



UNIVERSITI PUTRA MALAYSIA

**DEVELOPMENT OF A KNOWLEDGE-BASED COMPLIANCE
AUDITING SYSTEM FOR ENVIRONMENTAL IMPACT
ASSESSMENT (EIA) PROJECTS IN MALAYSIA**

MD. MIZANUR RAHMAN

FK 2001 67

**DEVELOPMENT OF A KNOWLEDGE-BASED COMPLIANCE AUDITING
SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROJECTS IN MALAYSIA**

By

MD. MIZANUR RAHMAN

**Thesis Submitted in Fulfilment of the Requirement for the
Degree of Doctor of Philosophy in the Faculty of Engineering
Universiti Putra Malaysia**

January 2001



DEDICATED TO MY

PARENTS : **Md. Abdul Kadir**
Maleka Begum

WIFE : **Hasina Begum Ulka**
and

CHILDREN : **Mahfuzur Rahman**
Mina Sultana

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment
of the requirement for the degree of Doctor of Philosophy

**DEVELOPMENT OF A KNOWLEDGE-BASED COMPLIANCE AUDITING
SYSTEM FOR ENVIRONMENTAL IMPACT ASSESSMENT (EIA)
PROJECTS IN MALAYSIA**

By

MD. MIZANUR RAHMAN

January 2001

Chairman: Associate Professor Mohamed Daud, Ph.D., MBA

Faculty: Engineering

Environmental Management Program (EMP) constitute an important component of the Environmental Impact Assessment (EIA) report of the development projects where the environmental monitoring programs and the environmental compliance auditing (ECA) aspects should be described in detail. ECA requires systematic selection of monitoring variables and analysis of the monitoring database and also requires that a uniform quality standard in auditing be maintained for different types of development projects and different stages of their development. ECA should produce an audit report that is easy to understand and could be used undertaking mitigation measures. Presently, in Malaysia, for the EIA projects, there is neither any specific guideline for conducting compliance auditing nor any systematic management of the data generated through monitoring of the projects.

The main objective of this study is to develop a knowledge-based environmental compliance auditing system (called ECA-KB) that uses expert's knowledge from different environmental fields and a quantitative technique of



evaluating the environmental compliance level of a particular project. ECA-KB comprises of three components namely monitoring database system, compliance auditing model, and knowledge base system. These three component systems have been integrated together to produce concise and comprehensive environmental compliance audit report for the EIA projects.

The study provides a tool for the decision-makers and the stakeholders namely the project proponents, environmental consultants, and Department of Environment (DOE) to monitor, evaluate environmental compliance level of the projects, generate compliance audit report, and to keep track on the compliance trend. The great potentiality of the developed ECA-KB is that it is produced in easy interactive and simplified manner that can be run as desktop applications by both the experts and the non-expert users. The system is available in installable CD's and can be reached to the potential users by several ways including distribution of CD's through market channel, demonstration in the seminars, and symposium.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia
sebagai memenuhi keperluan untuk Doktor Falsafah

**PEMBANGUNAN SISTEM AUDIT PEMATUHAN BERDASARKAN
KEPAKARAN UNTUK PROJEK PENILAIAN KESAN ALAM SEKELILING
(EIA) DI MALAYSIA**

Oleh

MD. MIZANUR RAHMAN

January 2001

Pengerusi : Profesor Madya Dr. Ir. Mohamed Daud, Ph.D., MBA

Fakulti : Kejuruteraan

Program Pengurusan Alam Sekitar (EMP) adalah komponen penting dalam Penilaian Kesan Alam Sekitar (EIA) bagi projek pembangunan dimana aspek Program Pemonitoran Alam Sekitar dan Audit Pematuhan Alam Sekitar (ECA) perlu dihuraikan secara terperinci. ECA memerlukan pemilihan pemonitoran pembolehubah dan analisis pemonitoran pengkalan data yang sistematik dan juga memerlukan satu standart yang seragam untuk dilaksanakan dalam pengauditan untuk projek pembangunan yang berlainan pada peringkat yang berbeza semasa pembangunan. ECA boleh menghasilkan laporan audit yang mudah difahami yang boleh digunakan untuk proses mitigasi. Buat masa ini, di Malaysia, tidak terdapat sebarang garis panduan yang spesifik untuk melaksanakan audit pematuhan atau pengurusan yang sistematik untuk projek EIA bagi data yang dihasilkan melalui pemonitoran projek.

Tujuan utama kajian ini adalah untuk menghasilkan Sistem Pematuhan Audit Alam Sekitar berdasarkan pengetahuan (ECA-KB) yang menggunakan pengetahuan pakar dari bidang yang berlainan dan teknik kauntitatif dalam menilai tahap pematuhan alam sekitar bagi sesuatu projek. ECA-KB terbahagi kepada tiga

komponen iaitu, Sistem Pengkalan Data Pemonitoran, Model Audit Pematuhan dan Sistem Berdasarkan Kepakaran. Ketiga-tiga komponen ini telah digabungkan bersama dengan pengaturcaraan komputer dan berupaya untuk berfungsi secara berkesan untuk menghasilkan laporan projek EIA.

Keputusan kajian ini memberikan pilihan kepada para pembuat keputusan serta pengusaha projek atau JAS, untuk mengawas, menilaian tahap pematuhan alam sekitar sesuatu projek serta penghasilan laporan audit pematuhan dan seterusnya memastikan pematuhan dapat mengikuti aliran perubahan semasa. Potensi ECA-KB yang telah dihasilkan adalah, ianya interaktif dan dipermudahkan sehingga boleh dioperasikan dari mana-mana komputer oleh pakar dan bukan-pakar. Sistem ini boleh diperolehi dalam bentuk cakera padat (CD) dan boleh mencapai sasarannya melalui beberapa cara seperti penjualan, demonstrasi diseminar atau simposium.

ACKNOWLEDGEMENTS

My sincere and grateful thanks to my committee members Associate Professor Dr. Ir. Mohamed Daud, Dato' Professor Dr. Mohd. Zohadie Bardaie and Associate Professor Dr. Mohd. Nasir Hassan for their continuous guidance, and encouragement in completing this study. I gratefully acknowledge their active and passive contribution in this study.

I acknowledge the contributions of all the expert participants of the Delphi survey. My sincere thanks to all of them. My special thanks to the staffs of EIA division, and library of the Department of Environment (DOE) Malaysia.

I acknowledge the co-operation received from my colleagues of the ESEIA research group, staffs and faculties of the Faculty of Engineering, and Science and Environmental Studies, UPM.

My thanks and appreciation to my parents, wife and children for their continuous inspiration and encouragement.

Most of all, praise be to the Almighty Allah. I would not have been able to make it without His help.



This thesis submitted to the Senate of Universiti Putra Malaysia has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy.

MOHD. GHAZALI MOHAYIDIN, Ph.D.
Professor
Deputy Dean of Graduate School
Universiti Putra Malaysia

Date:

TABLE OF CONTENTS

	Page	
DEDICATIONS	ii	
ABSTRACT	iii	
ABSTRAK	v	
ACKNOWLEDGEMENTS	vi	
APPROVAL SHEET	viii	
DECLARATION SHEET	x	
LIST OF TABLES	xv	
LIST OF FIGURES	xix	
LIST OF ABBREVIATIONS	xxii	
 CHAPTER		
I	INTRODUCTION	1
	General Introduction	1
	Statement of Problems	3
	Significance of the Study	6
	Objectives of the Study	7
	Scope of the Study	8
II	LITERATURE REVIEW	9
	Introduction	9
	Environmental Impact Assessment (EIA) Projects in Malaysia	9
	Legal Requirements in Malaysia	10
	EIA Projects in Malaysia	11
	Concepts and Definition of Environmental Auditing	14
	Benefits of Environmental Auditing	16
	Results of Environmental Audit Studies	18
	Monitoring as an Integral part of Environmental Compliance Auditing	20
	Effects of EIA Projects	21
	Effects on Physico-chemical Environment	22
	Effects on Biological Environment	26
	Effects on Socio-economic Environment	27
	Causes of Deviations in Impact Predictions	29
	Delphi Methods and Its Applications	31
	Environmental Quality Index	33
	Knowledge based System for Environmental Management	34
	Components of Knowledge Based Systems	36
	Visual Basic for Developing Knowledge Base Application	40
	Development of Visual Basic Program	43
	Concluding Remarks on Literature Review	46
III	METHODOLOGY	47



	Introduction	47
	Environmental Management Plan (EMP)	48
	Sampling Method	48
	Data Analysis	49
	Monitoring Aspects of the EIA Reports	49
	The Delphi Method	51
	Panel Characterisation and Composition	52
	Questionnaire Design	52
	First-round Questionnaire	53
	Second Round Questionnaire	53
	Third Round Questionnaire	54
	Analysis of the Delphi Findings	54
	Development of Environmental Compliance Auditing Model	56
	Monitoring Database	57
	Environmental Compliance Auditing	58
	Development of Knowledge Base System	61
	Conceptual Compliance Audit Model	62
	Selection of Domain Experts	62
	Knowledge Sources	62
	Knowledge Acquisition Planning	63
	Knowledge Elicitation	64
	Protocol Analysis	65
	Knowledge Coding	65a
	Development of Knowledge Based Compliance Auditing System (ECA-KB)	66
	Overall Data Collection Method	68
	Case Study on Taman Beringin Landfill Project (TBL)	69
	Data Gathering	69
	Data Analysis	70
IV	ENVIRONMENTAL COMPLIANCE AUDITING MODEL	72
	Introduction	72
	Major Activities of the Developmental projects	72
	Procedures of Environmental Compliance Auditing	73
	Air Quality Parameters	74
	Water Quality Parameters	75
	Soil Quality Parameters	76
	Noise Quality Parameters	76
	Biological Quality Parameters	77
	Operation and Management Quality Parameters	77
	Socio-economic Quality Parameters	78
	Indexing of the Parameters	79
	Calculation of Sub-index Values	79
	Calculation of Quality Index Values	80
	Operation and Management Quality Index	81
	Calculation of Overall Environmental Quality Index	82
V	RESULTS	84
	Environmental Management Plan (EMP)	84
	Monitoring Aspects in EIA Reports	87



Air Quality Monitoring	89
Water Quality Monitoring	90
Noise Quality Monitoring	90
Soil Quality Monitoring	91
Solid Waste, sewage and Waste Treatment Monitoring ...	91
Biological Quality Monitoring	92
Socio-economic Quality Monitoring	92
Parameters Suggested for Monitoring	93
Selecting Performance Indicators- The Delphi Approach	95
Process of Identifying the Performance Indicators	95
Weighting Score for the Component Parameters	95
Weightage Distribution Amongst the Environmental Components	99
Compliance Auditing of Individual Components	99
Components of Knowledge Based Compliance Auditing System ..	103
Knowledge Base System	105
Air Quality	105
Water Quality	107
Soil Quality	108
Noise Quality	110
Biological Quality	112
Socio-economic Quality	114
Operation and Management Quality	117
Development of Monitoring Database Management System (MDBMS)	118
Monitoring Database	118
Functionality of the MDBMS	121
Selecting Variables for Monitoring	122
Compliance Auditing System (CAS)	131
Compliance Auditing of Physico-Chemical Aspects	132
Compliance Audit Reporting System	157
Compliance Trend Analysis	168
Validation of Compliance Auditing System	177
Validation at Data Entry level	177
Validation on Data Manipulation of the System	179
Validation on the Flexibility of the System	180
Validation on the Applicability of the System	183
Validation on the Estimation of Sub-index and Quality Index	184
Validation on Noise Quality Assessment	185
Validation on Overall Environmental Compliance Condition	186
Case Study on Taman Beringin Landfill	188
Background	188
Status on Operational and Management Systems Performances	188
Status of Socio-economic Aspects	189
Performance Status of Physico-chemical Components ...	190
Compliance Auditing System	194
Monitoring Database Management System (MDBMS) ...	194



	Compliance Auditing System	195
	Compliance Trend Analysis	195
VI	DISCUSSION	196
	Knowledge Base System	196
	Monitoring Data Base Management System	199
	Compliance Auditing System (CAS)	200
	Applicability of the Compliance Auditing System	202
	Case Study on Taman Beringin Landfill Project	203
VII	CONCLUSION AND RECOMMENDATIONS	207
	Conclusion	207
	Limitation of the Study and Further Works Recommended	210
	REFERENCES	213
	APPENDICES	224
I	A Sample Table Used to Review Environmental Management Plan	224
II	A Sample Table Used to Review Monitoring Aspects	226
III	Questionnaire Used for Delphi Survey and Case Study	230
IV	Knowledge Base for the Compliance Auditing of EIA Projects	255
V	Compliance Audit Model Results for Taman Beringin Landfill	306
VI	List of EIA Reports Consulted	315
VII	List of Domain Experts Interviewed	319
VIII	Source Codes of the System	322
	BIODATA OF THE AUTHOR	380



LIST OF TABLES

Table		Page
1	Distribution of EIA Report According to States in Malaysia	12
2	Distribution of EIA Reports According to Project Activity	13
3	Year Wise Distribution of EIA Reports	13
4	Impacts on Socio-economic Conditions due to Development	28
5	Number of Expert Respondents in the Delphi Survey	52
6	Data Tables and the Data Flows of the Database System	59
7	Particulars of Data and Data Collection Techniques	68
8	Questionnaire Coverage and Expected Outputs on TBL	69
9	Major Activities of the Developmental Projects	73
10	Measuring Units and Average Timing for Air Parameters	75
11	Guideline Values for Noise Level	77
12	Parameters Selected for Socio-economic Quality Assessment	78
13	Coverage of EMP in the EIA Reports	84
14	Coverage of EMP according to Prescribed Activity	85
15	Coverage of Monitoring Aspects in the Table of Contents and Chapters	87
16	List of Variables Suggested for Monitoring	94
17	Selected variables for Air Quality Monitoring and Weighting Score ...	96
18	Selected Variable for Water Quality Monitoring and Weighting Score	96
19	Selected Variables for Noise Quality Monitoring and Weighting Score	97
20	Selected Variables for Soil Quality Monitoring and Weighting Score...	97
21	Selected Variables for Socio-economic Quality Monitoring and Weighting Score	98
22	Selected Variables for Monitoring Biological Aspects and Weighting Score	98
23	Distribution of Weighting Scores Amongst the Components	99
24	Knowledge Base for Estimating Sub-Index Values for Air Parameters	105
25	Knowledge Base for Air Quality Gradation Against AQI Values	106
26	Knowledge Base for Air Pollution Sources, Impacts and Mitigation Measures	106
27	Knowledge Base for Estimating Sub-Index Values for Water Parameters	107
28	Knowledge Base for Water Quality Gradation Against WQI Values ...	107



29	Knowledge Base for Water Pollution Sources, Impacts and Mitigation Measures	108
30	Knowledge Base for Estimating Sub-Index Values for Soil Parameters	109
31	Knowledge Base for Soil Quality Gradation for SQI Values	109
32	Knowledge Base for Soil Pollution Sources, Impacts and Mitigation Measures	110
33	Knowledge Base for Estimating Sub-Index Values for Noise Parameters	110
34	Knowledge Base for Noise Quality Gradation for NQI Values	111
35	Knowledge Base for Noise Pollution Sources, Impacts and Mitigation Measures	112
36	Knowledge Base for Estimating Sub-Index Values for Biological Parameters	113
37	Knowledge Base for Biological Quality Gradation for BQI Values	113
38	Knowledge Base for Biological Pollution Sources, Impacts and Mitigation Measures	114
39	Knowledge Base for Estimating Sub-Index Values for Socio-economic Parameters	115
40	Knowledge Base for Socio-economic Quality Gradation for SEQI Values	115
41	Knowledge Base for Socio-economic Factors, Impacts and Mitigation Measures on Socio-economic Conditions	116
42	Knowledge base for Operation and Management Quality	117
43	Knowledge Base on Operation and Management Factors, Impacts and Mitigation Measures	117
44	Data Tables of the Monitoring Database System	118
45	Example of a Data Table Form	119
46	List of Prescribed Activities Considered in MDBMS	123
47	Environmental Components/ sub components (Recipients) being Impacted by the Project Activities	125
48	Possible beneficial Uses of the Environmental Recipients	127
49	Data Validation for Air Pollutants	178
50	Validation Process for Data Manipulation	179
51	Validation Results for Water Quality Assessment	184
52	Validation Result for Noise Quality Assessment	185



53	Validation of CAS for Overall Environmental Compliance Conditions .	186
54	Results of the Operational and Management Conditions	189
55	Results on Socio-economic Conditions	189
56	Results of Ambient Air Quality	190
57	Average Water Quality of the Water Bodies Within the Vicinity	191
58	Results of the Noise Level in and around the Project	192
59	Inorganic Pollutants in Soil Samples	193
60	Results on Biological Conditions	193
61	A Sample Table Used for Review Study on EMP of EIA Reports	225
62	A Sample Table Used for Review Study on Monitoring Aspects of EIA Reports	227
63	Physico-chemical Aspects - Air	233
64	Physico-chemical Aspects – Water Quality	234
65	Physico-chemical Aspects - Soil Quality	235
66	Physico-chemical Aspects – Noise Quality	236
67	Biological Aspects	237
68	Socio-economic Aspects	238
69	Prioritisation amongst the Environmental Parameters	239
70	Physico-chemical Aspects - Air	241
71	Physico-chemical Aspects – Water Quality	242
72	Physico-chemical Aspects - Soil Quality	243
73	Physico-chemical Aspects – Noise Quality	244
74	Biological Aspects	245
75	Socio-economic Aspects	246
76	Prioritisation amongst the Environmental Parameters	247
77	Check List for Management Aspects of the Project	248
78	Check List for Operational Control of the Project	249
79	Assessment of Environmental Impacts of the Project	251
80	Socio-economic Assessment for the Local Community	254
81	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Air Pollution	256
82	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Water Pollution	262
83	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Soil Pollution	271



84	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Noise Pollution	277
85	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Biological Aspects	283
86	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Socio-economic Aspects	293
87	Knowledge Base for Environmental Compliance Auditing of EIA Projects: Operations and Management Aspects	302
88	List of EIA Reports Consulted	316
89	List of Domain Experts	320



LIST OF FIGURES

Figure		Page
1	A Skeleton Structure of Environmental Expert System	37
2	Three-tiered Architecture of Visual Basic Application showing the Separate Layers and How They are Linked	42
3	Components of a Visual basic Application Project	44
4	Different Components of the Overall Study Approach	50
5	A Simplified View of the Environmental Monitoring and Compliance Auditing Process	57
6	Integration of Database Components into the Environmental Compliance Audit Model	60
7	Different Task Components of the Knowledge Base System	61
8	Schematic Diagram Showing the Steps for the Development of Environmental Compliance Audit System	67
9	Steps Followed for Conducting Compliance Auditing of TBL	71
10	Overall results of the Monitoring Aspects as Covered by the EIA Reports	89
11	Frequency Distribution of Monitoring of Different Environmental Parameters	93
12	Schematic Diagram Showing Compliance Auditing System	104
13	Example of a Data table Form (Air Monitoring)	120
14	Schematic View of the Consultation Process of the Monitoring Database Management System and Interfacing with Monitoring Database	122
15	MDBMS Form Showing the Major Activities of the Project	124
16	A Sample Form Showing the Environmental Recipients being Impacted due to Discharges of Sewerage/ Wastes / Surface Run-off	126
17	A Sample Form Showing Major Uses of Downstream Surface Water	128
18	Recommended Variables for Monitoring	129
19	Tool bar Showing the Buttons for Different Data Tables for Entry and Editing of Monitored Data	130
20	Shows the Form of the Water Monitoring Data Tables	131
21	Major Components of the Compliance Auditing System	132



22	Shows the Air Quality Assessment Form and the Parameters Considered	136
23	Water Quality Assessment Form and the Parameters Considered	138
24	Out-put Form Showing the Parameters Used for Soil Quality Assessment	143
25	Form Showing the Parameters Used for Noise Quality Assessment .	147
26	Form Showing the parameters Used for Biological Quality Assessment	150
27	Form Showing the Parameters used for Socio-economic Quality Assessment	154
28	Form Showing the Parameters Used for Operation and Management Quality Assessment	157
29	A Sample Report Showing the Overall Environmental Compliance	158
30	A Sample Air Quality Compliance	159
30a	A Sample Form Showing Air Quality Trend Report	170
31	A Sample Form Showing the Biological Quality Trend Graphically	170
32	A Sample Form Showing the Compliance Level for Different Individual Components	171
33	A Sample Form Showing the Graphical Presentation of the Overall Compliance Trend	175
34	Recommended Monitoring Variables for TBL	194
35	Overall Compliance Status of TBL	195
36	Knowledge Base Development for Potential Impacts on the Environment	197
37	Knowledge Base Derivation for Remedial Measure for Environmental Control	198
38	Air Quality of Taman Beringin Landfill	307
39	Water Quality of Taman Beringin Landfill	307
40	Noise Quality of Taman Beringin Landfill	308
41	Soil Quality of Taman Beringin Landfill	308
42	Biological Quality of Taman Beringin Landfill	309
43	Socio-economic Quality of Taman Beringin Landfill	309
44	Operations and Management Quality of Taman Beringin Landfill ..	310
45	Overall Compliance Level of Taman Beringin Landfill	310

46	Environmental Quality Index for Individual Environmental Components of Taman Beringin Landfill	311
47	Compliance Audit Report on Air Quality of Taman Beringin Landfill	311
48	Compliance Audit Report on Water Quality of Taman Beringin Landfill	312
49	Compliance Audit Report on Noise Quality of Taman Beringin Landfill	312
50	Compliance Audit Report on Soil Quality of Taman Beringin Landfill	313
51	Compliance Audit Report on Operation and Management Quality of Taman Beringin Landfill	313
52	Compliance Audit Report on Socio-economic Quality of Taman Beringin Landfill	314
53	Compliance Audit Report on Biological Quality of Taman Beringin Landfill	314



LIST OF ABBREVIATIONS

AQI	Air Quality Index
BQI	Biological Quality Index
CAS	Compliance Auditing System
DOE	Department of Environment
EA	Environmental Auditing
ECA	Environmental Compliance Auditing
ECA-KB	Knowledge-based Environmental Compliance Auditing System
EIA	Environmental Impact Assessment
EQA	Environmental Quality Act
ES	Expert Systems
INWQS	Interim Water Quality Standards
IRM	Internal Resource Management
KBS	Knowledge Based System
MAQG	Malaysian Air Quality Guidelines
MDBMS	Monitoring Data Base Management System
NQI	Noise Quality Index
OEQI	Overall Environmental Quality Index
OMQI	Operational and Management Quality Index
SEQI	Socio-economic Quality Index
SQI	Soil Quality Index
USEPA	United States Environmental Protection Agency
VB	Visual Basic
WQI	Water Quality Index

CHAPTER I

INTRODUCTION

General Introduction

Physical development is necessary for economic growth and general well being of society in a country. However, such development normally brings changes in the environmental conditions in and around the development projects that could cause various short and long-term impacts on the environment. The environmental impacts could occur on the physico-chemical, biological, and socio-economic systems of the environment. The physico-chemical systems include the air, water, and soil; biological systems are the fauna and flora, and the socio-economic systems are the human and economic aspects of the environment.

In Malaysia, nineteen types of development activities have been identified as prescribed activities that require for the Environmental Impact Assessment (EIA) studies. These activities or projects include housing, resort, infrastructure, quarry, industry, waste disposal, petroleum, power generation, agriculture, mining, land reclamation, forestry, drainage, port, water supply, transportation, fishery, railway, and airport. In addition to EIA, a number of rules, and regulations have also been enforced with a view to control and regulate the adverse impacts of such development projects on the environment.

Environmental Impact Assessment (EIA) is a management tool used to identify the potential impact of physical development and subsequently to find out



the management and technical ways to reduce the environmental impacts (Canter, 1996; Ortolano and Shepherd, 1995).

Environmental Impact Assessment Guidelines introduced by Department of Environment (DOE) requires the project proponents to suggest an environmental management plan including a monitoring plan in their EIA report. The monitoring plan would provide qualitative and quantitative attributes of the environment that need to be monitored at regular interval and frequency while the project undergoes development and operation. The objective of the monitoring plan is to evaluate and assess the environmental performance of the project against the background environmental conditions and also to identify the areas where specific control measures are required. Monitoring of environmental conditions provides the necessary inputs for environmental compliance auditing and constitutes the integral part of the compliance auditing system (Fedra, 1997).

Environmental compliance audit is required to verify a project's compliance against the EIA approval conditions set by DOE to the project proponents and also against existing laws and regulations. The auditing process provides the management and control of the environmental practices of the project proponents through verifying the company's environmental policy, responsibilities, and organisation, risk management procedure, monitoring and reporting of environmental data (FAO, 1996).

Environmental compliance auditing system is a complex process because it requires the examination of multiple aspects of the environment. The project