future and hidden costs that can greatly influence the overall decision making process. Risk scenarios for each waste stream are defined that fully incorporate these future potential costs. In practice, these risk scenarios would ideally be constructed by a multi-disciplinary team that can use brainstorming techniques, life cycle inventory principles and data, as well as other internal resources to identify appropriate risk scenarios that include more precise probabilities and consequences.

To illustrate the method, Tables G.4 and G.5 represent the risk scenarios and associated costs that are applied to each waste stream over a three year forecast period. For the most part, these risks were arbitrarily defined, although they are generally plausible for each waste stream.

Table G.4 Additional costs for environmental accounting (waste stream 1).

RISK NO	DESCRIPTION	COST TYPE	COST	PROBABILITY
1	Air pollution control system upgrade in year 2	Type III	R 1 200 000,00	100%
2	Non-compliance fine in year 2	Type III	R 150 000,00	20%
3	Company image cost in year 3	Type IV	R 15 000 000,00	2%
4	Increase in utility costs in year 3	Type III	R 300 000,00	100%

Table G.5 Additional costs for environmental accounting (waste stream 2).

RISK NO	DESCRIPTION	COST TYPE	COST	PROBABILITY
1	Community impact per year	Type III	R 50 000,00	5%
2	Non-compliance fine in year 1	Type III	R 100 000,00	1%
3	Company image cost in year 3	Type IV	R 2 500 000,00	100%

The risk scenarios developed above were used to tabulate the results and calculate a total present value cost for each waste stream over a three-year evaluation period. These costs were discounted to present day using a 12% discount rate. The choice of discount rate here is purely arbitrary and is not intended to imply any statement on the appropriateness of the value.

G.4 RESULTS

Tables G.6 and G.7 illustrate the results of the TCA system and the EEGECOST model for the hypothetical case example respectively. The results of the TCA system indicate that the costs per ton for waste stream 2 (R 504,39) are now larger than those expected for waste stream 1 (R 493,88) as opposed to the conventional cost results.

Table G.6 Total Cost Assessment system.

RISK NO	YEAR 1	YEAR 2	YEAR 3	PRESENT VALUE TOTAL
WASTE STREAM 1				
I & II	R 4 000 000,00	R 3 570 000,00	R 3 200 000,00	R 10 770 000,00
1	-	R 1 070 000,00	-	R 1 070 000,00
2	-	R 27 000,00	-	R 27 000,00
3	-	-	R 240 000,00	R 240 000,00
4	-	-	R 240 000,00	R 240 000,00
Total	R 4 000 000,00	R 4 667 000,00	R 3 680 000,00	R 12 347 000,00
WASTE STREAM 2				
I & II	R 3 000 000,00	R 2 680 000,00	R 2 400 000,00	R 8 080 000,00
1	R 2 500,00	R 2 230,00	R 1 990,00	R 6 720,00
2	R 1 000,00	-	-	R 1 000,00
3	-	-	R 2 000 000,00	R 2 000 000,00
Total	R 3 003 500,00	R 2 682 230,00	R 4 401 990,00	R 10 087 720,00

The results from the EEGECOST model also indicate that the costs per ton of waste stream 2 (R 503,57) are larger than the costs of waste stream 1 (R 493,53). The results from the TCA system and the EEGECOST model delivered the same findings.

Table G.7 The EEGECOST model.

RISK NO	YEAR 1	YEAR 2	YEAR 3	PRESENT VALUE TOTAL
WASTE STREAM 1				
I & II	R 4 000 000,00	R 3 572 000,00	R 3 189 000,00	R 10 761 000,00
1	-	R 1 072 000,00	-	R 1 072 000,00
2	-	R 26 800,00	-	R 26 800,00
3	-	-	R 239 200,00	R 239 200,00
4	-	-	R 239 200,00	R 239 200,00
Total	R 4 000 000,00	R 4 670 800,00	R 3 667 400,00	R 12 338 200,00
WASTE STREAM 2				
I & II	R 3 000 000,00	R 2 679 000,00	R 2 391 580,00	R 8 070 580,00
1	R 2 500,00	R 2 250,00	R 1 993,00	R 6 743,00
2	R 1 000,00	-	-	R 1 000,00
3	-	-	R 1 993 000,00	R 1 993 000,00
Total	R 3 003 500,00	R 2 681 250,00	R 4 386 573,00	R 10 071 323,00

G.5 CONCLUSIONS

The results from the EEGECOST model compared well to the results from the TCA system, based on the same case study scenario. The model is therefore quantified and verified in terms of its functionality and applicability as a corporate decision making tool.