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The Environmental Impact Assessment by Using the Battelle Method

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Abstract: ***Environmental Impact Assessment (EIA) is a tool designed to identify and predict the impact of a project on the living and non-living things. The tool helps to interpret and communicate information about the impact, for the project site. If necessary, it is possible to study various alternatives and provide solution so as to abate/mitigate the negative consequences on human and environment. This is always necessary for new project as well as the expansion of existing facility for any industrial project. There are many methodologies available for evaluation and assessment of environmental impacts. Most of the EIA methodologies are complicated and involves many calculations. The basic inputs are subjective and the output may not help to get secondary impacts. It is also not possible to have spatial representation of data and comparison of alternatives. On the background use of various methods in this study the Battelle method has been identified as one of the most quantitative method. It can be easily used in different projects. The main objectives of this study is to develop a computer program on Battelle method to provide flexibility to expert judgments in entering of input data, maximize accuracy, provide baseline data for new project and minimize time, manpower, complicated work for large project. This study applicable to predict the impact, development of feasibility study of project, avoiding environmental disturbances by taking appropriate measures, avoid excessive financial burden for involving the environmental issue after implementation of project.***

Keywords: Environmental, Impact, Assessment, benefits

1. Introduction

An environment surrounding us includes living and non-living things. The living components are germs, plants, animals, and people while non-living components are land, water, and air. Every anthropogenic activity has some impact on the environment. More often it is adverse to the environment than beneficial. The basic needs of mankind (such as food, security and other) mainly depend on these activities. Consequently, there is a need to harmonize developmental activities with the environmental concerns. Environmental Impact Assessment (EIA) is a tool designed to identify and predict the impact of a project on the living and non-living things. Scenario of EIA in India: The environmental impact assessment was started in India with the impact assessment of river valley project in 1978-79 and scope has subsequently enhanced to cover other developmental sectors such as industries, thermal power projects, mining schemes etc. To facilitate collection of environmental data and preparation of management plans, guidelines have been evolved and circulate by Ministry of Environment and Forests (MoEF) to the concerned Central and State Government Departments. EIA has now been made mandatory under the Environmental Protection Act, 1989 for 29 categories of developmental activities involving investment of Rs. 50 Crores and above. (MoEF, 2006) EIA process: The EIA process in India is made up of the various stages. The process starts with scoping, screening, consideration of alternatives, baseline data collection, impact prediction, assessment of alternatives, delineation of mitigation measures and environmental impact statement, public hearing, environment management plan, decision making, and monitoring the clearance conditions. EIA methodologies: There are many methodologies available for evaluation and assessment of environmental impacts. Most of the methods suffer from excessive dependence on subjective-judgment and are weak in predicting and quantifying the impacts of the project on the environment, but the development of computer-aided EIA and modeling have been identified as the most effective approaches (Sinha, 1998). Some of the important methods developed over the period are discussed below.

1. Battelle method: This method has been identified as one of the most quantitative methods. In the Battelle method, 78 measurable environmental parameters are divided into four major categories of ecology, environmental contamination, aesthetics, and human interest. The first step includes the conversion of parametric estimates into an environmental quality (EQ) scale that ranges between 0 and 1, where 0 denotes extremely bad quality and 1 denotes very good quality. The next step includes multiplication of EQ values with the respective parameter importance unit (PIU) values to obtain environmental impact units (EIU) for each parameter. Addition of EIU values provides a composite score. Total environmental impact is calculated by evaluating the expected future condition of the environmental quality with and without the project. Therefore due to limitations of some method there is need of analysis of EIA methodology. In this study Battelle method was as identified the most suitable methods for EIA, a computer program on Battelle method is developed to provide flexibility to expert judgments in entering of input data, maximize accuracy in result, provide baseline data for new project and minimize time, manpower and complicated work for large project. The researcher's work about EIA methods is reviewed and their conclusions are discussed in the literature review. LITERATURE REVIEW: Lohani and Kan (1983) studied Ad hoc method. The authors reported that, this method is very easy to use, but it may not cover all the relevant impacts, because the criteria used to evaluate impacts are not comparable, the relative weights of various impacts cannot be compared. It is inherently inefficient as it requires sizeable effort to identify and assemble an appropriate panel of experts for each assessment and it provides minimal guidance for impact analysis while

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suggesting broad areas of possible impacts. Westman (1985) studied Checklist method. The author reported that, this method is too general or incomplete. It does not illustrate interactions between effects. The number of categories to be reviewed can be immense, thus distracting from the most significant impacts and the identification of effects to be qualitative and subjective. MoEF (1991) advised Delphy method for assessment of significance of impact by network matrix and Hazardous waste site selection by integration technique. Sinha S. (1998) studied EIA methods. The author reported that, a number of methodologies have been developed for assessment of environmental impacts and most of the methods suffer from excessive dependence on subjective judgments and are weak in predicting and quantifying the impact of the project on the environment but the development of computer-aided EIA have been identified as most effective approach. Ponce V. (2008) studied Battelle method. OBJECTIVE OF STUDY: To overcome limitations of Ad hoc, Checklist, Matrix, Mathematical matrices and Network method there is need to study use of Battelle method for assessment of environmental impact. The main objectives of this study is to develop a computer program on Battelle method to provide flexibility to expert judgments in entering of input data, maximize accuracy in result, provide baseline data for new project and minimize time, manpower, complicated work for large project. This proposed study will be applicable to predict the impact, development of feasibility study of project, avoiding environmental disturbances by taking appropriate measures, avoid excessive financial burden for involving the environmental issue after implementation of project. PROPOSED WORK: As discussed in literature review Battelle methods are more helpful in EIA aspect (Ponce, 2008; Sinha, 1998; MoEF, 1991). In this study, a case study on Shri Mahakali sugar industry at Rajarambapunagar, Kavathe Mahankal is selected for analysis of EIA by Battelle. The objectives of proposed work are as follows: Analysis of EIA by Battelle method. To study various attributes with impact potential of proposed study area of sugar industry in relation with Battelle method To study EIA of sugar industry by Battelle method Analysis and development of computer program for EIA by Battelle method. The Battelle methods form basis of this study. Hence these methods are discussed in the Chapter

2. Material and Methods

The Battelle Method: The Battelle method (DEE *et al.,* 1973) has been identified as one of the most quantitative method. It can be easily used in different projects. The principle lies in splitting the environmental impact in four major categories: Ecology, Environmental contamination, Aesthetics and Human interest. These categories are divided in to thematic data as shown below. The environmental classification as suggested by Battelle method in view of above four categories and their corresponding relative weights are shown in Table 2.1. These thematic data are divided into environmental indicators. For example in the sugar industry, water pollution could be represented by: BOD, pH, SS, COD, Oil and Grease, TDS etc.

Table 1: The Battelle environmental classification and their corresponding relative weights

ECOLOGY	240
Terrestrial Species and Populations	
Browsers and grazers	14
Crops	14
Natural vegetation	14
Past species	14
Upland game birds	14
Aquatic Species and Populations	
Commercia1 fisheries	14
Natural vegetation	14
Pest species	14
Sport fish	14
Water fowl	14
Terrestrial Habitats and Communities	
Food web index	12
Land use	12
Rare and endangered species	12
Species diversity	14
Aquatic Habitats and Communities	
Food web index	12
Land use	12
Rare and endangered species	12
Species diversity	14
AESTHETICS	**153**
Land	
Geologic surface material	6
Relief and topographic character	16
Width and alignment	10
Air	
Odour and visual	3
Sounds	2
Water	
Appearance of water	10

ENVIRONMENTAL POLLUTION	402
Water Quality	
Basin hydrologic loss	20
Biochemical oxygen demand	25
Dissolved oxygen	31
Fecal coliforms	18
Inorganic carbon	22
Inorganic nitrogen	25
Inorganic phosphate	28
Pesticides	16
pH	18
Stream flow variation	28
Temperature	28
Total dissolved solids	25
Toxic substances	14
Turbidity	20
Air Quality	
Carbon monoxide	5
Hydrocarbons	5
Nitrogen oxides	10
Particulate matter	12
Photochemical oxidants	5
Sulphur oxides	10
HUMAN INTEREST/SOCIAL	**205**
Education/Scientific	
Archeological	13
Ecological	13
Geological	11
Hydrological	11
Historical	
Architecture and styles	11
Events	11
Persons	11

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Land and water interface	16
Odour and floating material	6
Water surface area	10
Wooded and geologic shoreline	10
Biota	
Animals -domestic	5
Animals -wild	5
Diversity of vegetation types	9
Variety within vegetation types	5
Man-Made Objects	
Man made objects	10
Composition	
Composite effect	15
Unique composition	15

Religions and cultures	11
'Western Frontiers'	11
Cultures	
Indians	14
Other ethnic groups	7
Religious groups	7
Mood/ Atmosphere	
Awe/inspiration	11
Isolation/solitude	11
Mystery	4
'Oneness' with nature	11
Life Patterns	
Employment opportunities	13
Housing	13
Social interactions	11

Once the environmental indicators are chosen, the method follows three steps:

First step: at this stage, the goal of the method is to transform environmental indicators into environmental quality. The notation table defines a number from 0 to 1 (0 for poor quality and 1 for good quality). Thus it is possible to quantify evaluation both in the wrong or right direction (environmental deterioration or improvement).

Second step: a total of a 1000 points (or Parameter Importance Unit: PIU) are shared among the indicators by the user or expert of the EIA. They reflect the relative importance of each parameter.

Third step: the comparison between the situation with and without the project is done in Environmental Impact Units (EIU). It can even reflect benefits or losses in terms of environmental conditions.

Mathematically, it is represented as follows:

$$\sum EIU = \sum_{i=1}^{m} (EQ_i)_1 \cdot PIU_i - \sum_{i=1}^{m} (EQ_i)_2 \cdot PIU_i$$

Where:
EIU = Environmental impact unit.
$(EQ_i)_1$ = Environmental quality for indicator "i" with the project
conditions. (lies between 0 to 1).
$(EQ_i)_2$ = Environmental quality for indicator "i" without the project condition. (lies between 0 to 1).
PIUi = Parameter Importance Unit/Relative weight of the indicator "i".
$_m$ = Total numbers of environmental indicators.

3. Result and Discussion

The case study of Shri Mahakali sugar industry at Rajarambapunagar, Kavathe Mahankal was selected for analysis of EIA methodology. The data collected for analysis of EIA methodology is given in following section.

s:The degree of environmental impact obtained for Shri Mahankali sugar industry corresponds to the total value of **70.7** Units. This is given in Table 3.9.

Table 3.9: Environmental impact due to Shri Mahankali sugar industry

The environmental categoriwise results of environmental impact due to Shri Mahankali sugar industry (Sangli-Maharashtra) are given in Table 3

Table 2: Environmental categoriwise results of environmental impact due to Shri Mahankali sugar industry

Sr. No.	*Environmental categories*	*PIU*	*EIU*	*EIU in*
1	Ecology	148	41.4	27.97
2	Environmental contamination	510	-93.4	-18.3
3	Aesthetics	153	45.7	29.87
4	Human interest or social	189	77	40.74
Total		1000	70.7	7.07

The EIA of sugar industry is studied by Battelle and Delphy method. The relative advantages, disadvantages and future work requirements in these methods are discussed below

The Battelle Method

Advantages

1. The Battelle method can be easily used for the case study considered in this scope of study.
2. The principal advantage of this method is that it gives a comparative analysis between several situations. Thus, it is particularly efficient when effecting choice between alternatives.
3. This method has been identified as one of the most quantitative method.
4. This is the easiest method as compared to other methods for EIA.
5. It gives flexibility for required changes in the environmental indicators and it's PIU values according to type of the project.
6. It gives flexibility for required changes in the EQ value of environmental indicators.
7. The flexibility for required changes of indicators and it's PIU values according to project results in better EIA.
8. The mathematical calculations are based on only one type of mathematical expression for determination of EIU.
9. There is less theoretical part.

Disadvantages

1. The environmental acceptibilty range of EIU is not defined.

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2. In this method mathematical calculation part is maximum and critical. Therefore any changes in input data leads to complications.
3. In this method resources requirement is high such as time and skilled manpower.
4. The result of EIA depends on expert's judgment.
5. The environmental categoriwise results are not defined.
6. In this method judgment of inputs such as environmental indicators, PIU and EQ are not defined.
7. There is difficult to choose environmental indicator.
8. There is difficult to share PIU of environmental indicators.
9. There is difficult to decide environmental conditions with or without project.
10. There is difficult to transfer of environmental indicator into environmental quality

4. Conclusion

1. This study gives advantages, disadvantages and suitability of Battelle method for EIA.
2. The development of computer program can be easily applicable in different project. It gives flexibility in entry of input data. This is useful to maximize accuracy, this is also useful to minimize manpower, manmade mistakes, and complicated work for large project.
3. This study is also applicable for prediction of the impact, avoiding environmental disturbances by taking appropriate measures and avoid excessive financial burden for connecting the environmental issue after implementation of project.

5. Future Scope

The above research work further can be extended for solving problems of different kind of project for the betterment of society.

References

[1] Canter L. W., *Environmental Impact Assessment*, Second Edition, McGraw-Hill Series in Water Resources and Environmental Engineering, New York, 1996.
[2] Dee, N., Baker, J., Drobny, N., Duke, K., Whitman, I. and Fahringer, D., 'An environmental evaluation system for water resource planning', *Water Resources Research,* **9**(3): 523-535, 1973.
[3] EIA for Developing Countries, *Chapter 3: Methodology of EIA*, **http://www.adb.org/Documents/Books/Environment_Impact/chap3.pdf**, Aug 20, 2008
[4] Ferreira A. P., 'Environmental Evaluation Model for Water Resource Planning. Study Case: Piabanha hydrographic basin, Rio de Janeiro, Brazil', *Revista Eletronica Do Prodema, Fortaleza,* **2**(1), 7-18, ISSN1982-5588, 2008.
[5] Google Imagery, Digital *Globe, Cnes: Spot Image, Geo Eye,* **http://maps.google.co.in/intl/en_in/images/logos/maps_logo.gif**, Nov 22, 2009.
[6] Government of India, Ministry of Environment and Forests, Environmental Impact Assessment Division, New Delhi, *Environmental Impact Assessment Notification-2006,* **http://envfor.nic.in/divisions/iass/iass.html**, Aug 22, 2008.
[7] Government of India, Ministry of Environment and Forests, Siting of Hazardous Waste Disposal Areas, National Environmental Engineering Research Institute, Nagpur, 1991.
[8] Government of India, Ministry of Environment and Forests, *Technical EIA guidance manual for sugar industry,* IL and FS Ecosmart Limited, Hyderabad, 2009.
[9] Leopold, L., Clarke, F., Hanshaw, B. and Balslay, J., *'A procedure for evaluating environmental impact',* US Geological Survey Circular 645. Washington, DC: USGS, 1971.
[10] Lohani, B. and Kan, S., 'Environmental evaluation for water resources in Thailand', *Wat. Resource. Develop.* **1**(3):185-195, 1983.
[11] Pandey R. K., *'Assessing the overall environmental impacts of Vindhyachal super thermal power project at Singrauli',* School of Environmental Biology A. P. S. University Rewa (M. P.) India, Poll Res. **24**(4):871-874, 2005.
[12] Peterson, G., Gemmell, R. and Schofer, J., *'Assessments of environmental impacts: multi-disciplinary judgments of large-scale projects',* Ekistics 218: 23–30, 1974.
[13] Ponce V., '*The Battelle Environmental Evaluation System for Water Resource Planning',* **http://ponce.sdsu.edu/the_battelle_ees.html**, Aug 18, 2008
[14] Sinha S., 'Environmental impact assessment: an effective management tool', *TERI Information Monitor on Environmental Science,* **3**(1), 1-7, 1998.
[15] Westman, W., 'Ecology, Impact Assessment and Environmental Planning', *John Wiley and Sons*, Toronto, Ont., 1985.

Author Profile

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Table 3

RESULTS:

NAME OF INDUSTRY :	Shri Mahakali Sugar Industry, Rajaram Bapu Nagar, Kavathe Mahankal. At and Post: Kavathe Mahankal, Taluka: Kavathe Mahankal, Dist: Sangli.

The sum of Parameter Importance Unit (PIU) of the categories in this tables are **1000** **Points**

Sr. No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Ecology	148			
1	**Terrestrial species and populations**				
	Browsers and grazers	9	0.7	0.4	2.7
	Crops	9	0.8	0.5	2.7
	Natural vegetation	9	0.8	0.5	2.7
	Past species	9	0.6	0.3	2.7
	Birds	9	0.8	0.6	1.8
2	**Aquatic species and populations**				
	Fisheries	9	0.5	0.3	1.8
	Natural vegetation	9	0.8	0.3	4.5
	Past species	9	0.5	0.2	2.7
	Fish	9	0.4	0.2	1.8
	Waterfowl	9	0.6	0.2	3.6
3	**Terrestrial habitats and communities**				
	Food web index	7	0.8	0.5	2.1
	Land use	7	0.7	0.5	1.4
	Rare and endangered specie	7	0.7	0.4	2.1
	Species diversity	8	0.6	0.5	0.8
4	**Aquatic habitats and communities**				
	Food web index	7	0.8	0.6	1.4
	Land use	7	0.7	0.4	2.1
	Rare and endangered specie	7	0.7	0.4	2.1
	Species diversity	8	0.6	0.3	2.4
	Sub Total EIU				41.4

Sr. No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Aesthetics	153			
1	**Land**				
	Geologic surface material	6	0.7	0.4	1.8
	Relief and topographic character	16	0.6	0.4	3.2
	Width and alignment	10	0.6	0.3	3
2	**Air**				
	Odour and visual	3	0.8	1	-0.6
	Sounds	2	0.5	1	-1
3	**Water**				
	Appearance of water	10	1	1	0
	Land and water interface	16	0.8	0.3	8
	Odour and floating material	6	1	1	0
	Water surface area	10	0.8	0.3	5
	Wooded and geologic shoreline	10	0.6	0.3	3
4	**Biota**				
	Animals - domestic	5	0.9	0.4	2.5
	Animals - wild	5	0.6	0.4	1
	Diversity of vegetation types	9	0.7	0.5	1.8
	Variety within vegetation types	5	0.7	0.5	1
5	**Man-made objects**				
	Man-made objects	10	0.8	0.3	5
6	**Composition**				
	Composite effect	15	0.8	0.4	6
	Unique composition	15	0.8	0.4	6
	Sub Total EIU				45.7

Sr. No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Environmental contamination	510			
1	**Waste water quality**				
	Water consumption	56	0.5	1	-28
	Biochemical oxygen demand	48	0.9	1	-4.8
	Suspended solid	48	0.6	1	-19.2
	Chemical oxygen demand	48	0.9	1	-4.8
	Oil and Grease	48	0.9	1	-4.8
	T.D.S.	48	0.9	1	-4.8
	pH	38	0.9	1	-3.8
2	**Air quality**				
	Nitrogen oxides	24	0.9	1	-2.4
	Sulphur oxidants	24	0.8	1	-4.8
	Suspended particulate matter	28	0.6	1	-11.2
	Other	12	0.9	1	-1.2
3	**Land pollution**				
	Land use	32	0.9	1	-3.2
	Soil erosion	32	0.8	0.4	12.8
4	**Noise pollution**				
	Noise from machinery	12	0.4	1	-7.2
	Noise from vehicles	12	0.5	1	-6
	Sub Total EIU				-93.4

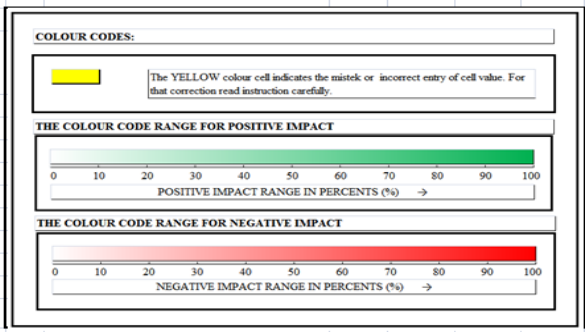
Sr. No.	Environmental Categories	PIU	$(EQi)_1$	$(EQi)_2$	EIU
	Human interest or Social	189			
1	**Education or scientific packages**				
	Archaeological	8	0.7	0.4	2.4
	Ecological	8	0.8	0.5	2.4
	Geological	5	0.7	0.5	1
	Hydrological	5	0.8	0.4	2
2	**Historical packages**				
	Events	5	0.6	0.4	1
	Persons	5	0.4	0.3	0.5
	Religions and cultures	5	0.6	0.5	0.5
3	**Cultures**				
	Indians	8	0.8	0.7	0.8
	Other ethnic groups	5	0.8	0.3	2.5
4	**Mood or atmosphere**				
	Admiration	5	0.8	0.4	2
	Isolation	5	0.8	0.3	2.5
	Oneness with nature	5	0.8	0.4	2
5	**Life patterns**				
	Employment opportunities	16	0.9	0.2	11.2
	Housing	16	0.8	0.4	6.4
	Social interactions	14	0.8	0.3	7
6	**Composition**				
	Economic view	16	0.9	0.3	9.6
	Agricultural view	16	0.8	0.4	6.4
	Public view	14	0.8	0.4	5.6
	Health related plans	14	0.7	0.4	4.2
	Development plans	14	0.8	0.3	7
	Sub Total EIU				77

Total sum of EIU = $EIU = \sum_{i=1}^{m}(EQi)_1 \cdot PIU_i \cdot \sum_{i=1}^{m}(EQi)_2 \cdot PIU_i$ = **70.7** **Points.**

RESULT: The degree of environmental impact obtain from the study area of sugar industry corresponds to the total value of **70.7** **Units.**

THE CATEGORIWISE RESULTS ARE AS FOLLOWS:

SR. NO.	CATEGORIES	PIU	EIU	EIU IN %	COLOUR CODE
1	Ecology	148	41.4	27.97	27.97
2	Environmental contamination	510	-93.4	-18.3	-18.3
3	Aesthetics	153	45.7	29.87	29.87
4	Human interest or Social	189	77	40.74	40.74
	TOTAL	1000	70.7	7.07	7.07



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