Procedure of Comprehensive of Environmental Impact Assessment (EIA): The Utility of Expert System

Mongkon Ta-oun[1], Mohamed Daud[2]
Mohd Zohadie Bardaie[3], Shamshuddin Jusop[4] and Ibrahim Elfaig[5]

ABSTRACT

An expert system in EIA (Environmental Impact Assessment) procedures was developed using C Language Integrate Production System (CLIPS). This system allows EIA personnel to consider the importance of project activities in relation to its impact on the environment. A set of rules which were incorporated in to the expert system. The rule was developed according to the limit of legislative control of environmental quality. The main role of this system is to assist EIA experts, company consultants and interested people in understanding the principle of EIA process. The system is very useful in supporting EIA expert and all interested people to easily understand the decision making EIA procedures. This expert system has friendly graphical user interface and logical finite answers to the question posed by the user.

[1]Scientist, Department of Land Resources and Environment, Faculty of Agriculture, Khon Kaen University, Khon Kaen
[2]Associate Professor, Faculty of Engineering, Universiti Putra Malaysia
[3]Professor, Faculty of Engineering, Universiti Putra Malaysia
[4]Professor, Faculty of Agriculture, Universiti Putra Malaysia
[5]Researcher, Faculty of Engineering, Universiti Putra Malaysia

1. Introduction

As a new development area grows, so do environmental problems most of which includes Pollution from urban wastes, industrial developments and loss or destruction of natural resources. Environmental Impact Assessment (EIA) is a process designed to identify, predict, evaluate and communicate information about the impacts on the environment of a proposed project and to detail out the mitigating measures prior to project approval and implementation. The aim of an EIA is to ensure that potential problems are foreseen and addressed at an early stage in the project's planning and design. It is a process, which is used to predict the environmental consequences of the proposed development project (DOE, 1994). EIA is generally understood to be an instrument of preventive environmental management. It is essentially a planning too for preventing environmental problem due to an action. It seeks to avid costly mistakes in project implementation, costly either because of environmental damage, or because of midification that may be required subsequently in order to make the action environmentally acceptable (Halimah, 1995). One of the problems of EIA in developing countries is the lack of information exchange, in which work done in one EIA is duplicated in another; because the opportunity for learning from the past is absent that EIA still needs promotion and improvement (Werner, 1993).

However, EIA should provide an adequate information basis for decision making on activities affecting the environment. Moreover, All environmentally relevant impacts of development should be identified, analyzed and evaluated. To complete an EIA efficiently and to realize its objectives the various phases should be taken into consideration (Masera and Colombo, 1992). Therefore, prior to produce the EIA report, it is a must to consider the importance of project activities whether it is suitable to produce the EIA report.

Applying an expert system to assist in the decision making can solve these problems. An Expert system is a computer program designed to model the problem-solving ability of a human expert (Durkin, 1994). The kind of knowledge that is dealt with in expert system, therefore is non-algorithmic, subjective and rare. An example: while an algorithmic program might perform a statistical analysis, an expert system would be used to interpret the statistics as they relate the subject of laboratory analysis.

The objectives of this study are to design, develop, test and implement an expert system for EIA to enhance the procedures of environmental assessment activities mamely for decision making EIA report. A reliable expert system will enable the user to make better decisions: this expert is aimed at EIA consultants, project managers, educators, and The Department of Environment in decision making.

2. Development Approach

The research is divided into 2 parts; the first part includes collection of necessary information and the second part is the coding of knowledge for the problem domain. Building of the expert system is an evolutionary prcess that involves continuous improvement of the system. The development of the expert system mainly consisted of three stages: knowledge acquisition, knowledge representation and software implementation.

2.1 Knowledge acquisition

Knowledge acquisition is the process of gathering necessary information for the expert system. It is the most time consuming aspect in creating a knowledge-based system. Developing that knowledge into a knowledge-based system should take no more time than would be required in designing a handbook that presents the same knowledge in a useful format. The objective is to gain knowledge on comprehension in EIA procedures and to encode it into the system. The sources of knowledge can be gleaned from environmental assessment literature (EIA report), Environment Quality Act and domain Experts, and knowledge based systems. In the case of decision making, the EIA procedure is illustrated in Figure 1, where knowledge base was categorised by the limit of detail activities with regards to EIA order 1987 (DOE 1995).

2.2 Knowledge representation

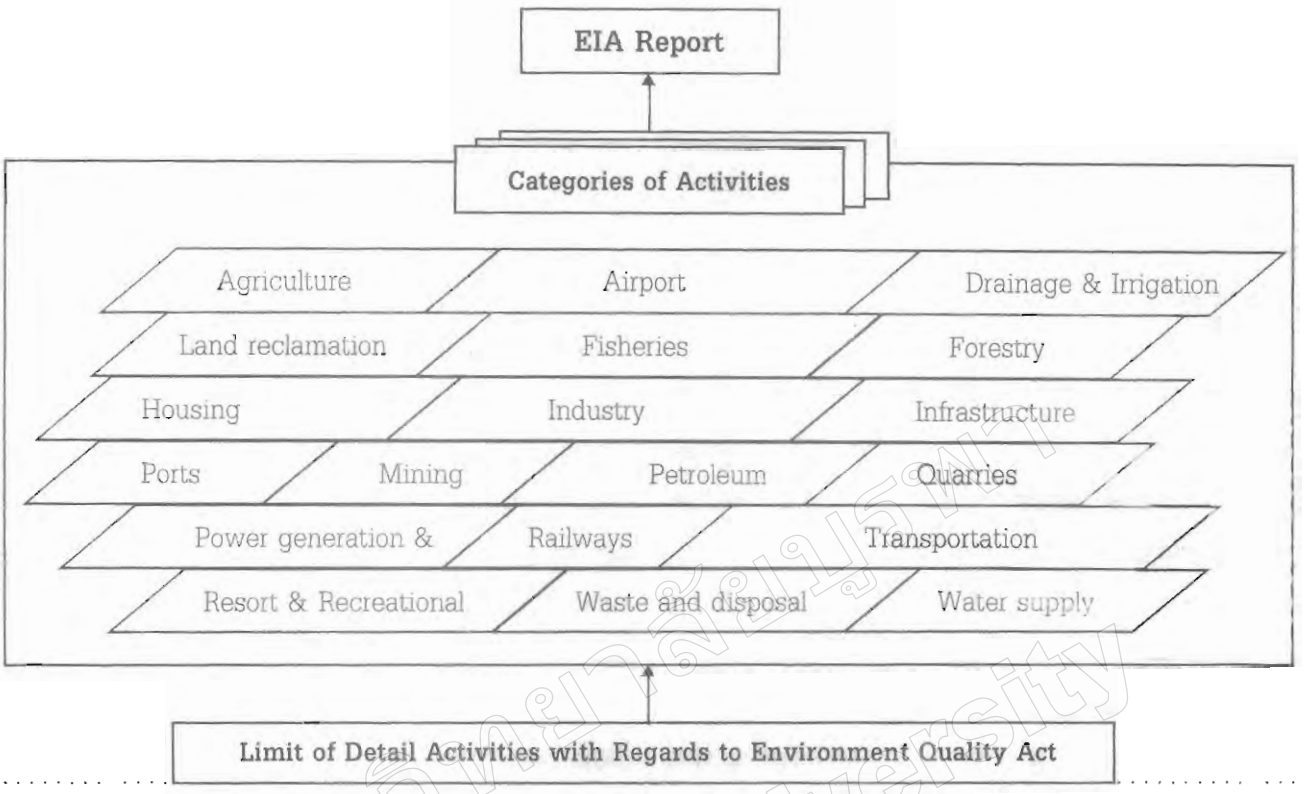
Production rules were used in the question and sub-menu with knowledge to be expressed in IF/ THEN (condition-action) statements. It is widely used methods that have been devised for representing information. In the expert system all the knowledge was structured as rules. Domain knowledge is captured in a set of rules and entered in the systems knowledge base. When the IF portions of the rule matches information contained in the working memory the system performs the action specified in the THEN part of rule.

2.3 Software implementation

In this research, CLIPS (C Language Integrated Production System) was selected for developing the expert system. CLIPS was designed at NASA (National Aeronautic and Space Administration)'s Johnson Space Center with the specific purpose of providing high portability, low cost, and easy integration with an external system (Giarrantano, 1993 ; Giarrantano and Riley, 1994). CLIPS enables users to work with object oriented programming capabilities including classes with multiple inheritance, abstraction, encapsulation, poly morphism, dynamic binding and message passing with message handlers, and to define functions, over loaded functions and global variables interactively. Furthermore, CLIPS allows a set of the constructs to be grouped together to maintain explicit control over and restricting the access of the constructs by other modules.

3. Expert System Development Results and dicussion

An application of expert system for comprehension in EIA procedures is a very user-friendly program. The system used window technique for data entry of command. The user is directed to what information is needed using the mouse without the need to remember the command to avoid mistaken during data entry or select the question for the interesting project activities for study. The details of system can descriptive as following.



- Land Cover, Surface area (project development covering...hectare)
- Size of development project (number of room of resort/hotel)
- Number of family (involve resettlement)
- Volume of project development (cubic meter)
- Location (state, out state, hill station, national park, island, etc.)
- Characteristic (mangrove, new route, branch lines, drainage of wet land, wild life, virgin, etc.)
- Production of chemical with capacity (ton/day, etc.)
- other

Figure 1 Knowledge acquisition of expert system for decision making in EIA procedures.

3.1 General Features of an Expert System

One of the features of this expert system is that, the program is created using menu bar and message box facilities. By using the menu windows, answer options with the question have been arranged in a systematic manner for user simplicity in that the user will find it easier to go through the questioning procedure.

The system has several advantages such as the user does not need to know command names, they are always presented with a valid command list, meaningful command names such as quit imply the command function, typing effort is minimal, this is important for occasional system user who cannot type quickly. The user interface is the most important component of any application. If the interface is well designed, the application will be easy, almost intuitive to use. Design the interface poorly, then the user will start looking elsewhere for an easier to use product. The system graphical user interface supports high-resolution color screen and interacting with mouse as well as keyboard. It has multiple windows, which allow different information to be displayed simultaneously on the user's screen, and also that the system commands are selected from the menu rather than typing them out.

3.2 The Expert System Structure

The design of expert system structure for EIA procedure comes in more attractive knowledge representation. By experience, an expert forms several sets of rules on a given problem. These sets of rules reflect the skill of the expert on the given problem. For this reason a set of rules may be applied to the given task when needed, which on the other hand means that the same set of rules is inapplicable to other problems. These, in the case of decision making EIA procedure, a modular structure is implemented in the system as shown in figure 2.

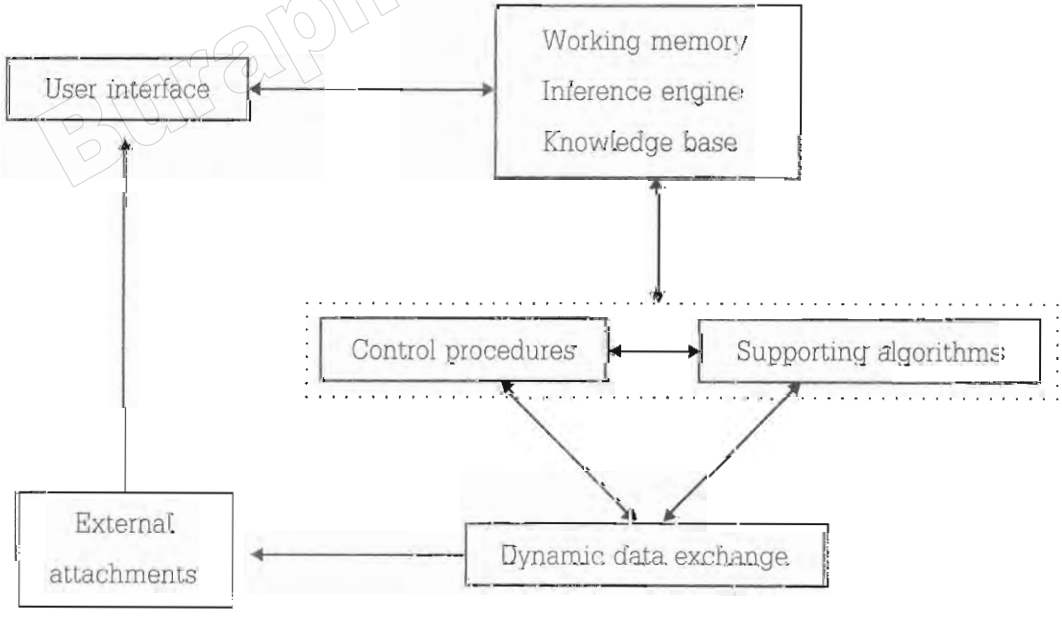


Figure 2. The structure of a general expert system (and also that used in this system)

An advantage of the modular structure is that it provides a natural ordering of the domain rule set by a top down approach, where a specific module is used when appropriate. To satisfy this goal the CLIPS is used in the system. The CLIPS developmental uses the fast pattern matching algorithm, which was developed by Forgy (1982) to implement the forward chaining inference engine.

3.3 Forward Chaining Systems

In a forward chaining system facts represented in a working memory which is continually updated. Rules represent possible actions to take when specified conditions hold on items in the working memory - they are sometimes called condition-action rules. The conditions usually patterns that must match items in the working memory, while the actions usually involve adding or deleting items from the working memory (Dakin, 1994). These strategies may help in getting reasonable behavior from a forward chaining system, but the most important thing is how we write the rules.

In this study, the expert system has questions for user to answer. Each question will be either choice or put the numerical number by the keyboard. The question numbers of each expert system depends on the nature of problems to be solved. The user must complete answers to questions from initial until the end of question which is the process of solving problem. Therefore, expert system will manipulate heuristics knowledge base for giving the advice and/or prediction to be used in solving each problem. The expert system will use the knowledge base which was collected and created to rule base of system in the program that cosists of 19 categories of project activities.

3.4 EIA Procedures Menu

The EIA procedure menu illustrates the principle of Environmental Impact Assessment. This menu consists of 3 parts; they are EIA procedures, Procedural steps for preliminary assessment, and Decision making in EIA Procedures. The user is guided throughout in selecting the interested information (see Figure 3). In this research a prototype expert system was built containing rules drawn primarily from knowledge extract from past EIA reports, Environment Quality Act and domain experts. All the facts are first listed and then the rules are written to form a small prototype program. Initialy this prototype handles a small domain, focussing on only a small portion of the system. Such a prototype is used to give a clear picture ordeal to approach the larger domain. In other words it serves as a stepping stone to the design of the larger system. From the small prototype the program was gradually expanded either within the prototype itself by adding new facts and cleanses locally or by introducing new modules of program linked to the existing prototype. Finally all these small units of program are linked together to form a single stand alone expert system program.

3.5 Expert System Recommendation

This study gives the examples of knowledge base and rule base, which is developed as a tool in decision making in EIA procedure below.

The facilitate approval of an agricultural activity project an EIA report must be made as required by the Environmental Quality Agency (EQA). In this case the expert system developed will deal three main questions. For each question, the user can select the answer by using mouse or keyboard. The answer is a choice (1, 2, 3..) of either YES or NO

depending on each question as illustrated in Figure 4. All information is available in a consistent and plausible framework that links the related of factors in a simple logical format of IF-THEN rules. The user can use the screen and the keyboard and mouse to interface with the system. The expert system will ask the user the question and display the set of possible answers to be selected. The rules used in this part of the program are shown in the rule of prediction function. Example in Figure 4 is a screen in which 19 categories of project activities are shown. If the user chooses the first selection that has question on agriculture activity, the user must chose the goal required and another guide screen will then appear.

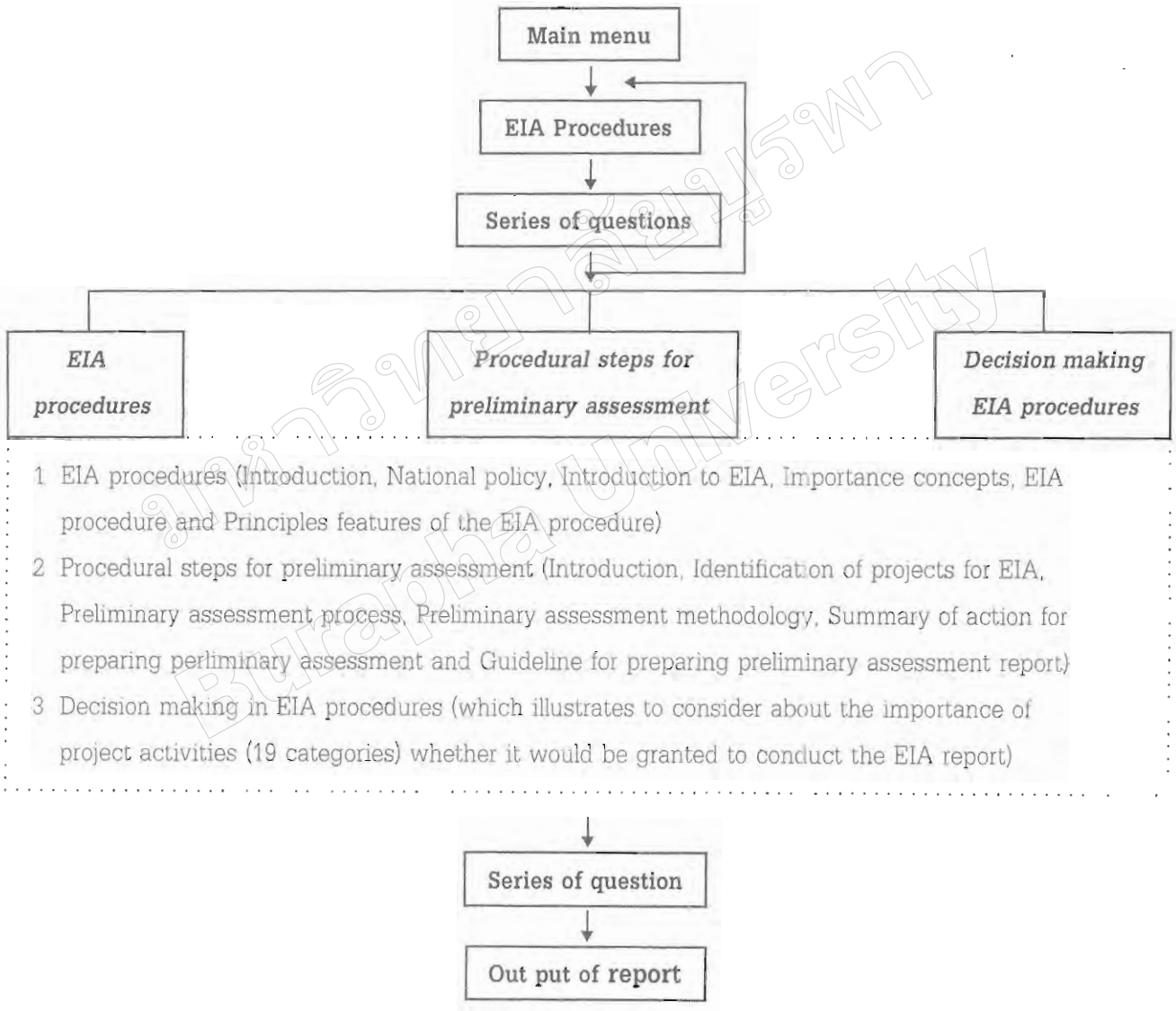


Figure 3 The EIA procedures menu of an expert system for comprehension in EIA (Environmental Impact Assessment) procedures.

3.6 Rule of Prediction Function

Environments of CLIPS is used in developing the expert system and designed to support rule based, object oriented and procedural programming. CLIPS also supports more complex nesting of conditional elements in the IF portion of a rule, and allows "AND", "OR", "NOT" conditional elements to be placed with in a not conditional element. CLIPS capabilities are believed to be sufficient for representation of the system's knowledge base, but are lacking in graphics capabilities to develop a user interface and reasoning explanation facility. The example of rule is used in the category of dam construction as follows:

, The example of dam rule.

(area ? area) (volume ? volume)

=> (if (and (>=?area 200) (>=?volume 4500)) then (printout wdisplay (str-cat "Construction of dam or impounding area of "?area" hectares or groundwater development of "?volume" cubic meters, EIA needed under Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987") crlf))

The rule says If Construction of Dam or Impounding area has more than 200 hectares or Groundwater Development volume has more than 4500 cubic meters THEN EIA needed under Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order, 1987.

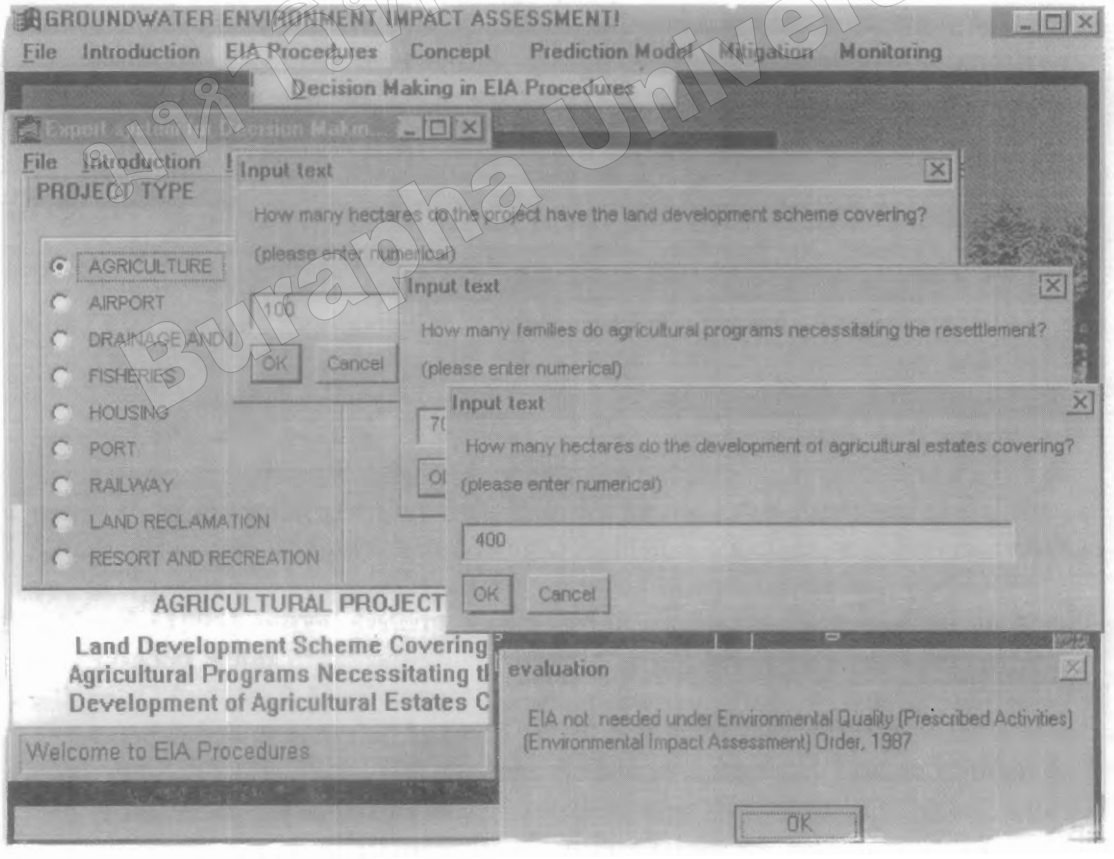


Figure 4. The screen shown of question and answer of agricultural activity project will be consideration for decision making to need EIA prodedure

4. Conclusion

The Department of Environment has been taken the responsibilities in making decisions on EIA regarding new development projects. Presently, the techniques and methods used in EIA are continuously being improved to be more effective and easier to audit. The expert system for decision making in EIA procedure, was developed through a combination of interviews with field experts, formal field research and legislative control. Once this expert can be loaded into a computer system connected to a network system and/or personal computer (PC), it could be used by many people related activities.

5. Acknowledgement

The authors wish to acknowledge the Department of Environment (DOE) Malaysia in allowing them to use the DOE resource room and in giving them helpful suggestions and advice on Environmental Impact Assessment (EIA). In addition, to thank Ms Tan Bee Hoon from Faculty of Foreign Languages, University Putra Malaysia for editing this paper.

References

Aler, B. (1994). Using CLIPS for AXAF is power automation knowledge based system. In proceeding of the intersociety energy conversion engineering conference 1994. IEEE, Piscataway, NJ, USA, 94CH3478-5.1:7-12.

Biswas, A.K. and Q.U. Geping. (1987). Environmental Impact Assessment for developing countries Tycooly International, London, 231 p.

DOE. (1994). Environmental Impact Assessment (EIA),Procedure and requirements in Malaysia., Department of Environment, Ministry of Science, Technology and Environment, Kuala Lumpur.

DOE. (1995). A handbook of Environmental Impact Assessment (EIA) guideline. Department of Environment, Ministry of Science, Technology and Environment, Kuala Lumpur.

Cheremisinoff, P.N. and A.C. Morresi. (1977). Environmental Assessment and Impact statement handbook. ANN Arbor Science Publishers, Inc., Michigan, 438 p.

Corwin, R., P.H. Heffernan, R.A. Johnston, M. Remy, J.A Roberts and D.B Tyler (1975). Environmental Impact Assessment. Freeman, Coopert & Company, Sa Francisco, 277 p.

Durkin, J. (1994). Expert systems design and development. Prentice Hall Internation, Inc., London 800 p.

Fortlage, C.A. (1990) Environmental Assessment (A practical Guide). Gower Publishing company, Vermont, USA, 152 p.

Giarratano, J.C. (1993). CLIPS version. Software technology Branch Lyndon B. Johnson Spaccenter, USA, 162 p.

Giarratano, J.C. and G. Riley. (1994). Introduction to CLIPS in Expert system principles and programming. PWS publish company, Boston, 363 - 400 p.

Halimah, H. (1995). Implementation of EIA regulations: the past, present and future. Department of Environment, Ministry of Science, Technology and Environment, Kuala Lumpur.

Masera, M. and A.G. Colombo. (1992). Content and phase of an EIA study. Environmental Impact Assessment (1) : 53-77.

United Nations ASIAN and Pacific Development Centre. (1983). Environment of development project. Kuala Lumpur, Malaysia, 334 p.

Wener, G. (1993). EIA in Asia : Lessons from the past decade. In Environmental Impact Assessment for developing countries. Butterworth-Heinemann LTD, Linacre House, Jordan Hill, Oxford OX28DP,UK.