Chapter 6: Case Study

6.1 Goals of Case Study

The aim of the Environmental Evaluation Matrix tool that has been developed is to identify possible areas of environmental concern. The tool has been applied to a project in the South African process industry as a case study. The goals with the case study was to determine:

- The relevance of the tool by evaluating the environmental impacts relevant to the process industries,
- The amount of value added to the decision-making process or knowledge base and
- The ease with which the tool could be applied and used.

The aim with the case study was thus to identify strengths of the tool as well as areas for improvement and to build a business case to support the application of the tool.

6.2 Background to Case Study Project

The tool was applied to a project that was identified by an industry partner. The industry partner is an international company within the South African process industry that focuses on chemical and petrochemical products. Technical experts that were involved with the project were identified and completed the scoring guideline questions of the Environmental Evaluation Matrix (EEM) tool. Technical reports were used to determine what information was available when the project moved through gates 1 to 3.

The project aimed to increase the production capability of an existing plant by 15% by upgrading, removing bottlenecks and installing new equipment. The expansion would have enabled the company to supply the expected increase in product demand in the global marketplace of 4% (at the commencement of the project). In order to increase the production capability, the company had to increase its raw material input and three alternatives options to achieve this were identified. The project investigated all three alternatives, which were:

- Alternative A: Use of coal from existing or future coal mines
- Alternative B: Use of natural gas (a new input that has not been used before)
- Alternative C: A combination of the above

The project was, however, stopped before it entered Gate 3 due to changing market conditions. Figure 6.1 indicates the dates the specific project moved through gate 1 and gate 2. The Draft Environmental Impact Report was nevertheless finished, and it was later used as a basis for a similar project the company undertook.

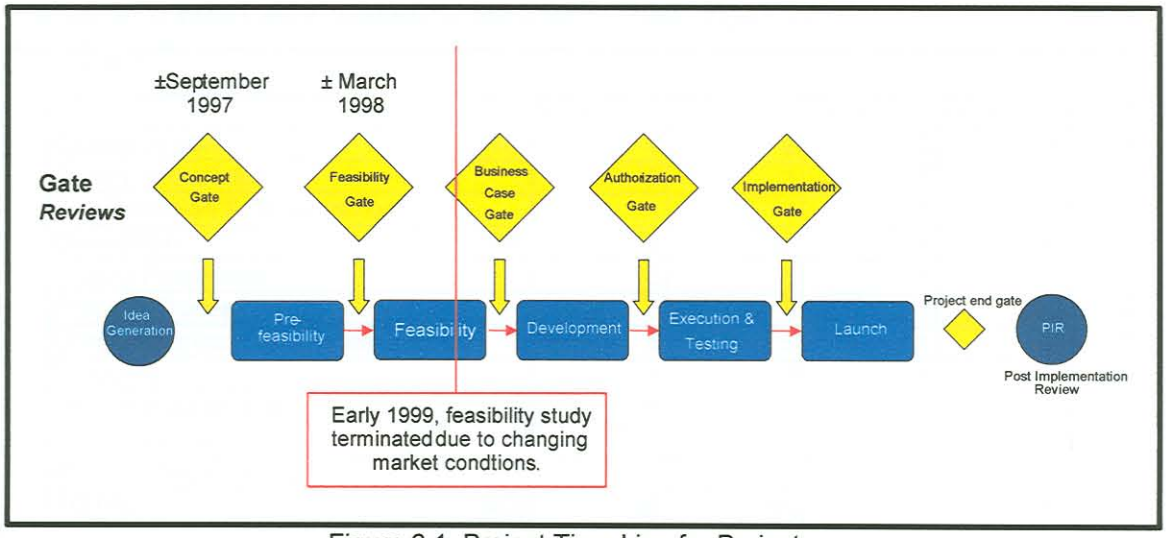

Figure 6.1: Project Time Line for Project

The same systems boundaries that were applied for the Environmental Impact Assessment (EIA) were used for purposes of the case study. Therefore, the EEM tool was only applied for the proposed 15% expansion and the environmental effects of this production increase. The technical expert regarded the environmental impacts after mitigation action to be similar for alternatives A and B. Due to the fact that the combination alternative entered the feasibility phase the scoring guidelines were only completed for alternative C.

6.3 Results

6.3.1 Values obtained from the Environmental Evaluation Matrix

The following values were obtained for the different gates (Figure 6.2):

Gate 1:

		Water	Air	Land	Mined
Construction	**(10)**	**6**	**2**	**2**	**6**
Supply Processes		5	1	1	5
Site Selection & Development		1	1	1	1
Operation	**(20)**	**16**	**12**	**4**	**12**
Supply Processes		5	1	1	5
Primary Process		5	5	1	5
Complementary Processes		5	5	1	1
Products		1	1	1	1
Decommissioning	**(10)**	**6**	**2**	**2**	**2**
Supply Processes		1	1	1	1
Process Implementation		5	1	1	1
TOTAL	**(40)**	**28**	**16**	**8**	**20**

Gate 2:

		Water	Air	Land	Mined
Construction	**(10)**	**7**	**7**	**7**	**10**
Supply Processes		4	3	3	5
Site Selection & Development		3	4	4	5
Operation	**(20)**	**10.5**	**9**	**7**	**4**
Supply Processes		4	3	3	3
Primary Process		2	1	1	1
Complementary Processes		1.5	2	3	0
Products		3	3	0	0
Decommissioning	**(10)**	**5**	**5**	**5**	**6.5**
Supply Processes		0	0	2	1.5
Process Implementation		5	5	3	5
TOTAL	**(40)**	**22.5**	**21**	**19**	**20.5**

Gate 3:

		Water	Air	Land	Mined
Construction	**(50)**	**15**	**19**	**22**	**10**
Supply Processes		10	9	9	5
Site Selection & Development		5	10	13	5
Operation	**(100)**	**47**	**28**	**34**	**32**
Supply Processes		21	11	11	17
Primary Process		16	7	11	5
Complementary Processes		5	5	5	5
Products		5	5	7	5
Decommissioning	**(50)**	**20**	**10**	**11**	**10**
Supply Processes		13	5	6	5
Process Implementation		7	5	5	5
TOTAL	**(200)**	**82**	**57**	**67**	**52**

Hotspots

Figure 6.2: Environmental Evaluation Matrices for Gate 1 to 3.

The percentage of cells that are hotspots follows no specific pattern, as 32% of the cells are hotspots at Gate 1, 59% of the cells are hotspots at Gate 2 and only 38% of the cells are hotspots at Gate 3. Since the three gates follows different evaluation methods the progress of four specific cells through the three gates were analysed on a similar scale of 0-100% (Figure 6.3). The scores for the cells at different gates were thus expressed as percentages (Table 6.1). The four cells are:

- Operation: Supply Processes: Water
- Operation: Supply Processes: Air
- Operation: Complementary Process: Land
- Operation: Supply Processes: Mined

	Operation: Supply Processes: Water		Operation: Supply Processes: Air		Operation: Complementary Process: Land		Operation: Supply Processes: Mined	
Gate 1	5	100%	1	20%	1	20%	5	100%
Gate 2	4	80%	3	60%	3	60%	3	60%
Gate 3	21	84%	11	44%	5	20%	17	68%

Table 6.1: Expressing scores as percentages

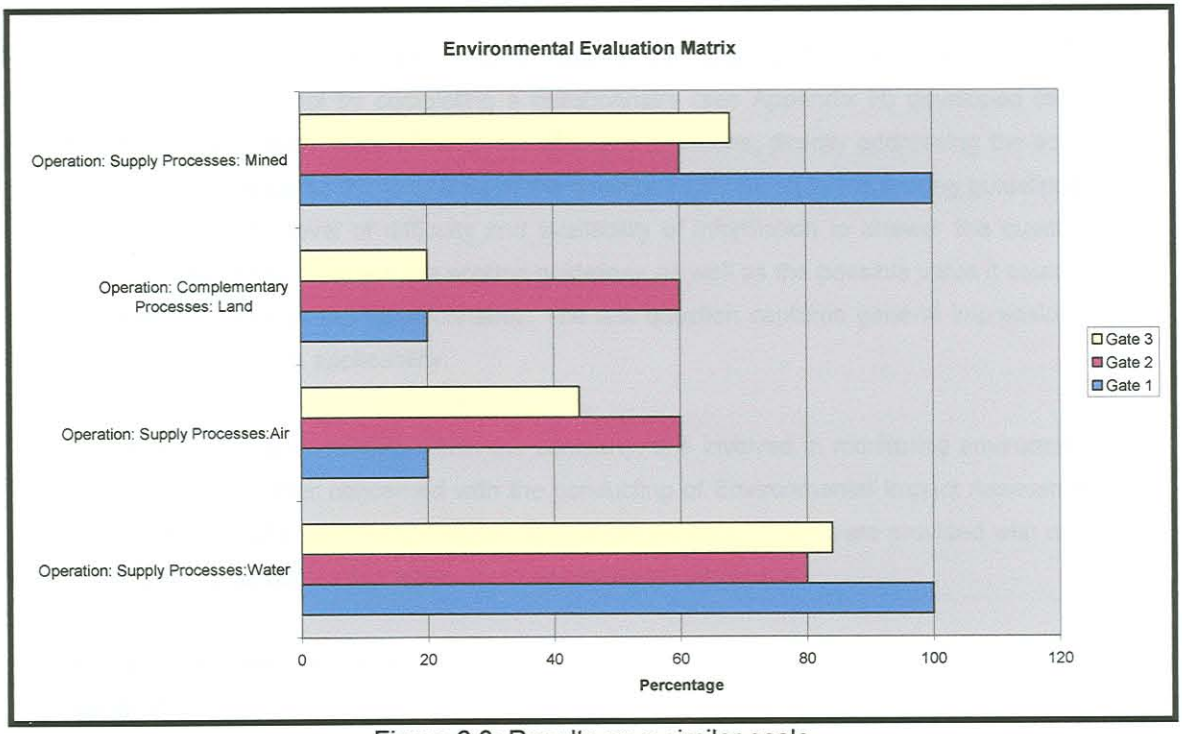

Figure 6.3: Results on a similar scale

It can be concluded that the evaluation processes at the three gates are independent from each other and that a prediction of other gate outcomes cannot be made at preceding gates. The conclusion will nevertheless have to be confirmed with more case studies. The conclusion is based on the fact that scores for individual cells follow no pattern between the

various gates. Various patterns were identified, some which are followed by more than one cell e.g. for the cell "Operation: Supply Processes: Water" as well as for "Operation: Supply Processes: Mined" the score decreased between Gate 1 and 2 and then increases between Gate 2 and 3. This is however not the case for "Operation: Supply Processes: Air" where the score first increases and then decreases. Further case studies can be used to analyse the various patterns and to attempt to find correlation between them.

It is not possible to truly interpret the results of the EEM applied to the case study since there is nothing to measure it against. The conclusion was thus reached that completed projects should be used as case study to determine matrix values to measure results against. That would also improve the interpretation of the results since the environmental effects of completed projects can be compared with the projects' matrix evaluations.

6.3.2 Feedback on application of environmental evaluation matrix tool

The goals with the feedback sessions were to obtain opinions on the scoring guidelines and to determine who, inside the organisation, should complete the scoring guidelines. Feedback was obtained from the process engineers who managed the technical aspects of the project and who completed the scoring guidelines as well as from environmental specialists within the company.

The project technical experts provided feedback on the nature of the questions as well as the applicability of the tool by completing a questionnaire (see Appendix H) developed for this purpose. The questionnaire consists out of seven questions, directly addressing the scoring guidelines. It evaluates the relevance of the questions addressed in the scoring guidelines as well as the clarity, level of difficulty and availability of information to answer the questions. The time needed to complete the scoring guidelines as well as the possible value it could add are also evaluated in the questionnaire. The last question captures general impressions of the matrix tool and its applicability.

Two environmental specialists within the company, one involved in monitoring environmental impacts and the other concerned with the conducting of Environmental Impact Assessments (EIA), were identified as environmental responsible persons. They were provided with copies of the scoring guidelines and asked to complete the questionnaire.

a) Project technical experts

General:

The project technical experts note the scoring guidelines' "pre-gate" focus, taking the environmental effects and impacts of the extraction, purification and/or conversion of raw materials into consideration as part of supply processes of all three phases. This aspect of the scoring guidelines is highlighted as extraordinary, especially in the construction phase

since the current models within the company do not consider the environmental friendliness of raw material manufacturing for construction purposes. It only focuses on total life cycle cost and the safety of use of a material. This highlights the priorities of the process industry, i.e. safety and costs over the plant life cycle. At this stage, it seems that environmental issues are not considered at all during the phase of plant construction. The environmental impacts of raw material manufacturing are thus ignored as long as the chosen raw material is bought from an approved vendor.

The "Yes/No" nature of the questions is criticised by the project technical experts. They feel answers or alternative options must be provided in quantitative terms in order to minimize emotional and subjective judgements. They are also of the opinion that more detail on the intensity of occurrence or quantity of occurrence should be provided at Gate 2, since there is a vast difference between for example 1000 litres of water and 1 million litres of water being used.

The project technical experts identified certain questions for which the information is not available at the specific gates. For example, supplier agreements with regards to packaging material are not in place at Gate 2 although specific design philosophies, which guide processes that are only finalized post Gate 4, exist.

It is noted that for some questions one of the answers is impossible to occur e.g. C 2.1 question one *"Is the construction process designed to avoid the use of water?"* where a positive answer is impossible since all construction processes need water. The project technical experts also feel that some of the questions are "Not Applicable" to the specific project e.g. C 2.1 question three *"Is the site such that it can be made operational with minimal production of residues with high water pollution potential?"*

Construction:

Certain questions in the scoring guidelines address the design of the construction phase. The project technical experts are of the opinion that although the impacts of construction should be taken into consideration, the design of the construction process fell outside company boundaries and is the responsibility of the contractor. The company does specify to the contractor that the safe disposal of waste and chemical residue, etc. is responsibility of the contractor. Questions addressing the design of the construction process are thus regarded as irrelevant.

The project technical experts note the difference between optimised and minimised solutions. Many questions asked whether certain possible impacts have been minimized, e.g. transportation of construction materials. An optimised solution is found, mostly centred around cost-effectiveness, which is not always the optimal environmental solution.

Operation

The relevance of questions, with regards to design considerations focused on energy use, is questioned by the project technical experts since *"any plant is designed to strike a balance between OPEX (cost of energy) and CAPEX vs available technology vs legislation"*.

Decommissioning

The project technical experts note that the decommissioning process has not been designed at Gate1, 2 or 3 of the project life cycle. Therefore all questions related to the design of the process must be negative. Decommissioning is apparently not considered when a process is being designed and implemented.

b) Environmental experts

Environmental Specialist A:

The first environmental expert is of the opinion that the scoring guidelines address too many aspects, with a lack of emphasis on detailed analysis. The project technical experts' view that the rating is too subjective is supported. The environmental expert do, however, rate the clarity as good but hold the opinion that the scoring guidelines must provide more examples and be more company specific. The availability of the information to answer the questions identified as a main problems. It is noted that the scoring guidelines included a focus on products, packaging material and the decommissioning phase, which is not currently included in analyses.

The environmental specialist states that the current scoring guidelines could not be applied in the company and suggests that perhaps scoring guidelines of this nature should only focus on fewer aspects, in the region of ten aspects for example, and should apply a quantitative scoring system.

Environmental Specialist B:

The second environmental expert also notes that the scoring guidelines address decommissioning, products as well as a "pre-gate" focus which is not currently part of the evaluation process. This environmental expert shares the project technical experts' views on "pre-gate" focus inclusion in such a document as well as the fact that some questions are "Not Applicable" to all projects (see section 6.3.2b). The environmental expert is especially concerned about whether the answers to the questions should take mitigation actions into consideration or not. The opinion was expressed that the design team must be involved in completing the scoring guidelines since so many questions address design decisions.

6.4 Conclusions & Recommendations

The following strengths and weaknesses are identified based on the feedback received (Table 6.2):

Strengths	Weaknesses
The scoring guidelines address aspects currently ignored such as products, decommissioning and "pre-gate" activities.	The questions are too general, not detailed enough and with inadequate examples, descriptions and quantitative measures.
It forces the design engineer to consider environmental aspects often not considered.	Lack of available information to answer the questions.
	Subjective rating system.

Table 6.2: Strengths and Weaknesses of Scoring Guidelines

The scoring guidelines' approach to consider the environmental aspects of "pre-gate" operations is in line with *greening the supply chain* or *supply chain environmental management* initiatives. This concept of supply chain environmental management is observed as a recent and novel managerial principle, especially in South East Asia (Rao, 2002). Since this part of the EEM tool was met with scepticism, it is recommended that the concept be introduced into industry practices through additional environmental criteria to evaluate suppliers against. Table 6.3 lists examples of environmental questions that can be used to evaluate suppliers' environmental performance (Yarwood & Eagan, 1998). Companies can even assign rating values to the answers thereby rating approved suppliers.

	Yes/No
Does the supplier have an Environmental Management System (EMS) in place?	
Does the supplier have formal energy conservation practices in place?	
Does the supplier have ISO 9000 in place?	
Does the supplier have ISO 14000 in place?	
Does the supplier publish an environmental report regularly? Annually Bi-annually	
Does the supplier have a water conservation program in place?	
Does the supplier have a formal program in place for minimizing air emissions?	
Does the supplier have adequate operational procedures in place to address unplanned environmental impacts?	

Table 6.3: Examples of questions to address environmental performance of suppliers

Source: Adapted from Yarwood & Eagan, 1998.

It is evident that the generic scoring guidelines cannot be applied directly within a specific company. The scoring guidelines will have to be adapted according to the company-specific needs and priorities, so that a quantitative rating system can be used. A generic quantitative rating system cannot be developed since there are no agreement on what quantity of impact is regarded as negligible and what as a project terminator. Based on the feedback that information is not available at the various phases, it is questionable whether quantitative environmental information will be available before Gate 3. The only threat in adapting the scoring guidelines for a specific company, is that certain aspects the company do not focus on might be ignored although these may be very relevant and of concern.

It is true that the scoring guidelines address many aspects and do not focus on detailed analysis. The original concept, however, was that the scoring guidelines should provoke environmental considerations in the design phase and inform decision makers of potential environmental concerns. Detailed analysis can be done during the Environmental Impact Assessment.

One case study cannot be entirely conclusive. It is recommended that the scoring guidelines must be applied in a "real-time" project, as it moves through the phases and gates, since only then a reliable conclusion on the impact of the scoring guidelines on the design and decision making phases can be drawn.

The scoring guidelines do add value, even if it only highlights aspects currently ignored. No conclusion could, however, be reached on whether the value added justify the time consumption of the scoring guidelines. It is furthermore concluded that the scoring guidelines of the EEM tool should be completed by a team of project and environmental responsible persons with different viewpoints and expertise.