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.

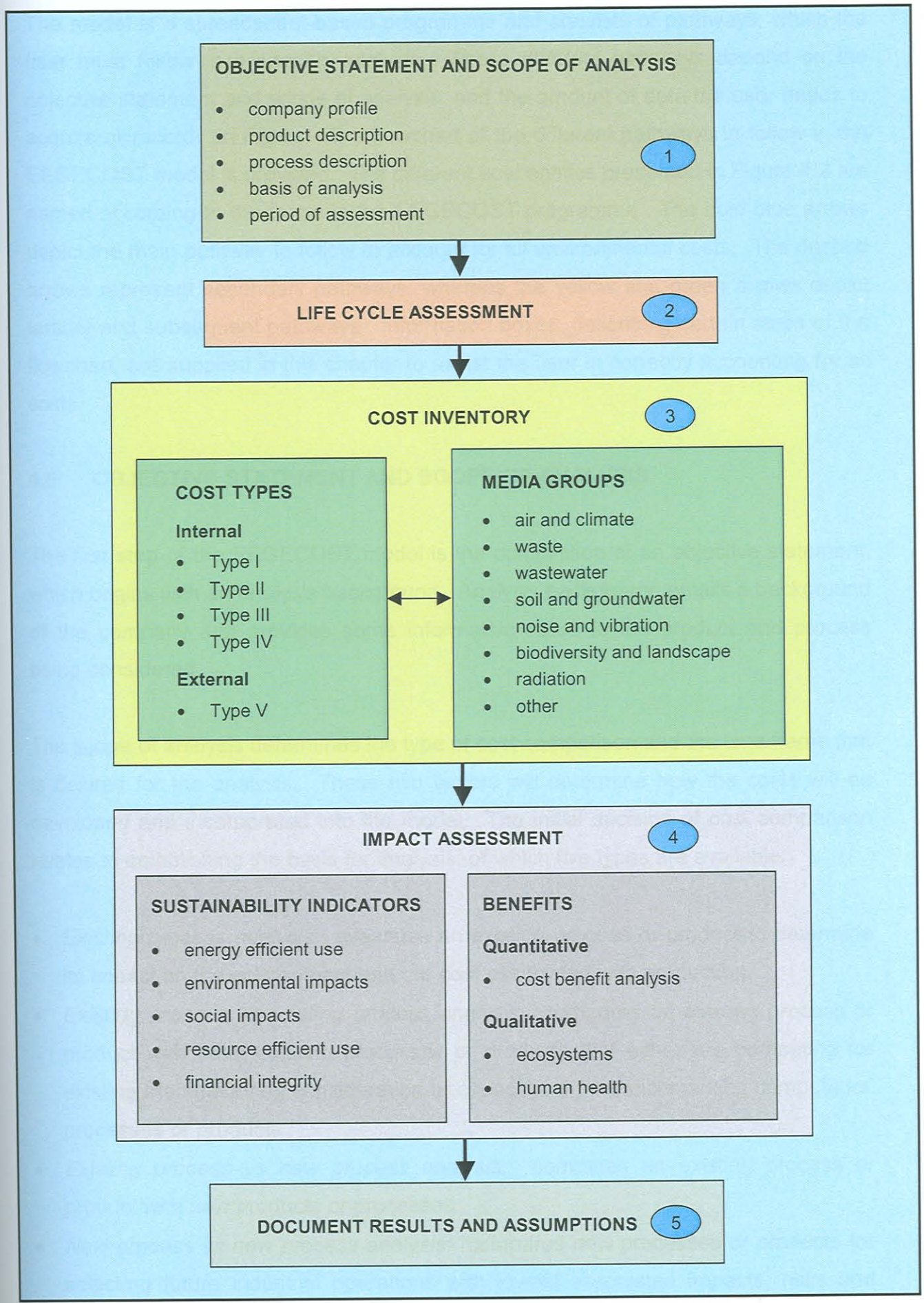

Figure 4.1 Structure of the EEGECOST model.

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.

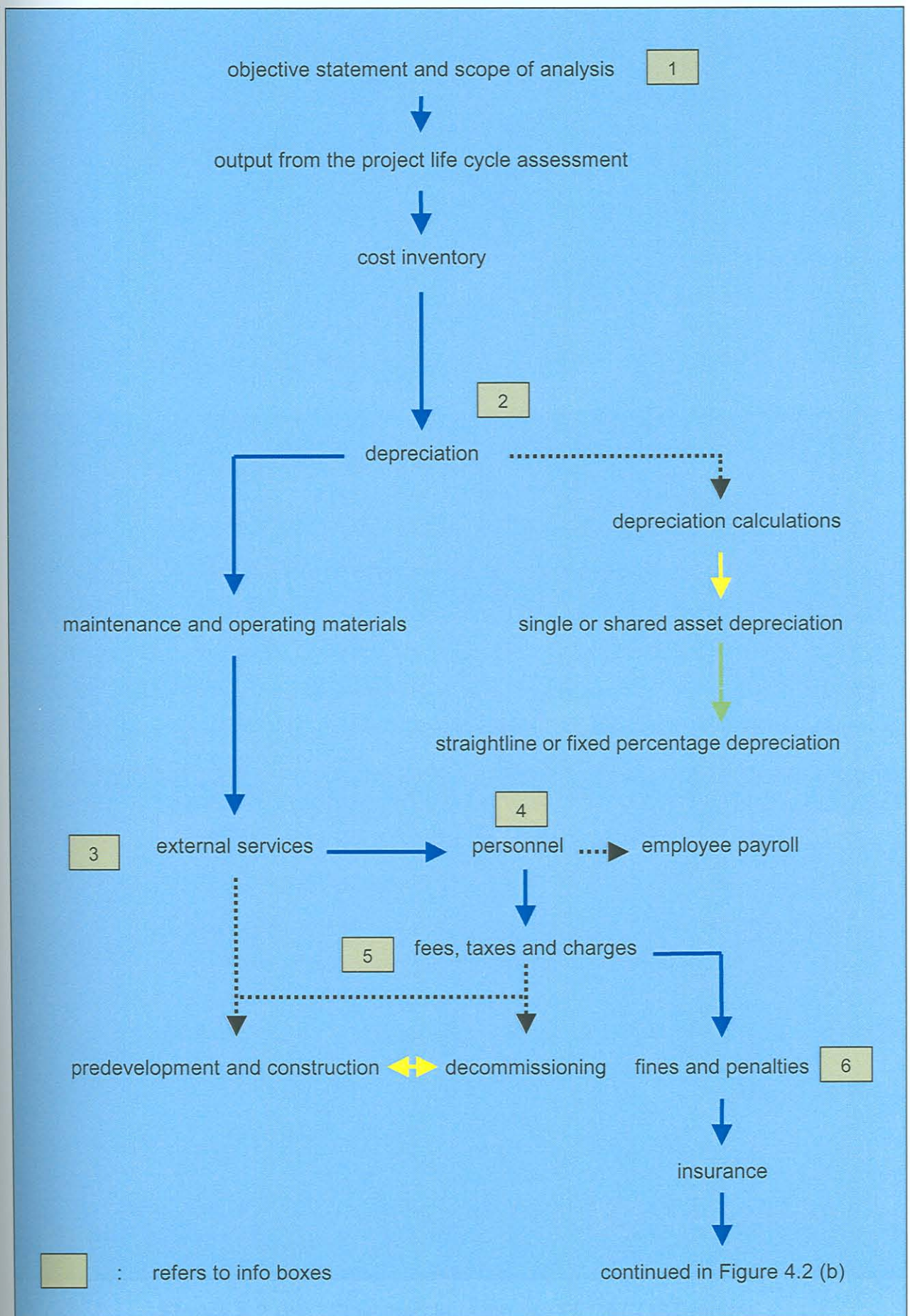

Figure 4.2 (a) Flowchart in using the EEGECOST model.

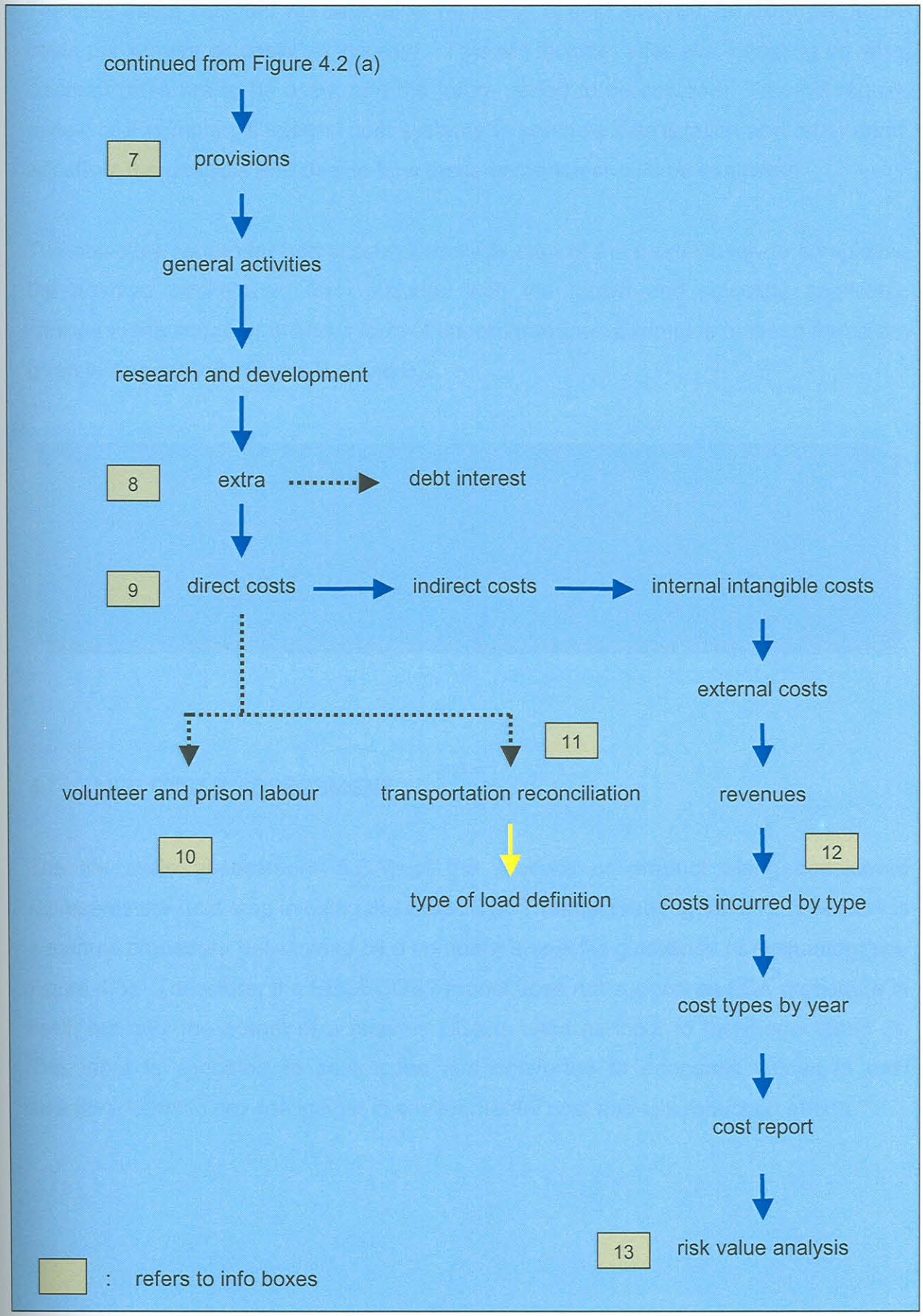

Figure 4.2 (b) Flowchart in using the EEGECOST model.

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.

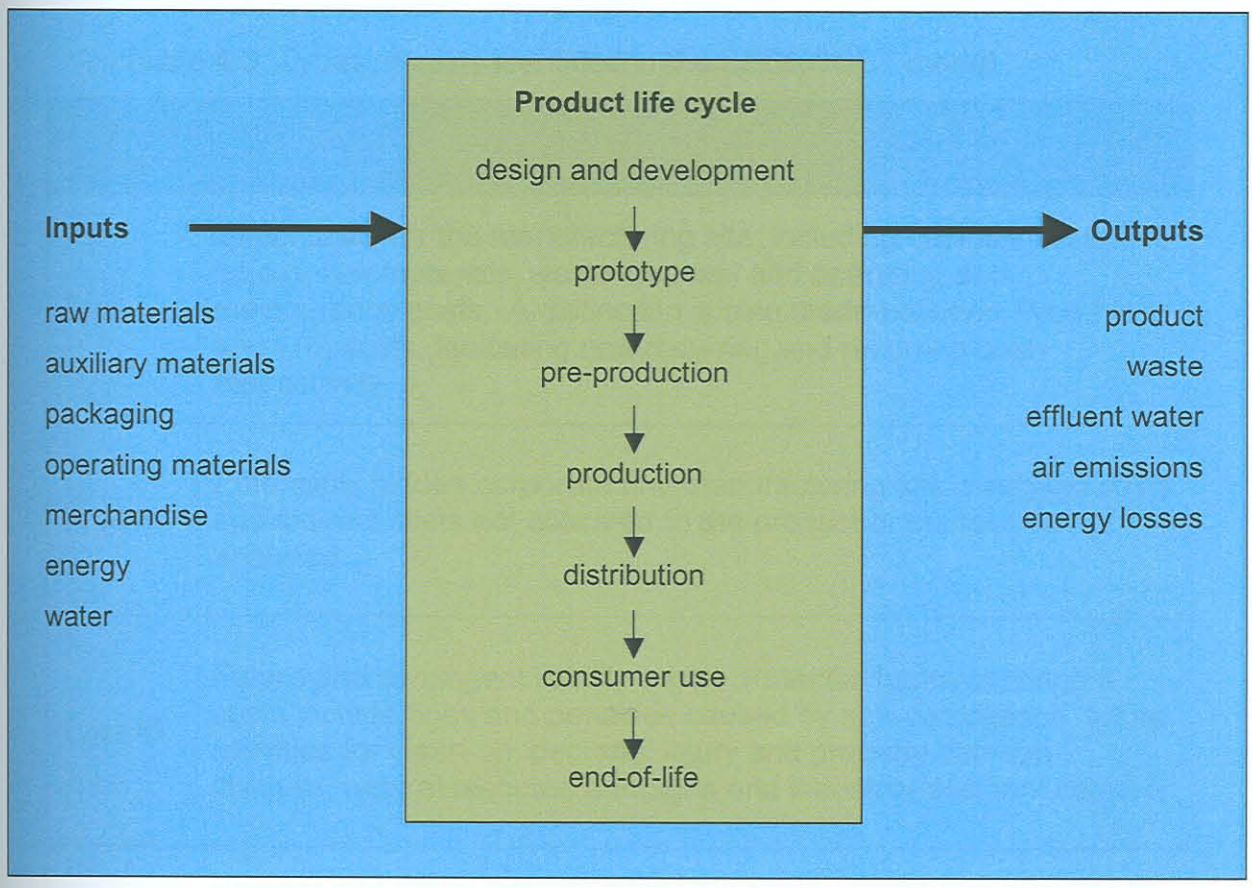

Figure 4.3 Product life cycle and material flows.

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.