Environmental Impact Assessment for Iron Ore Mines – An Expert System

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Abstract-**An attempt has been made to generalize the issues in effective Environmental Impact Assessment (EIA) with a special attention to iron ore mines. It is of high priority to address the potential environmental impact issues that may arise due to proposed mining activities i.e. an assessment of the potential impacts of a project on the existing environment. India produces approximately 200 MT iron ore per year which is the principal raw material in construction industry and allied industries. No doubt that the demand for such deposit is quite high both for domestic and export market. In reality the rate of environmental impacts is also equally high. Many of iron ore mines have been abandoned due to environmental degradation and hazards in mining areas which causes a major concern. The technical reasons attributed for such abandonment being lack of application of proper environmental management skills and effective environmental impact assessment. Environmental engineers have to come out with modifications in EIA for iron ore mines in order to accelerate the productivity with an eco-friendly approach. This paper will outline the usage of artificial intelligence techniques and technology for effective environmental impact assessment. This discussion will make new direction for future research on EIA methods.**

Keywords – iron ore industry status, environmental degradation, environmental impact assessment, expert system.

I.INTRODUCTION

Iron is the most valuable element for any social growth. Iron ore deposit in 1904 heralded the industrial revolution which is the foundation and the raw material for industrial development. The iron ore demand is increasing at a greater phase[1]. The prominent iron ore deposits found in India are haematite and magnetite ore deposits; in terms of resources stands to the order of 14.63 billion tonnes and 10.62 billion tonnes respectively. There is a huge upsurge in the number of mining projects all over the country are often accompanied with massive environmental and social burdens. It is the time for mining and environment engineers to think of eco-friendly techniques and technologies for the iron ore exploitation so as to achieve sustainable development. The scale and significance of the impacts on environment and ecology generally depend on size and capacity of mines and level of mining activities involved etc[2].

Now, Environmental Impact Assessment (EIA) is the most popular monitoring tool applied worldwide for all types of industrial projects before and after starting the proposedprojects. Environmentally sound mining technologies and practices should be adopted to minimize environmental degradation. Environmental considerations should be an integral component of mining operations, from the planning stage to mine closure. EIA procedure uses the systematic identification and evaluation of the impacts on the environment caused by a proposed iron ore mining project. To increase the effectiveness of the EIA process, experienced experts provide formal procedure and technical guidance manual to prepare EIA reports. Experts are heavily involved in all aspects of the impact assessment. Experts help to identify the activities potential for significant impacts, plan for data collection, provide judgment on the level of significance for specific impacts and suggest the ways of reducing or preventing impacts [3]. The preparation of an EIA requires expertise in project management and environmental engineering.

There is a critical lack of environmental scientific expertise on implementing effective EIA process. To overcome such ineffective process, artificial intelligence can be used to assist the end users in accessing expert's domain knowledge in order to predict and evaluate the environmental impacts. Expert system is such artificial intelligence technique which simulates the experts problem solving abilities that is human reasoning skill in decision making process and also assist to prepare EIA reports, support to predicate the potential environmental impacts and counsel EIA consultants to prepare complete and effective EIA report in a short time.

Iron Ore Status

In the rapid industrialization era, metals are the mainstream of the social and economic development. Massive high quality of iron ore deposits provide great support to the growth of the country's iron and steel industry which had a reserve of about 11.8 percent share in the global reserve of iron ore. As per estimation, India has total resources of over 25.25 billion tonnes in which most explored deposits are haematite and magnetite in the order of 14.63 billion tonnes and 10.62 billion tonnes respectively. The major deposits of haematite belong toPre-Cambrian
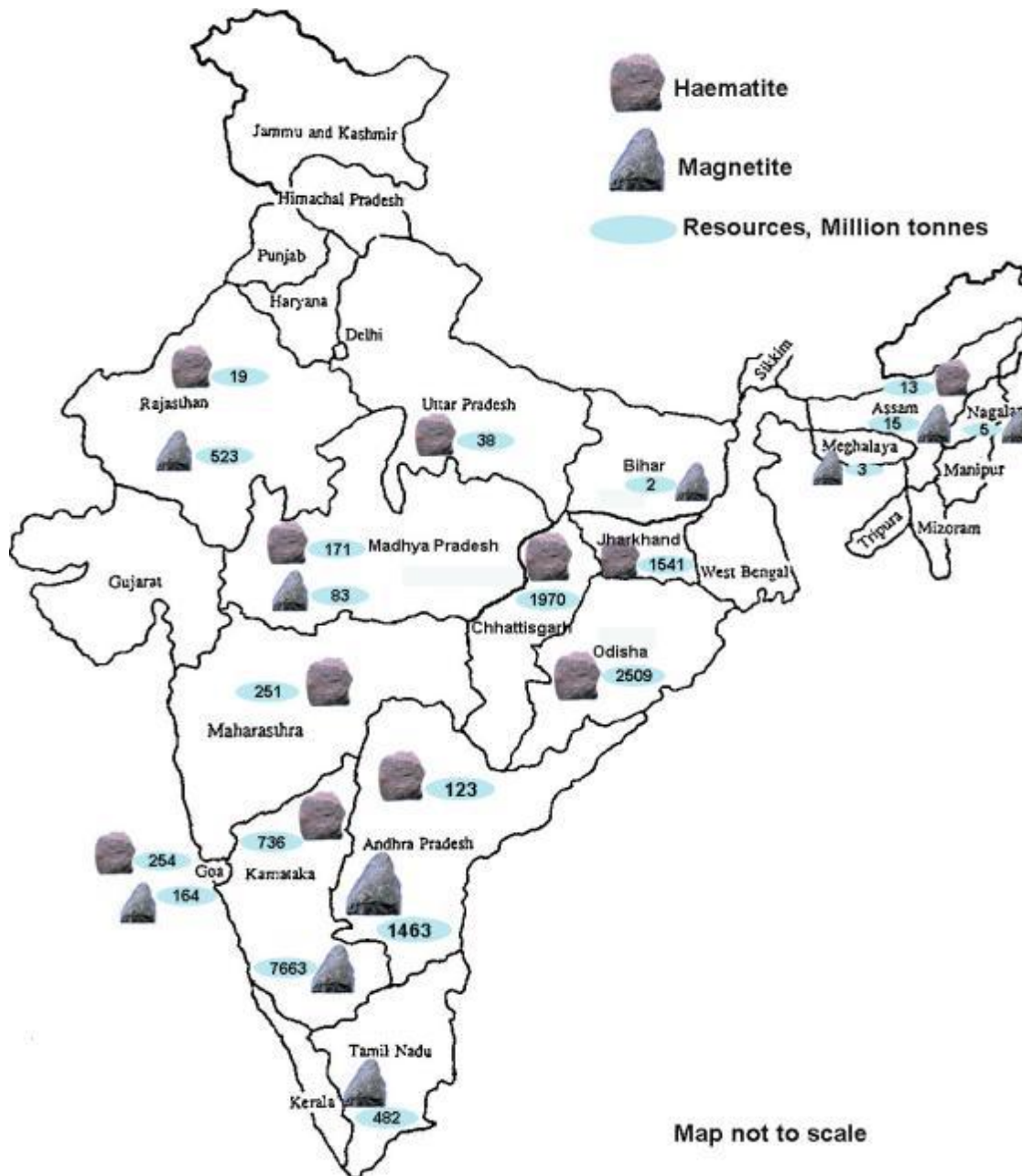
Figure 1 shows details of iron ore resources in India

age and the ore is within Banded Iron Ore Formations (BIF) and mostly accumulated in Singhbhum district (Jharkhand), Keonjhar (Orissa), Bellary (Karnataka), Bastar district (Chattisgarh) and Goa. The other principal iron ore is magnetite, mostly deposited in the form of oxide that is either of igneous or metamorphoses banded magnetite silica formation. Such deposits are confined at the Chikmagalur district in Karnataka and Salem and North Arcot districts in Tamil Nadu[2].

In 2010-11, India's iron ore production level was above 212.64 million tonnes that is output increased by 1.63% and in terms of global iron ore output was 9.13 percent[5]. The total iron ore production was shared between public sector (27%) and private sector

(63%)companies. As per statistics reports, from the iron ore distribution zones almost the entire production of iron ore (96%) accumulated from Orissa, Karnataka, Chhattisgarh, Goa and Jharkhand and the remaining (4%) production was reported from Andhra Pradesh, Madhya Pradesh, Maharashtra and Rajasthan[6]. Based on overall trend so far the index of mineral production (base 1993-94=100) and total iron ore production for the last five years is depicted in Figure 2.

Currently, there are 577 iron ore mining leases granted and the production comes from as many as 319 (approx.) mines of which, 34 are owned by Public Sector Companies while 285 are with the private sector. Majority of the mines in the public sector companies are large and

deploying advance mechanized techniques while in the private sector the mines are small and only semi-mechanizedmethods[7]. As a controversy, the country domestic steel production just reached 66.01million tonnes and steel consumption growth in last five years was range bound at 9-13% which is per capita steel use is 53 kg. The capacity of around 305 million tonnes per annum (MTPA) is required at 95% capacity utilization by 2019-20[4]. This capacity can be enhanced through consolidation of leases, improvement in the operating capacity of existing mines, opening up of new deposits, etc.

From the initial stage (exploration) to final stage (mineral processing), iron ore mining creates direct or indirect impacts on social and environment conditions. The environmental problems associated with the iron ore mining are diverse[2]. Therefore it is necessary that environmental concerns/concepts must be integrated with the mining operations at the planning stage itself to minimize all the adverse affects effectively.
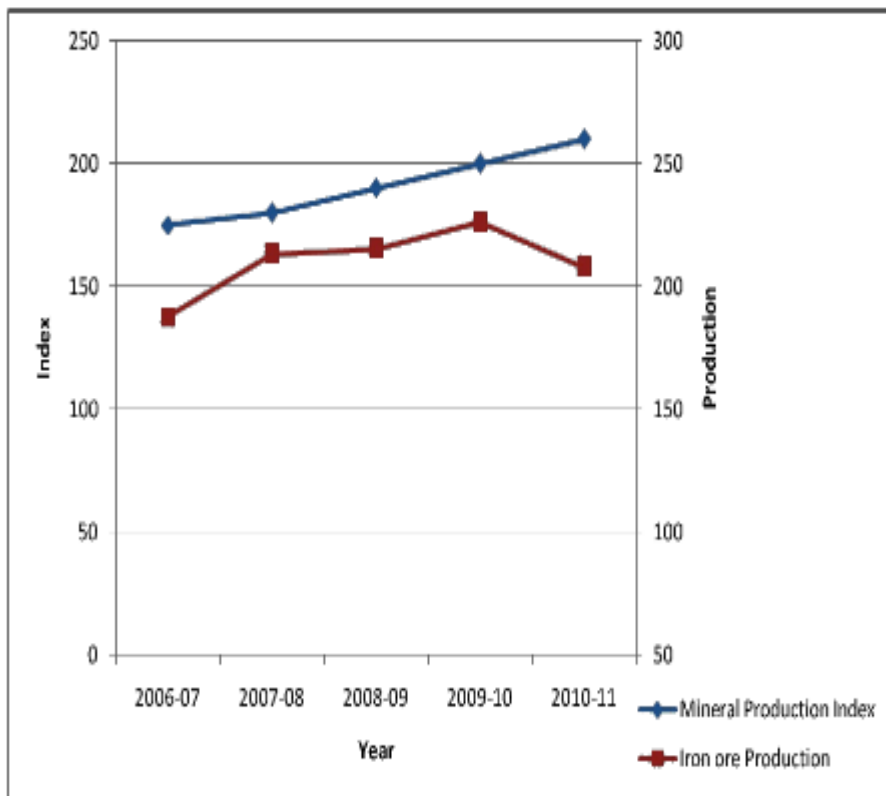

Figure 2: Index of mineral production and iron ore production

Environmental Impacts & Its Controls

Nature has enriched the earth with non-renewable mineral wealth. In fact the nation developments rely on mineral exploitation. Moreover, mining projects invariably causes disturbances to the environment. The most significant environmental damages due to iron ore mining are the deterioration of forest ecology, alteration of land use pattern and change in local drainage system due to inadequate landscape management. The magnitude and significance of the impacts on environment and ecology depend on size and scale of mining activities in conjunction with the topography and climatic conditions of the area, the nature of mineral deposits, method of mining and capacity of mines, agricultural activities, forest reserves, etc[2]. Iron ore mining and processing of ore, affects the environment in myriad ways. Figure 3 shows various unit operations of iron ore mines and its associated environmental aspects.
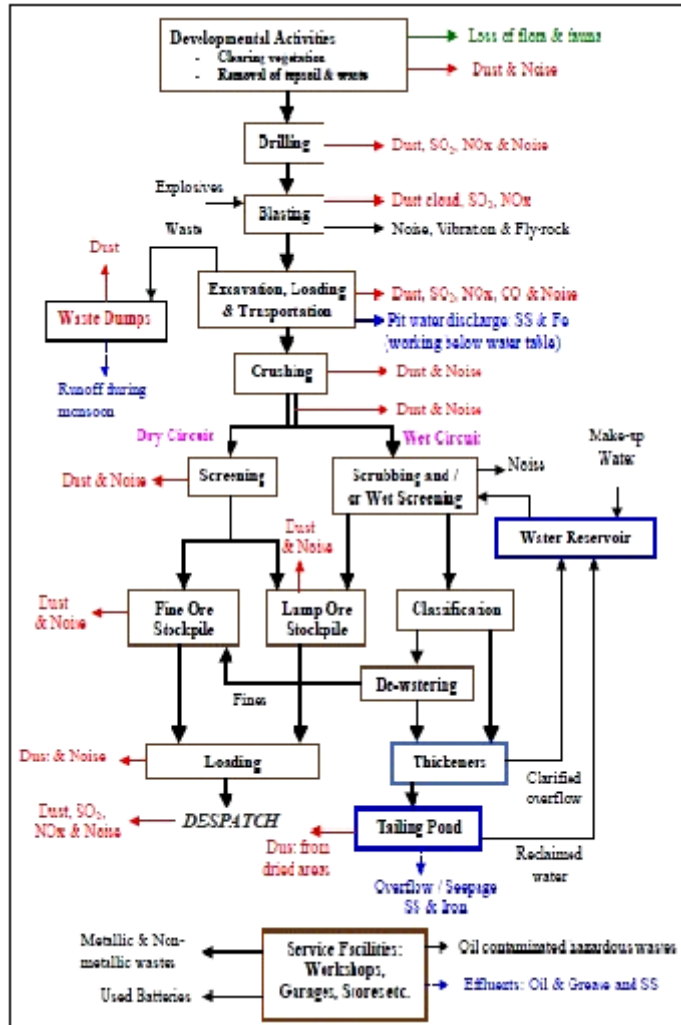
Figure 3: Environment & Iron ore extraction

Though mining activities use environment and ecology resources of particular area temporarily, it leaves permanent impacts in that area which could be classified as[2]:

(a)Land degradation and change in land use pattern

(b)Effect on flora and fauna

(c)Effect on air quality due to dust and noxious fumes

(d)Noise pollution and ground vibrations

(e)Impact on water quality and drainage pattern

(f)Socio-economic impacts

In order to protect the environment, there is a greater need for adopting better operational practices and cleaner technologies in the iron ore industry. Mining techniques in conjunction with the suitable mitigation measures during pre-mining, active mining and post-mining phases should be carefully selected, not only on the basis of yielding the highest possible production and profitability but also the environmental enhancement and positive socio-economic impacts. Guidelines for Integrating Environmental Concerns with Exploitation of Mineral Resources help to identify and highlight the salient aspects of the various problems and also briefly indicate some of the steps that need to be incorporated during the planning and various stages of the mining operations [8]. The National Mineral Policy 2008 described that "A framework of sustainable development will be designed to take care of biodiversity issues and for ensuring restoration of the ecological balance. Mineral development as well as protection of environment should get equal preference for sustainable development. The guiding principle shall be that a miner shall endeavour to leave a mining area in a better shape than he found it".

The eco-friendly mining and zero waste exploitation techniques would be the most preferred option to contain the environmental impacts within outlined limits.

Environmental Impact Assessment

Iron ore sector is on the threshold point of expansion, by opening up of new mines and expansion and expansion of existing mines. The iron ore mining has been contributing for

strengthening of economic and social development. However, growing mechanization, lack of environmental awareness and illegal mining has increased environmental degradation. The environmental impacts can be minimized by careful planning the surface layout of the mining lease area and by integrating the environmental aspects of each and every unit operation of mining activities. One way to ensure that development takes place at the least environmental cost is to carry out Environmental Impact Assessment (EIA). Environmental Impact Assessment is a process designed to identify and predict the impact of man's health and wellbeing as a result of development projects, also to interpret and communicate information about that impact [9]. The procedure of EIA originated in the United States in the second half of the 20th century. It can be broadly defined as the systematic identification and evaluation of the potential impacts of proposed projects.

It is imperative to examine the potential impacts on environment due to iron ore extraction. EIA process has been improved or widened to make it more transparent and acceptable to the society. Such impact assessment study should not be limited to the immediately visible effect, but also foresee the impact of current mining operations on environment in future. Typically, the EIA process begins with screening to ensure time and resources are directed at the proposals that matter environmentally and end with some form of follow up on the implementation of the decisions and actions taken as a result of an EIA report.

The results of EIA process, which are intended to:

- Establish existing environmental scenario in respect of various physical and biological environmental parameters, demography etc
- Assessment of likely impacts due to the proposed mining and allied activities. This covers identification of impacts of activities of a mine on various environmental attributes. The probable impacts have been identified qualitative and quantitatively.
- Suggest methods and measures contemplated for minimizing environmental damage
- Manpower and organization set up for implementation of environmental control measures
- A scheme for implementation and monitoring of environment management plan and

- A broad estimate of the cost of environmental management

Although it is generally agreed that EIA plays an important role in the decisions affecting the environment, the questions are still raised whether EIA effectiveness and its influence on decision making is satisfactory[10]. The term "effectiveness" refers to whether something works as intended and meets the purpose(s) for which it is designed. EIA process is most effective when even preliminary findings are made available early in the preparation process. At that time, alternatives which might be desirable from an environmental viewpoint (sites, technologies, mitigation measures, etc.) can be considered realistically, and implementation and operating plans can be designed to respond to critical environmental issues in the most cost-effective manner. Later on, making a major design change, selecting an alternative proposal, or deciding not to proceed at all with a project can become very expensive. Even more costly are delays in implementation of a project because of environmental issues which were not considered during design[11]. The effectiveness of EIA is heavily influenced by the legislation of specific jurisdictions, policies, frame of notification, public participation and the influence of environment committee members also. For better EIA decision-making, EIA tool should be based on a detailed description of the actual environmental situation as well as on a systematic analysis of every potential effect due to a proposed project or action. One factor that is relevant in controlling the effectiveness of EIA is the accuracy of the baseline data. Expert knowledge and scientific disciplines on such areas of EIA should be involved in complex processes because of the various interference and interactions between the different environmental factors.

Expert System

There is a critical lack of environmental scientific expertise on implementing effective EIA processes and information & knowledge exchange. Based on a review on recent literatures and interview with environmental expertise, there is no computerized system to produce Environmental Impact Assessment reports especially in India. In fact, EIA reports submitted to Expert Appraisal Committee members were not in accordance format and guidelines recommended in MoEF manual/notification. Therefore, it would be useful to have an expert system on the preparation of EIA reports[12]. Expert systems are used to support end users in accessing expert's domain knowledge whenever an expert is not available in person[13]. It simulates the expert's problem solving abilities that is human reasoning in decision making process. EIA-Expert System is an efficient tool for supporting the decision making process and
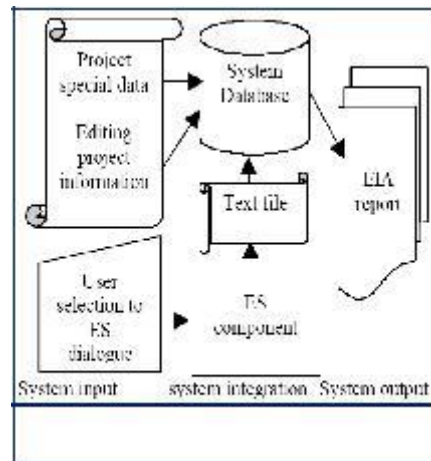
Figure 4: System Operating Stage

evaluating whether the project is viable. Such expert system incorporates with user interface, knowledge base and inference engine that used in preparing of EIA reports which is designed to be inbuilt with effective EIA methods to predict the impacts will have on the surrounding environment due to iron ore extraction activities. The methods adopt a stepwise approach to the impact assessment and generation of EIA reports. The domain expert follows up the instructions coded in the system and comes to a conclusion about the viability of a particular project. The system has to infer the correct conclusions about carrying out steps in EIA approaches [14]. The information about EIA components such as existing environment, project description, potential impact, mitigation measures and residual impact are stored in the expert database system. The interface of the system would be improved by formulating the questions consistently. The user interacts with the expert system interface by answering itsquestions, which leads to specify the classes of environmental component and prescribed activity [15]. Between these question sessions, the system draws conclusions and provides advice about useful mean of mitigation measures. The system facilitates the end user to edit, delete or add information to the generated EIA report data and so on. Finally the system sends the report to the report destination that is selected by the user

such as printer, file and screen (Figure 4). Some of the advantages of using expert systems for EIA are (a) Expert system helps users cope with large volumes of EIA work, (b) it delivers EIA expertise to thenon-expert, (c) enhances user accountability for decision making which mimic the reasoning capability of human experts, (d) provides a structured approach to EIA and alternate options for consideration [3].

CONCLUSION

The level of production and export of iron ore will reach the estimated or projected scale of

specialist/analyst with the help of available technology. There is not only uptrend in iron and steel and allied industries and also environmental degradation due to iron ore exploitation. The environmental degradation occurs due to lack of environment consideration while planning any of mining operations and illegal extraction of iron ore deposit. As an evident, recently Supreme Court issued an order to close almost all the iron ore mines of Karnataka and Goa and to submit

EIA reports of mine lease area. There is great need of new approaches to suggest methods and measures contemplated for minimizing environmental damage. Future technology should be incorporated not just with less maintenance cost and more productive concept, also the real eco- friendly operation concept. In order to protect the environment, government formulated guidelines, procedures, EIA notification and format and environmental committee members. Even it is made mandatory for all mines especially iron ore mines to submit EIA reports while getting approval for new, renewal and expansion of mine lease area. There is lack of environmental scientific expertise in the preparation of EIA reports and ignorance of environmental concern of project proponents. In such case, submitted such reports to environmental committee members for approval are not meeting any of MoEF outlined standards. Expert system is an approach to overcome inefficient environmental impact predication and preparation of reports. To create iron ore extraction as sustainable, not only government policy needs change but also mindset of project proponents and consultants.

REFERENCES

[1] "Iron ore pricing emerges from Stone Age", Financial Times, October 2009

[2] "Comprehensive Industry Document on Iron ore mining", Central Pollution ControlBoard, MoEF, August 2007

[3] Lohani, BN., Evans JWl, "Environmental Impact Assessment for Developing Countries in Asia", Asian Development Bank 1997, Vol 1, pp. 356

[4] Sengupta, S., "Indian Iron ore industry in Global Perspective", Steelworld, October 2006,pp.10-17

[5] Sharma, RK., "Iron Ore Exports", Federation of Indian Mineral Industries, New Delhi

[6] "Mineral and Metal Scenario", Annual Report 2010-2011, Ministry of Mines.

[7] Ericsson, M., "Iron ore corporate concentration", Journals of Mines, Metal & Fuels,2010

[8] Singh, G., "Environmental Impact Assessment of Mining Projects", Proceedings of International Conference on TREIA-2008 at Nagpur, Nov.23-25, 2008

[9] Lumpur, K., "A Handbook of EIA Guideline", Department of Environment, 1995

[10] Kruopiene, J. &Zidoniene, S., "Evaluation of Environmental Impact Assessment Effectiveness in Lithuania", Environmental Research, Engineering and Management, 2008. No.2(44), pp. 28-33

[11] Environmental Assessment Sourcebook 1999, Chapter 1

[12] Jazzar, M, Daud, M, Bardaie, MZ, Ramli, AR & Said, S, "A Knowledge Based Expert System for EIA Using Blackboard Approach" MJCS, Malaysian Journal of Computer Science, Vol 11, No. 2. pp 15-22.

[13] Jackson .P,"Introduction to Expert Systems", Addison Wesley England, 3rd Edition

[14] Hakansson, A, "An Expert System for the Environmental Impact Assessment Method",Division of Computer Science, Department of Information Science, Uppsala University, Sweden

[15] Ghani, AA, Aljack, EA, "Development of Expert Database System for Environmental Impact Assessment", Malaysian Journal of Computer Science, Vol. 12 No.1, June1999,pp. 19-27