CHAPTER 3
RESEARCH METHODOLOGY AND DATA COLLECTION

3.1 RESEARCH METHODOLOGY

The first phase of the research study involves the collection of relevant data of all projects in the industrial sector approved under the EIA Order (1987) for the period between April 1988 and December 1998.

The second phase involves systematic analysis of plant-level effluent data generated by using the World Bank's U. S. based industrial pollution projection program *Decision Support System for Integrated Pollution Control* (DSS/IPC) to identify major sources of the priority pollutants. The relative importance of the pollution sources or industrial sectors is assessed by estimating their respective pollution loads discharged.

The third phase involves assessment of the effectiveness of the DSS/IPC system for application in Malaysia. Finally, additional studies and programmes are proposed to complement this research project.

3.2 USE OF THE DSS/IPC SYSTEM

The DSS/IPC system is a product of the joint effort of World Bank, World Health Organization (WHO), Pan American Health Organization (PAHO), Tebodin Consultants and Engineers, and Dutch Institute for Health and Environment (RIVM). The software automates the framework for pollution load inventory and environmental assessment in a given area described in the WHO/PEP/89.1 document *Management and Control of the Environment* 1989. It incorporates the module for the calculation and analysis of pollution control costs in order to assess rapidly the pollution situation in a specific geographical location and to analyse alternative pollution control strategies and policies.

The DSS/IPC system is a personal computer based software package that comprises a set of extensive databases and a number of computation modules. Computation modules enable a user to estimate: firstly, air, water and solid waste emissions based on the inventory of economic activities for a given location; secondly, the ambient concentrations of air and water pollutants by using simple (screening) dispersion models with minimum meteorological and hydrological data; thirdly, the total costs of control options by using standardized engineering-type cost functions; and finally, the long-run marginal cost schedules to achieve a certain level of emission reduction (or decline in ambient concentration) for a chosen pollutant.

In support of the calculation and analysis, the DSS/IPC software contains the following data bases, compiled by media of discharge:

1) the pollution-intensive technological processes across all sectors of economic activity, including mining, manufacturing industries, energy, transport and municipal sector, that are grouped according to the UN International Standard Industrial Classification (ISIC) at 4-digit level;
2) the principal control options available for each process, including good housekeeping and waste prevention programmes;
3) the emission factors, associated with these processes and "process-control option" combinations;
4) the normalized cost units and parameters for control technologies; and
5) the health guidelines for air and water pollutants where applicable.

3.3 IMPLEMENTATION OF THE DSS/IPC SYSTEM

The DSS/IPC system runs under Windows 3.1x and has convenient export/import links with Microsoft Excel or other data processing programs. The database is maintained in Microsoft Access, but can be manipulated directly through the DSS/IPC software. The minimum PC hardware requirements are 486 processor with 12 Mb internal memory and 250 Mb hard disk.

To start a study, a user has to define areas (one or several) by which all subsequent information will be processed and presented. The minimum data for each area to be used by the system comprises output or input for major industries (at a four-digit ISIC level), together with basic information on municipal services and traffic, as well as existing levels of pollution controls. If the analysis includes water pollution, then rivers and lakes that receive discharges from the area(s) should be defined as well.

From this information, the DSS/IPC can estimate air, water and solid waste pollution loads, using default emission coefficients. The estimates can be refined with further knowledge of local emission factors and control technologies (which can be used to calibrate default values). Based on these loads, simple air and water dispersion models offer estimates of pollutant concentrations if basic geographical data are provided.

The system contains two air dispersion models and five water models which can be selectively run by the user in any combination.

For air quality modeling, a very simple "area" model calculates the annual average concentration of a pollutant as a result of emissions from all sources identified in the area, and a more complex "point source" model which generates the maximum hourly ground level concentration of a pollutant (with the corresponding downwind distance) that is attributed to a particular source of emissions, like a power plant.

Water quality models enable a user to calculate annual (or seasonal) mean concentrations of conservative substances in a river or lake; critical phosphorus load for a lake (relative to estimated load); and dissolved oxygen deficit, as well as the decaying levels of coliform in a river downstream of the discharge point.

For solid waste, as a tool to identify the potential hazardous wastes, the DSS/IPC system would categorise the waste based on a comprehensive list of activities which are likely to create hazardous waste as published in the Hazardous Waste Act of the Netherlands in 1991.

After ambient concentrations for air, water or solid pollutants are estimated and priority pollutants are defined, the DSS/IPC system can generate the total and marginal costs for the different levels of controlling selected pollutants. These costs are based on standardized functions and a set of default parameters, which can also be refined by using locally specific economic data.

3.4 DATA COLLECTION

This research project served as an initial attempt to build a database containing an inventory of all potentially polluting industrial projects approved under the EIA Order (1987) for the period between April 1988 and December 1998 (See Table 1.1 under Chapter One). In order to establish a reliable picture of industrial pollution, an extensive exercise was conducted to obtain data from DOE for the 257 EIA reports categorised under the industrial sectors within that period. Data collected include the year of EIA reports, project title, project site, type of EIA either preliminary or detailed, the project proponent, EIA consultant, production method and output, and pollution control measures used. These information are summarized under Appendix A, where the EIA reports have been categorized into various industrial subsectors.

Appendix B.1 recorded all the International Standard Industrial Classification (ISIC) activities and their correlated processes accounted for by the DSS/IPC industrial pollution projection system. This categorization corresponds to ISIC established by the United Nation's Bureau of Census to track the flow of goods and services within the economy. The ISIC codes facilitate comparisons between facility and industry data. Appendix B.2, B.3 and B.4 presented data files with emission factors, reduction measures and reduction factors by polluting processes and relevant pollutants that used in the DSS/IPC package.

Out of the 257 approved EIA projects, 142 EIA reports has been identified and referred, while the balance of 115 EIA reports are presumably misplaced or lost at DOE's libraries. This caused a constraint to the full analysis of the extent and pollutant distribution pattern; resulting in only a 55.3% coverage of evaluation scope being established. The referred EIA reports are further subdivided to reflect their categories under the main industries in Malaysia to be discussed in Chapter Four.

Moreover, among the 142 EIA reports been evaluated, 50 EIA projects are not covered under the DSS/IPC list of activities or processes as indicated in the Appendix B; causing a further reduction in the coverage of evaluation scope to 35.8%. Those projects not covered are mainly natural gas processing plant and solvent/waste recovery facilities, probably due to their minority in sectoral composition for the U. S. industries, or these facilities are incorporated to be part of the other sectors. Consequently, only 92 EIA reports have been assessed using the DSS/IPC program.

Figure 3.1 shows the distribution of the major industrial subsectors, where they are ranked in decreasing order in the number of EIA projects being investigated and accounted for under the DSS/IPC list of activities or processes; i.e., inorganic chemical industry (15), plastic resin industry (13), organic chemical industry (11), non-ferrous metals industry (10), iron and steel industry (7), pulp and paper industry (6) and petroleum refining industry (4). While the other industries (26) consist of a conglomeration of various industries like cement, paint, oleochemical, etc., where their individual numbers are small within the scope of this research study. Figure 3.2 further presents the relative percentage of the seven main industrial subsectors being concentrated.

Figure 3.1
Distribution of Major Industrial Subsectors

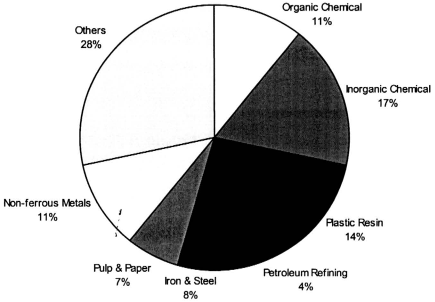
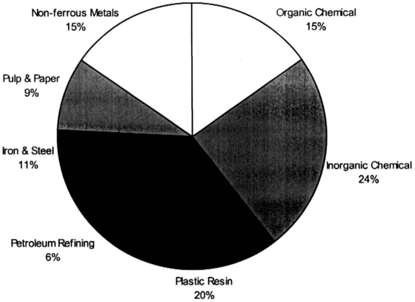


Figure 3.2
Distribution of 7 Major Industrial Subsectors



3.5 DATA PROCESSING

The DSS/IPC system utilized two main model steps in the pollution load inventory calculation; first, the inventory of polluting sources, their production levels and the levels of adopted controls; and second, the calculation of pollution loads by multiplying the levels of production by the corresponding emission factors and by the corresponding reduction factors if pollution control technologies (reduction measures) are adopted.

(Emission load by pollutant) =

(production level) * (emission factor for this process and pollutant) *

(reduction factor for this pollutant and adopted control technology, if any).

Emission factors are average values that take into account the type of process used in that industry, input or other technological characteristics that are relevant for emission levels (e.g. quality of fuel used), and the presence (or absence) of waste prevention programmes.