CHAPTER 3

METHODOLOGY

3.1 Introduction

To attain the goal of this study, a list of environmental aspects and impacts of an electrical/ electronic industry, which is seeking the ISO 14001 certification, is taken as the core data for this study. However, not all of the identified environmental aspects and impacts are used in this study. A sample of 8 for each issue of concern is taken randomly from the list of environmental aspects and impacts register. The entire study is carried out by participant observation in an environmental consulting firm.

3.2 Literature review and internet search

For all the areas of this research, an extensive use of myriad of materials published in print and on the Internet are assessed. The printed materials included the MS ISO 14001 and MS ISO 14004, books, articles, journals and seminar papers.

3.3 Document review

The Initial Environmental Review (IER) and internal audits findings are reviewed in order to have a comprehensive understanding and baseline information of the

company' s position with respect to the environment during the initial stage of EMS development.

3.4 Legal review

In order to assess the possible legal implications of ISO 14000, all legislative, regulatory and other codes of practice as well as the corporate standards applicable to the company's activities, products and services are identified and reviewed.

3.5 Personal interview

Personal communications with consultants, auditors and key personnel involved with environmental activities in the electrical/electronic industry are carried out in order to gain more information, comments and experiences.

3.6 Methodologies for assessing significant impacts

For the purpose of this study, three methods that have been developed by a consulting firm are applied for assessing the significant impacts, namely:

- Method A (qualitative)
- Method B (quantitative)
- Method C (quantitative)

3.6.1 Method A –Qualitative Assessment

(I) Identifying Probability

Firstly, the probability of the impact occurring is identified by using a separate Significance Assessment Matrix (SAM) for each environmental aspect. Table 3.1 shows the probability criteria of the SAM, e.g. air emission– release of HCL fumes. Column that is appropriate for the probability is then selected and this will define the level of significance associated with the different severity criteria.

Table 3.1: Significance Assessment Matrix (SAM) - Probability

Environmental Aspects : Release of HCL fumes					Environmental Impact: Local air pollution			
SEVERITY					***PROBABILITY***			
Regulatory Compliance	*Corporate Standards*	*International Issues*	*Environment*	*Reputation*	***Very Likely***	***Unlikely***	***Likely / Occasional***	***Routine***
Not under regulatory control	No Corporate Standards exist	No International issues	No Receptor	Would be noticed	Low	Low	Low	Low
Release well below legal limits	Well below corporate standards	Subject to debate by NGOs / International concern	Minor impact on receptor / resource used	Community awareness (minor concern)	Low	Low	Medium	Medium
Release close to legal limits or where compliance status is not verified	Release below Corporate Standards	Action being taken at government or industry levels	Short term major (long term minor) impact on receptor / resource used	Likely to result in complaint from local community or staff member	Low	Medium	High	High
Release above legal limits	Release above Corporate Standards	Issue could prevent or limit access to overseas market	Long term major impact on receptor / resource used	Potential Media coverage	Low	Medium	High	Top

Identification of probability

Probability Criteria	
Very unlikely	Impact could arise under emergency conditions (eg. Fire/explosion)
Unlikely	Impact could arise if control mechanism fail / has happened less than twice per year
Likely / Occasional	Impact could arise if control mechanism fail / has happened more than twice per year
Routine	Impact arises during normal operations

(II) Identifying Severity

For each aspect, there are five key criteria to be determined in order to assess the significance priority:

i) Regulatory compliance:

is the impact under consideration regulated under the laws of Malaysia or international laws that apply to the organisation's operations, does the impact meet requirements or limits imposed? Or the organisation does not know the compliance status due to the lack of monitoring data?

ii) Corporate standards:

are there any standards or limits, which are set by the organisation or corporate headquarters?

iii) International:

are there any environmental issues that are the concern of the international or regional community that might affect the way in which third parties view the organisation conducts its business?

iv) Environment:

what kind of damage will be caused to a receptor (e.g. flora, fauna, marine, aquatic and terrestrial, neighbours, groundwater, rivers, buildings)? For materials and natural resources this topic considers whether the resource is renewable or not and whether the materials require special measures for use, handling and storage)

v) Reputation:

what kind of damage could be done to the reputation of the organisation should the impact occur. Community is defined as the employee and community within the boundary of 3km of the facility.

The responses to these questions will define the individual levels of significance for each significance criteria. Then, the significance ranking is inserted at the bottom of the column. The highest ranking in any column will define the maximum significance ranking for the impact under review. For example, Table 3.2 shows the severity of an environmental aspect –release of HCL fumes. The highest ranking falls on the environment criterion column. The level of significance is identified as "high".

Table 3.2: Significance Assessment Matrix- Severity

Environmental Aspects : Release of HCL fumes					Environmental Impact: Local air pollution			
SEVERITY					*PROBABILITY*			
Regulatory Compliance	***Corporate Standards***	***International Issues***	***Environment***	***Reputation***	*Very Likely*	*Unlikely*	*Likely / Occasional*	*Routine*
Not under regulatory control	No Corporate Standards exist	No International issues	No Receptor	Would be noticed	Low	Low	Low	Low
Release well below legal limits	Well below corporate standards	Subject to debate by NGOs / International concern	Minor impact on receptor / resource used	Community awareness (minor concern)	Low	Low	Medium	Medium
Release close to legal limits or where compliance status is not verified	Release below Corporate Standards	Action being taken at government or industry levels	Short term major (long term minor) impact on receptor / resource used	Likely to result in complaint from local community or staff member	Low	Mediu m	High	High
Release above legal limits	Release above Corporate Standards	Issue could prevent or limit access to overseas market	Long term major impact on receptor / resource used	Potential Media coverage	Low	Mediu m	High	Top

Identification of probability

Probability Criteria:	
Very unlikely	Impact could arise under emergency conditions (eg. Fire/explosion)
Unlikely	Impact could arise if control mechanism fail / has happened less than twice per year
Likely / Occasional	Impact could arise if control mechanism fail / has happened more than twice per year
Routine	Impact arises during normal operations

(III) Level of control

Lastly, the level of probability is adjusted again according to the level of control to get the final judgment of the significance level. Table 3.3 is used to identify the level of control of an environmental aspect. For the case of release of HCL fumes, there are some physical and management control, therefore, the probability level remains.

Table 3.3: Adjust probability according to level of control

Level of control		Tick	
1	Very high level of physical & management control		If this is selected, reduce probability by 1 level
2	Some physical & management control	✔	If this is selected, probability level remains
3	Poor or no physical or management control in place		If this is selected, increase probability level by 1

Table 3.4: Significance Assessment Matrix

Environmental Aspect: Release of HCL fumes					Environmental Impact: Local air pollution			
SEVERITY					***PROBABILITY***			
Regulatory Compliance	***Corporate Standards***	***International Issues***	***Environment***	***Reputation***	***Very Unlikely***	***Unlikely***	***Likely / Occasional***	***Routine***
Not under regulatory control	No Corporate Standards exist	No International issues	No Receptor	Would not be noticed	Low	Low	Low	Low
Release well below legal limits	Well below Corporate Standards	Subject to debate by NGOs / International concern	Minor impact on receptor / resource used	Community awareness (minor concern)	Low	Low	Medium	Medium
Release close to legal limits or where compliance status is not verified	Release close to Corporate Standards	Action being taken at government or industry levels	Short term major (long term minor) impact on receptor / resource used	Likely to result in complaint from local community or staff member	Low	Medium	High	High
Release above legal limits	Release above Corporate Standards	Issue could prevent or limit access to overseas market	Long term major impact on receptor / resource used	Potential Media coverage	Low	Medium	High	Top

Probability criteria:	
Very unlikely	Impact could arise under emergency conditions (eg. Fire/explosion)
Unlikely	Impact could arise if control mechanism fail / has happened less than twice per year
Likely / Occasional	Impact could arise if control mechanism fail / has happened more than twice per year
Routine	Impact arises during normal operations

Level of control:			
Level of control		Y/N	
1	Very high level of physical & management control		If this is selected, reduce probability by 1 level
2	Some physical & management control	✔	If this is selected, probability level remains
3	Poor or no physical management control in place		If this is selected, increase probability level by 1

Priority Rating	
Low	Not a priority for management
Medium	Manageable situations
High	Set specific targets & programs for improvement
Top	Immediate actions required

Significance level = High

3.6.2 Method B- Quantitative Assessment

This is a quantitative method, which involves a scoring scheme. It consists of five key criteria on environment and four key criteria on business. To obtain the final score for each of the aspect, the score for each key criterion is determined, and multiplied them all together. The higher the score, the more significant the environmental impact. The scores are ranked in position in order to prioritise actions to be taken.

The key criteria included in the method are defined as below:

i) Scale of impact:

the coverage of impacted areas. Is it within the facility boundaries, or does it extend to local, regional or even global scales?

ii) Severity of impact:

the seriousness of the impact.

iii) Probability of occurrence:

the likelihood of an aspect occurring. How possible is it?

iv) Duration of impact:

the period during which the impact is felt. How long does the impact last?

v) Regulatory /Legal exposure:

applicable regulation to the aspect. Is the aspect regulated under any law or regulation?

vi) Technical feasibility:

Is there any alternative technology to reduce impact?

vii) Economic feasibility:

The economic viability of applying the alternative technology.

viii) Customer benefits:

Is the application of available alternatives to reduce the impact preferred by the customers?

ix) Public image/Stakeholder concerns:

Will the application of available alternatives improve the company's image?

Table 3.5: Scoring matrix of Method B - example of calculation (e.g. air emission – release of HCL fumes)

Scale of impact

Score	Description
1	On site only. Impacts do not extend beyond plant boundary
3	Site vicinity, local community
5	Regional (e.g. air basin, watershed area, etc.)
7	Very large geographical region, hemisphere or global impact

Severity of impact

Score	Description
1	Negligible damage or harm
3	Marginal /minor damage or harm but clearly detectable impact e.g. within regulation limits
5	Critical /substantial damage or harm. Significant environmental. Degradation attributable to a discrete environment. Aspect or that contributes to a known violation or exceed standard.
7	Life threatening or catastrophic impact.

Probability of occurrence

Score	Description
1	Improbable. Very unlikely or rare occurrence, less than once every ten years.
3	Remote. Unlikely occurrence, less than once per year.
5	Probable. Likely more than once per year.
7	Frequent. Very likely to certain. More than once per year to on-going /routine.

Duration of impact

Score	Description
1	Less than one day.
3	One day to several days.
5	Several days to several weeks or months.
7	Greater than one year.

Regulatory /Legal exposure criteria

Score	Description
1	No legal requirement.
3	Minor penalty or fine for non-compliance /violation (e.g., nuisance complaint, minor notice violation) Little or no potential for plant shutdown / no major operational disruption. No criminal law applicability.
5	Significant legal or regulatory compliance requirements. Major permit condition. Potential for significant operational impacts, production delays, constraints, or plant shutdown. Major regulatory fines or penalties for violations or non-compliance. Criminal law applicability.

..... continuation of Table 3.5: Scoring matrix of Method B - example of calculation (e.g. air emission – release of HCL fumes)

Technical feasibility criteria

Score	Description
5	Limited. Best available control technology or equivalent is already applied. Major technical challenges, disruptions or adverse impacts to product quality or productivity would occur. Alternatives are unproven for this application.
3	Reasonable. Alternative technologies exist. Implementation can occur with some limited impact to operations, productivity or product quality. Some technical barriers to overcome.
1	High. Proven alternative technologies exist. Implementation can occur with minimal technical barriers to overcome.

Economic feasibility criteria

Score	Description
5	Not economically viable. Return on investment criteria cannot be satisfied. Excessive capital or operating costs. Inadequate funding available.
3	Marginally viable. Minimum return on investment criteria may be achieved. Adequate funding is or may be available. Investment would be considered significant.
1	Viable. Return on investment criteria can be satisfied. Adequate funding is very likely to be available.

Customer benefits criteria

Score	Description
5	Marginal or Negative. Application of available alternatives would have undesirable ramifications from the customer's perspective (e.g., increase in price).
3	Acceptable. Application of available alternatives would be the customer.
1	Preferred or desirable. Customer would prefer available alternatives, given projected impacts to product price and quality.

Public image / Stakeholder criteria

Score	Description
5	Marginal or Negative. Application of available alternatives would not have a positive impact on affected stakeholders or improve company's public image.
3	Acceptable. Application of available alternatives would have a slight positive impact on affected stakeholders or marginally improve the company's public damage.
1	Preferred or desirable. Application of the available alternatives would have a very positive impact on affected stakeholders and /or clearly contribute to a positive public image.

Total score = 3x5x5x5x5x1x3x3x1

= 16875

3.6.3 Method C – Quantitative Assessment

Method C is a quantitative method, which involves a numerical scoring system. This method categorised the significance level into three ranges: "very significant", "significant" and "non-significant". The key criteria used in this method are defined as below:

i) Legislation:

is the impact under consideration regulated under the laws of Malaysia or international laws that apply to the organisation's operations? Does the impact meet requirements or limits imposed? Organisation does not know the compliance status due to the lack of monitoring data?

ii) Local impact:

the coverage of impacted areas. Environmental impact on local scale.

iii) Impact on external community:

community within the boundary of 3km of the facility.

iv) Regional /Global impact:

environmental impact on regional /global scale.

v) Policies /Directives:

is the impact governed under any Malaysian or international's policy /directive?

vi) Management costs:

the cost of managing the impact.

vii) Customer satisfaction /Demand and competitive advantage:

if an impact arises, what is the response of the customers?

viii) Frequency of occurrence:

how frequent does an aspect occurs?

ix) Seriousness of impact:

how serious is the impact?

Once a score is determined for all key criteria, the score of frequency and seriousness has to be multiplied. The figure is then used to multiply the other criteria. Finally, the score for all the criteria are added together to determine the significance. The score is classified according to the range of significance:

- "very significant"

  - when V equal to or above 63 ($V \geq 63$)

- "significant"

  - when V is equal to or above 28 but not more than 63 ($28 \leq V < 63$)

- "non-significant"

  - when V is below 28.

Table 3.6: Scoring matrix of Method C - example of calculation

Environmental aspect: Discharge of HF and HNO3 acid fumes
Environmental impact: Air pollution and acid rain

Legislation

1	No legislation
2	There is administrative legislation regulating reporting requirements which do not impose sanctions
3	Substantial legislation exists with sanction and emission limits, but emissions are within these limits / compliance status not known
4	Restrictive legal requirements, emissions close to the limits imposed

Local impact

1	No impact
2	Impact is minimum (environmental impact on local scale which is under control)
3	Impact is significant (environmental impact on local scale which is not under control)
4	Impact is high (environmental impact on local scale)

Regional /Global impact

1	No impact
2	Impact is minimum (environmental impact on regional /global scale which is under control)
3	Impact is significant (environmental impact on regional /global scale which is not under control)
4	Impact is high (environmental impact on regional /global scale)

Impact on external community

1	No impact
2	Impact is minimum (request of information by external community)
3	Impact is significant (possibility of impact on external community)
4	Impact is high (impact on external community)

Policies /Directives

1	No reference to government policies /directives
2	Reference with regards to formal government policies /directives in the form of communications
3	Substantial reference to government policies /directives; situation does not comply in communication requirements
4	Situation in non-compliance with government policies /directives

..... continuation of Table 3.6: Scoring matrix of Method C - example of calculation

Management costs

1	No impact
2	Low cost
3	Medium costs
4	High /Very high cost

Customer satisfaction /Demand & competitive advantage

1	No impact
2	Customer queries
3	Potential loss of market share
4	Loss of market share

Frequency

1	Never
2	Rarely
3	Often
4	Always

Seriousness

1	Not serious
2	Serious
3	Very serious

Example of calculation:

Frequency	= 4
Seriousness	= 3
Legal requirement	= 3 x frequency (4) x seriousness (3) = 36
Local impact	= 4 x 4 x 3 = 48
Regional /Global impact	= 2 x 4 x 3 = 24
External community	= 4 x 4 x 3 = 48
Policies /Directives	= 1 x 4 x 3 = 12
Management costs	= 3 x 4 x 3 = 36
Customer satisfaction /Demand & Competitive advantage	= 2 x 4 x 3 = 24
Total	= 36 +48 + 24 + 48 + 24 + 48 + 36 +24 = 228

Significance level = "very significant"