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# APPLICATION OF COMPUTER/INFORMATION COMMUNICATION TECHNOLOGY IN ENVIRONMENTAL IMPACT ASSESSMENT

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**ABSTRACT**
The integration of technology into urban planning service delivery has been described by experts as a "silver bullet" solution for urban planners to embrace and boost their professional efficiency. The paper seeks to discuss application of computer/information communication technology in environmental impact assessment, it also expatiates upon how urban planners can take advantage of available technological aids and techniques to boost their presentation and solutions to urban problems. Examples of technologies driven urban transformation and innovation are discussed. Furthermore, a comparison of some old techniques and their equivalent new techniques are provided. Data for the study was obtained through literature review. The study concludes that from efficiency standpoint, adopting these new technologies will lead to efficiency in urban service delivery and Finally recommends that Information Communication Technology can also provide urban planners with competitiveness through integration between their staff, partners and inter-organizational functions, as well as providing critical information on Urban service delivery.

**Keywords:** Information, communication, technology, urban planning, environmental impact assessment

## INTRODUCTION

Environmental impact assessment is, in its simplest form, a planning tool that is now generally regarded as an integral component of sound decision making. As a planning tool it has both an information gathering and decision making component which provides the decision maker with an objective basis for granting or denying approval for a proposed development. (Justice La Forest 1991). It is also a planning tool that its main purpose is: "to give the environment its due place in the decision making process by clearly evaluating the environmental consequences of a proposed activity before action is taken. The concept has ramifications in the long run for almost all development activity because sustainable development depends on protecting the natural resources which is the foundation for further development" (Alan Gilpin 1995)

Therefore, Environmental Impact Assessment (EIA) is defined as a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse.

The main purpose of this work is to highlight the importance of computer technology in the preparation of environmental impact assessment. It will focus on the general processess involved in the conduct of environmental impact assessment and various methods for the assessment and how computer technology can possibly enhance the process.

**ENVIRONMENTAL IMPACT ASSESSMENT METHODS**

While most practical impact assessment studies use several methods or combinations of methods, a classification of methods and approaches will help in a summary presentation and discussion of the various techniques. The scientific literature on environmental impact assessment is very large and is growing rapidly. and a recent overview with special reference to developing countries can be found in Biswas and Geping1987. The following summary of methods is largely based on Biswas and Geping, 1987.

1. **Ad hoc methods** Ad hoc methods provide little, if any, formal guidance for an impact assessment. While varying considerably with the team of experts, they usually identify a broad area of impact rather than define specific parameters which should be investigated or attempt a quantitative assessment. A major advantage, however, is in their ease of use and the possibility to tailor them to the specific circumstances of a given assessment problem without the constraints of a rigid formalism. As a consequence, however, they depend very much on the background, expertise and experience of the people undertaking them. While fast, and possible to conduct with minimal effort, they do not include any assurance of completeness or comprehensiveness; they may lack consistency in the analysis due to lack of guidance and a specific formalism; and they require the identification as well as the assembly of an appropriate group of experts .
2. **Checklists and matrices** Checklists consist of a list of environmental parameters to be investigated for potential impacts. They therefore ensure complete coverage of environmental aspects to be investigated. Checklists may or may not include guidelines about how impact-relevant parameters are to be measured, interpreted, and compared. A typical checklist might contain entries such as:
    1. Earth: mineral resources; construction material; soils; land form; force fields and background radiation; unique physical features;
    2. Water: surface (rivers, lakes and reservoirs, estuaries); coastal seas and ocean, underground; quality; temperature; recharge; snow, ice, and permafrost;
    3. Atmosphere: quality (gases, particles); climate (micro, macro); temperature;
    4. Flora: trees; shrubs; grass; crops; microflora; aquatic plants; endangered species; barriers; corridors;
    5. Fauna: birds; land animals including reptiles; fish and shellfish; benthic organisms; insects; microfauna; endangered species; barriers; corridors;
    6. Land use: wilderness and open space; wetlands; forestry; grazing; agriculture; residential; commercial; industrial; mining and quarrying;
    7. Recreation: hunting; fishing; boating; swimming; camping and hiking; picnicking; resorts.

*Table 3: Example of ES Summary table showing relative weights given to significance of impacts*

| Topic area | Description of impact | Geographical Level of Issue Importance | | | | | Impact | Nature | Significance | Mitigation Measure |
|---|---|---|---|---|---|---|---|---|---|---|
| | | I | N | R | D | L | | | | |
| Human Beings | Disturbance to existing properties from traffic & noise | | | | * | | Adverse | ST, R | Major | Provision of double glazing for affected properties |
| | Coalescence of existing settlements | | | * | | | Adverse | LT, IR | Major | Additional screen planting |
| Flora & Fauna | Loss of grassland of local nature conservation value | | | | | * | Adverse | LT, IR | Minor | Creation of new habitats |
| | Creation of new habitats | | | | | * | Beneficial | LT, R | Minor | |
| | Increased recreation pressure on SSSI | | * | | | | Adverse | LT, IR | Minor | Provision of Ranger Service for SSSI |
| Soil & Geology | Loss of 100 ha agricultural soils | | | * | | | Adverse | LT, IR | Minor | None proposed |
| Water | Increased rates of surface water run-off | | | | * | | Adverse | LT, IR | Minor | Use porous material for parking areas |
| | Reduction in groundwater discharge | | | * | | | Adverse | LT, R | Minor | |

KEY: I = International, N = National, R = Regional, D = District, L = Local; ST = Short term, LT = Long term, R = Reversible, IR = Irreversible

Source: Preparation Of Environmental Statements For Planning Projects That Require Environmental Assessment. A Good Practice Guide (UCE 1995)

Obviously, checklists do carry a geographical, as well as cultural, bias or, if universal in intent, carry a large number of mutually exclusive categories. They are usually also implicitly oriented towards certain categories of projects, related to the history of their development. Further, their elements may be interrelated (for example, the categories of water bodies and their relevant properties in the example above) such that the linear presentation

in the listing has to be interpreted as a hierarchical or even multidimensional system in many cases.

Impact matrices combine a checklist of environmental conditions likely to be affected with a list of project activities, the two lists arranged in the form of a matrix. The possible cause--effect relationships between activities and environmental features are then identified and evaluated cell by cell. Matrices can be very detailed and large, the classical Leopold matrix contains 100 by 88 cells, and is thus somewhat cumbersome to handle (Leopold, Clarke, Hanshaw et al., 1971).

| Environmental and socio-economic factors | Issues arising from the development | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Traffic | Waste | Workforce | Site vehicles | Site machinery | Raw materials | Landscaping | Temporary buildings or cabins |
| | Flora | | | | | | | | |
| | Fauna | | | | | | | | |
| | Water | | | | | | | | |
| | Microclimate | | | | | | | | |
| | Aesthetic appeal | | | | | | | | |
| | Noise | | | | | | | | |
| | Air quality | | | | | | | | |
| | Local residents | | | | | | | | |
| | Local businesses | | | | | | | | |
| | Local landowners | | | | | | | | |

Develop a scoring system, for example:

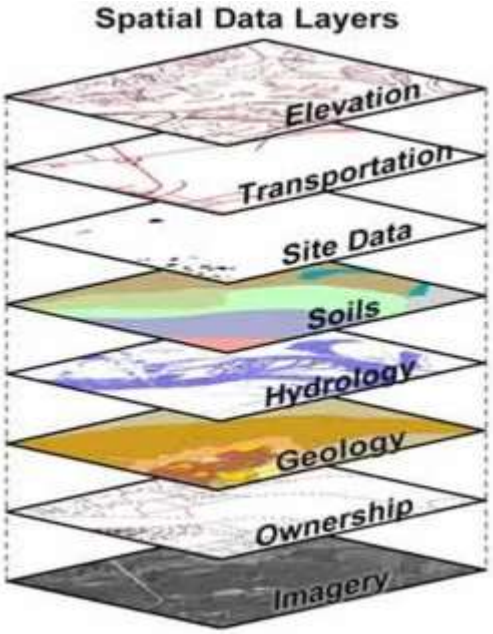
0 = no impact
1 = low impact
2 = moderate impact
3 = high impact

Spilt values can be assigned, and some more important factors could be weighted (e.g. score doubled) to increase validity.

Totals can then be calculated for each factor.

**Overlays**

Overlay methods use a set of physical or electronic maps, of environmental characteristics and possible project impact upon them, that are overlaid to produce a composite and spatial characterization of project consequences (McHarg, 1968; Dooley and Newkirk, 1976). Modern geographical information systems such as GRASS, developed for EIA by the US Army Corps of Engineers, use graphic workstations to implement overlay techniques using digital cartographic material and the more versatile logical interactions between spatial features.




**Networks and diagrams** Networks are designed to explicitly consider higher order, i.e., secondary and even tertiary consequences in addition to the primary cause--effect relations addressed by the methods above.

**Cost--benefit analysis** Cost--benefit analysis (CBA), in a narrow sense, is an attempt to monetize all effects for direct comparison in monetary terms. While providing a clear answer and basis for the comparison of alternatives, the monetization of many environmental problems is sometimes extremely difficult and thus can affect the usefulness of the method considerably.

Numerous approaches to help monetize environmental criteria have been developed. Some of the more frequently used include the cost of repair, i.e., the estimated cost to restore an environmental system to its original state, or the willingness to pay, based on direct or indirect (e.g., travel cost) approaches to assess the value, for example, of park land or wilderness.

**Modeling** Systems analysis and modeling are among the few techniques that allow consideration of multi-dimensional problems that involve multiple (and usually conflicting) objectives, multiple criteria, multiple purposes and users, as well as interest groups.

Basically, modeling attempts to replicate a real-world situation, so as to allow experimentation with the replica in order to gain insight into the expected behavior of the real system. Models, implemented on computers, are extremely powerful tools of analysis, though they are often demanding and complex.

Modeling has been used extensively in developed countries, but its use for impact assessment in developing countries has been rather limited because of constraints on resources, especially in expertise and data.

**COMPONENTS OF EIA**

Although legislation and practice vary around the world, the fundamental components of an EIA would necessarily involve the following stages:

1. **Screening** to determine which projects or developments require a full or partial impact assessment study; Screening is done to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail. Guidelines for whether or not an EIA is required are country specific depending on the laws or norms in operation. Legislation often specifies the criteria for screening and full EIA.
2. **Scoping** to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the development, finding alternative designs or sites which avoid the impacts, incorporating safeguards in the design of the project, or providing compensation for adverse impacts), and finally to derive terms of reference for the impact assessment.
3. **Assessment and evaluation of impacts and development of alternatives**, to predict and identify the likely environmental impacts of a proposed project or development,

including the detailed elaboration of alternatives; several techniques can be used in predicting the impacts. The choices should be appropriate to the circumstances. These can be based on:

- Professional judgment with adequate reasoning and supporting data. This technique requires high professional experience.
- Experiments or tests. These can be expensive.
- Past experience
- Numerical calculations & mathematical models. These can require a lot of data and competency in mathematical modelling without which hidden errors can arise
- Physical or visual analysis. Detailed description is needed to present the impact.
- Geographical information systems,
- Risk assessment, and
- Economic valuation of environmental impacts

4. **Reporting the Environmental Impact Statement (EIS) or EIA report**, including an environmental management plan (EMP), and a non-technical summary for the general audience. The final EIA report is referred to as an Environmental Impact Statement (EIS). Most national environmental laws have specified what the content of EIS should have. Multilateral and bilateral financial institutions have also defined what should be contained in an EIS.

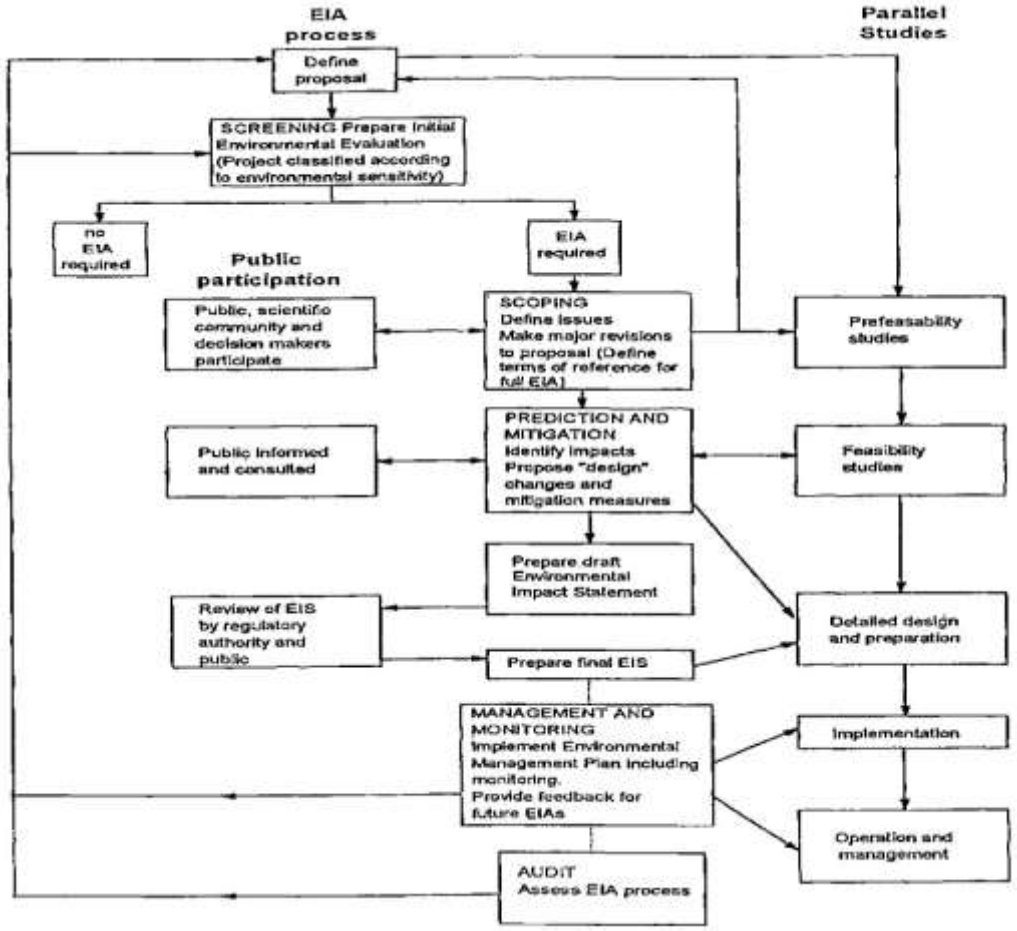



**Figure 1: processes of environmental impact assessment. source: FAO**

**HARDWARE AND SOFTWARES FOR ENVIRONMENTAL IMPACT ASSESSMENT**

A. GLOBAL POSITIONING SYSTEM (GPS)

The global positioning system is a satellite based navigation system made up of a network of 24 satellites place into orbit by the US department of defense. GPS is originally intended for military use, but in the 80s the government made the system for civilian. Functions of the handheld GPS are:

- Giving a location
- Point to point navigation
- Plot navigation
- Keeping track of your track

B. GIS BASED SOFTWARES

These software or platforms are installed on the computer to perform environment related functions such as geo referencing and give additional information on the selected areas.

Some of the software include: ArcGIS; IDRISSI; ILWIS; Quantum GIS; GLOBAL MAPPER etc. their function are as follows:

- To develop the structure of the geo-referenced database correctly
- To take advantage of any spatial and temporal dependency problem in putting together the general structure
- To use enlightened judgment on the choice of variables
- To ensure the compatibility of the systems variables derived from various surveys.  Constantly integrating information from multiple sources

**COMPUTER –AIDED DESIGN AND DRAFTING**

AUTODESK Auto CADD, ArcMAP, Autodesk revit etc.

C. EDGE Version 3.1 of Environmental Design Guide for Engineers (EDGE)

EDGE is a project-related software tool that provides more than 200 opportunities to incorporate pollution prevention into projects during the design phase. Each opportunity is supported by examples, pictures, and references to help you evaluate the applicability and potential benefits to your project.

D. IVAM LCA Data A database in SimaPro 7 format to be used for environmental life cycle assessment (LCA).

D. AUDIT

AUDIT is a (modular-structure) program for environmental management and controlling to analyze and simulate complex systems. As a comprehensive program for material flow balances, AUDIT can be applied to all processes and material flows within the company.

E. MICROSOFT OFFICE SUITE

Microsoft office, Microsoft access, Excel, project etc.

**COMPUTER APPLICATION IN THE PROCESSES OF ENVIRONMENTAL IMPACT ASSESSMENT**

**I. SCREENING**

As stated earlier, Screening is done to determine which projects or developments require a full or partial impact assessment study; also to determine whether or not a proposal should be subject to EIA and, if so, at what level of detail. Guidelines for whether or not an EIA is required are country specific depending on the laws or norms in operation. This stage is also determined by planning authorities and environmental agencies. This determination is carried out based on perceived environmental and social concerns with little or no computer applicability.

**II. SCOPING**

At this stage, to identify which potential impacts are relevant to assess (based on legislative requirements, international conventions, expert knowledge and public involvement), to identify alternative solutions that avoid, mitigate or compensate adverse impacts on biodiversity (including the option of not proceeding with the development, finding alternative designs or sites which avoid the impacts, incorporating safeguards in the design of the project, or providing compensation for adverse impacts), and finally to derive terms of reference for the impact assessment. Specifically, the scoping stage involves:

- Defining issues which may involve public participation and may be achieved through –public discussions with decision makers and stakeholders; focused group discussions**, internet surveys** and use of mails.
- Defining the term of reference of the project which is project specific depending on the impacts anticipated from the project; the scope and environmental opportunities and constrains.

**III. PREDICTION OF IMPACTS AND MITIGATION**

At this stage, likely environmental impacts of a proposed project or development are predicted and identified, including the detailed elaboration of alternatives; several techniques can be used in predicting the impacts. The choices should be appropriate to the circumstances.

Also mitigation measures are suggested based on the gravity of the impacts so suggested. This involves not only the expertise of the predictors and proper understanding on the dynamics of the environment. This requires little or no computer application but the use of GIS could greatly improve the prediction of impacts. More so, DBMS can be used in this case. Also, when the impacts are weighted, spreadsheet could be used to calculate total impacts of the proposed project.

**IV. ENVIRONMENTAL MANAGEMENT AND MONITORING**

In addition to providing an input to design and appraisal, environmental issues are incorporated into the implementation phase of the project cycle. An Environmental Management Plan (EMP) should set out the actions for monitoring and evaluation of the project during implementation or construction and operation. This can be achieved through the use of programmed database (DBMS) that operators can have access to online; with periodic checks by the authorities responsible to carry out such functions i.e the environmental protection authority.

**V. ENVIRONMENTAL AUDIT**

When the project is in existence, then an environmental audit may be required in order to satisfy that it is operating to an appropriate environmental standard. The audit seeks to confirm the operational practices and to highlight any deviation from the accepted norm. An environmental evaluation is increasingly undertaken to confirm that the performance of the project, once constructed and operational, conforms to the specification and environmental performance standards. Frequently, the environmental evaluation seeks to examine the EMP and review the monitoring data in order to reveal aspects where improved practice is possible and where future EIAs can be enhanced.

As stated earlier, there is a program for auditing, however, it a periodic stock taking and can be achieved through the use of spreadsheets and DBMSs.

**CONCLUSION**

The use of computers has evolved over the years to be part of life's endeavour. Apart from the fact that it makes work a lot easier, it makes it faster and accessible to greater number of persons at a particular point in time. Environmental impact assessment which is at the domain of town planners and architects as provided for by the Nigerian urban and regional planning act of 1992

has taken advantage of the advancement in the ICT to further enhance its activities. As we suggest that more programs (software) and hardware be developed to meet the present and anticipated future challenge of planners other professionals indeed.

**RECOMMENDATIONS**

1. There is the need for further research on the application of ICT in Urban and regional planning/urban service delivery EIA in particular,
2. Professionals like town planners They should embrace information communication and technology so that a greater level of connectivity with other professionals can be achieved.
3. Embracing of I.C.T can help in enhancing the public access to information and facilitating public participation in decision-making.
4. Government should employ the use of mapping to secure its territories and also find out the hide outs of bandits, kidnappers, insurgents and what have you

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