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Effectiveness of Environmental Impact Assessment (EIA) Implementation in Major Airports of Nepal

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Abstract
Environmental Impact Assessment is a management tool which is used to identify and evaluate potential environmental impact caused by the proposed project to help in decision making and environmental management. Performance evaluation of EIA study in sectoral development of international airport infrastructure is needed because such infrastructures are considered as national pride projects in Nepal. EIA study reports might lack further guidelines and monitoring and could fail to win public support and neglecting the development of project alternatives as well as they are incompetent with lack of political will and inadequate preparedness on the part of government. In this study, three types of EIA effectiveness (procedural, transactive and substantial) was evaluated for major airports of Nepal. The procedural effectiveness index (PEI) was determined through a mathematical relation which included procedural and transactive effectiveness of EIA study. The weightage coefficient for each variable of relation was determined using AHP (Analytical Hierarchy Process) method. For the substantial effectiveness of EIA, compliance check of mitigation measures proposed during EIA study was evaluated for physical environmental parameters. It was observed that the PEI value of both Pokhara Regional International Airport (PRIA) and Gautam Buddha International Airport (GBIA) was 78% and that for the proposed Nijgadh International Airport (NIA) was 65%. The substantial effectiveness of EIA during construction stage at PRIA and GBIA was 79% and 54% respectively. The compliance during operation stage at GBIA was 57%. These values indicated that the EIA study of those airports could not succeed to fully comply with environmental safeguard. Hence, a strategic environmental assessment of plan should be conducted followed by follow-up study for sustainable development with better environmental management.

Keywords
Analytical Hierarchy Procress, EIA effectiveness, International airports of Nepal, Procedural Effectiveness Index

1. Introduction

Physical infrastructure is the foundation for socio-economic development of a country. Besides the benefits, the construction of those projects often incurs environmental damages. To minimize the negative externalizes of construction projects, many countries mandate the implementation of Environmental Impact Assessment (EIA) at certain stage(s) of a project within their jurisdiction [1].

EIA is an integration of procedures used to formulate decisions, which offers an orderly, replicable and cross-disciplinary assessment. It is challenging to reach the overall objective judgement of the EIA process, there is a need of evaluative framework for legal procedure compliance, arrangement of application and practice of implementation in EIA study [2]. However, there are three different components of effectiveness of EIA study as given [3].

- Procedural: does EIA study comply with existing legal provisions and applications?
- Transactive: does EIA study process deliver its outcome with efficient use of resources (example: time, cost, expertise)
- Substantive: does EIA study fulfill to achieve its objectives?

Performance evaluation of EIA study in development of international airports is needed because such infrastructures are considered as national pride projects of Nepal.

1.1 Study Area

Three out of four major airports considered for the analysis of EIA procedural effectiveness for this study are: Pokhara Regional International Airport (PRIA), Gautam Buddha International Airport (GBIA) and Nijgadh International Airport (NIA) as shown in Figure 1.

Figure 1: International airports of Nepal

When TIA was constructed in 1955 AD, there was no legal obligation to conduct EIA study. With the increase of air traffic at TIA, CAAN forwarded a project named as Air Transport Capacity Enhancement Project (ATCEP) under Asian Development Bank (ADB) loan.
The project had been classified as category B under ADB safeguard policy statement (SPS), 2009. Therefore, an Initial Environmental Examination (IEE) study was carried out. Since, this study aims to evaluate the procedural effectiveness of EIA, the PEI value of ATCEP at TIA has not been determined. However, the substantial effectiveness through compliance of mitigation measures for physical environment was checked.

1.2 Problem Definition

EIA is critical among various stakeholders because it provides detailed and systematic analysis of environmental implication due to proposed project with alternatives before any decision is made. It provides minimum quantitative analysis. However, it clarifies the trade-offs associated with the proposed project [1].

In Nepal, the proposed NIA is a national pride development project. Therefore, its EIA study should have followed different standard policies, strategies and norms or codes prescribed by international financial agencies such as ADB, World Bank, IFC. However, the study lacked funnel assessment and analysis of ecosystem services of the vast forest area, as well as assessment of aircraft noises and engine emissions, hazardous building materials and waste management, and other critical issues related to the construction of ICAO category of international airport [4].

EIA study reports lack further guidelines and monitoring without succeeding to win public support and neglect the development of project alternatives, as well as they are incompetent with lack of political will and inadequate preparedness on the part of government [5]. Therefore, it could be precious to evaluate the effectiveness of such EIA study. Its effectiveness is based on several factors or criteria [6]. Hence, the first task was to identify such decisive criteria in detail, with appropriate weightage corresponding to their attribute in EIA study.

EIA is less quantitative in nature but for decision makers it does help to clarify complicated and non-tangible trade-offs associated with the project. It also helps to bring the balance between interests of project and safeguarding of environment. This study had provided a robust analysis to quantify the EIA procedural and transactive effectiveness through a mathematical relationship in a scientific manner with an appropriate tool.

1.3 Objectives

The primary objective of this study was to evaluate the effectiveness of EIA of major airport projects in Nepal. The specific objectives of this study included the followings;

- To determine Procedural Effectiveness Index (PEI) value of EIA study of major airports in Nepal.
- To analyze substantial effectiveness through compliance of proposed mitigation measures of EIA study for physical environmental parameters in those airports construction.

Bio-physical environmental parameters are major parameters with high negative impacts due to proposed project [4]. Therefore, physical environmental parameters were considered for the compliance of mitigation measures in this study.

2. Methodology

This study evaluates procedural, transactive and substantial effectiveness of EIA of major airports in Nepal. The decisive parameters were defined and their relative weightage coefficient was determined. These parameters and its coefficient were integrated to develop a mathematical relation between procedural and transactive effectiveness to determine PEI value. The proposed methodological framework for this study is illustrated in figure 2.

2.1 Parameters for Procedural Effectiveness Index

Effectiveness of EIA can be investigated both in its substantial and procedural characteristics [7].

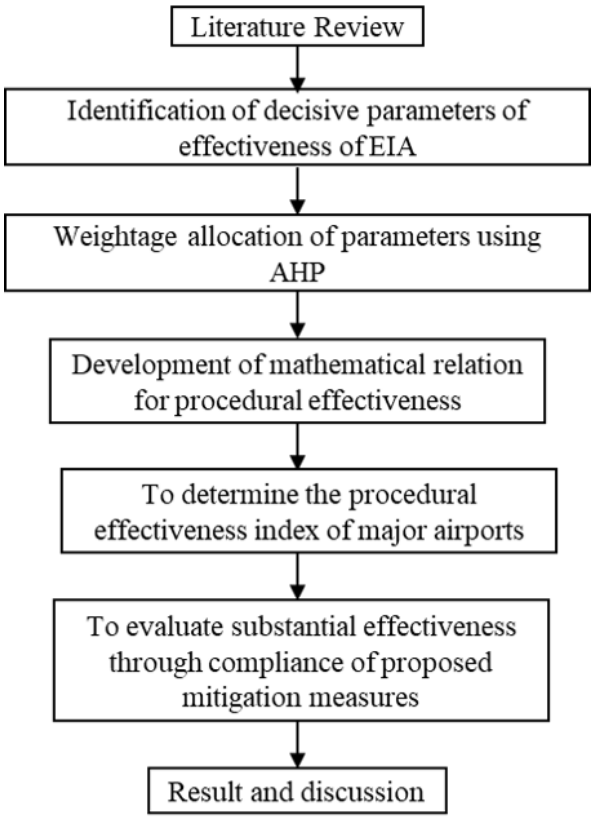

Figure 2: Methodological framework of the study

As per National Environmental Impact Assessment Guidelines 1993, five different environmental parameters must be considered in the Environmental assessment, i.e physical, biological, chemical, socio-economic and cultural. Beside this, there are some key sub-parameters like species extinction rate, threatened species type, CO_2 emission, land use change, wetland change, land degradation, rain use efficiency and soil pollution which should be considered to make effective assessment of environmental impact cause due to proposed project. However, this study overviews the basic procedural framework for conducting EIA and its implementation status in Nepal. On the basis of literature review, eight different parameters have been considered under two categories for this study. In order to evaluate the procedural effectiveness, basic parameter type was used which includes four parameters as given below:

- Comprehensiveness
- Stakeholder confidence
- Attestation
- Accuracy

Similarly, in order to evaluate transactive effectiveness, operative parameter type was used which includes four parameters as given below:

- Interdisciplinary
- Review capacity
- Participation
- Accountability

Procedural effectiveness was related to "efficacy" which analyzed its compliance with standard procedural, best practices, legal provision and guidelines used to achieve the expectations. Transactive effectiveness was related to "efficiency" which evaluated the contribution of EIA study to environmental protection through efficient use of resources.

2.2 Procedural Effectiveness Index (PEI)

Procedural effectiveness index of EIA methodology was an expression for developing relationship between basic and operative parameter type in order to evaluate the capacity of EIA study in fulfilling the proposed objective through optimal management of given resources [8]. The proposed mathematical relation to determine PEI is given in equation 1 [8].

$$PEI = [(\alpha.BP - UF) + \beta.OP] * 100 \quad (1)$$

where, PEI = procedural effectiveness index of EIA, BP = basic parameter type of PEI, OP = operative parameter type of PEI, UF = uncertainty factor, α = coefficient for basic parameter, β = coefficient for operative parameter.

The output of equation 1 was resulted in the form of percentage which illustrated the level of procedural effectiveness of EIA study. The level of effectiveness based on the value of PEI were divided into five levels starting from 'very low' (0% - 20%), 'low' (21% - 40%), 'moderate' (41% - 60%), 'high' (61% - 80%) to 'very high' (81% - 95%) [8].

2.2.1 Basic Parameters (BP) of PEI

This parameter consisted four variables – comprehensiveness (Co), stakeholder confidence (St), attestation (At) and accuracy (Ac). The mathematical relation between these variables is given in equation 2.

$$BP = \gamma.Co + \delta.St + \eta.At + \lambda.Ac \tag{2}$$

Here, $\gamma, \delta, \eta, \lambda$ were relative coefficients whose value was determined using AHP.

Comprehensiveness (*Co*) dealt with the consideration of all environmental components which were likely to be impacted from the proposed project. Hence, it measured multiplied effect of three different indicators as given in equation 3.

$$Co = CEP * KEP * IIA \tag{3}$$

where,
CEP = indicator for considering all likely impacting environmental parameters. Its value was either '0' pr '1'.
KEP = indicator for assessment of key environmental issues. Its value was either '0' or '1'.
IIA = indicator for gathering sufficient base information to identify impacts and their management through alternative process study. Its value was either '0' or '1' as well.

Stakeholder confidence (*St*) variable was used to evaluate the understanding of the stakeholders about identifying the baseline information required to determine the impacts and their clarity about proposed project objectives. It helped to form boundary of environment to be considered for impact analysis. Its value was either '0' or '1'.

Attestation (*At*) variable was used to assess the concrete base for determining the impact. The baseline data should have clear evidence and/or review proceedings which helps to minimize uncertainties. Therefore, it had three values: 0, 0.5 or 1 based on the consideration of baseline data with relevant evidence and follow-up study after construction.

Accuracy (*Ac*)variable evaluated the use of standard and legal guidelines during the EIA study. In case of international airport, environmental guidelines from ICAO, ADB, world bank should be followed. It represented two different indicators as given in equation 4.

$$Ac = UTp * STu \tag{4}$$

where,
UTp = indicator for considering standard relevant protocols like ICAO, ADB standards. Its value was either '0' or '1'.
STu = indicator for evaluating the suitability of guideline used. Therefore, it had three values: 0, 0.5 or 1 based on the consideration that those guidelines were supported by academic research and publication.

2.2.2 Operative Parameters (OP) of PEI

This parameter consisted four variables – interdisciplinary (Id), review capacity (Rc), participation (Pp) and accountability (Acc). The mathematical relation between these variables is given in equation 5

$$BP = \theta.Id + \omega.Rc + \sigma.Pp + \phi.Acc \tag{5}$$

Here, $\theta, \omega, \sigma, \phi$ were relative coefficients whose value was determined using AHP.

Interdisciplinary (*Id*) variable dealt with the integration of specialties from different background in the preparation and evaluation of EIA study. It helped to bring multiple perspective on the complex nature of study. A minimum of six professionals were suitable for the evaluation of EIA study. Therefore, it had three values: 0, 0.5 or 1 based on the consideration of less than four, five to six and more than six professionals for the evaluation process.

Review capacity (*Rc*) variable represented the ability of stakeholders to perform EIA study in such a way that it ensured the integrity and effectiveness of the process. Therefore, sufficient staffs with skills and qualification are required to evaluate social, scientific and technical data of this process [6, 9]. This variable used two indicators as given in equation 6

$$Rc = QRC * SFR \tag{6}$$

where,
QRC = indicator for evaluating the qualification of

review committee members. It had three values: 0, 0.5 and 1 based on the graduation degree and minimum of five-year field experience by more than 50% of the committee members.
SFR = indicator for consideration of sufficient fund required by the committee. It had three values: 0, 0.5 and 1 based on the availability of fund for reviewer allowances, data purchase, lab expenses, field investigation, etc.

Participation (*Pp*) variable presented the inclusion of public hearing to the overall manifestation of the EIA study process. According to sub-rule 2 of rule 7 of EPR 2022 of Nepal, such public consultation must be fulfilled for the EIA study. It aids in quality enhancement of the process, effective assessment of impact and enforce decision making [6]. Its value was either '0' or '1' based on the consideration of public participation.

Accountability (*Acc*) variable measured the assurance to disclose documentation to all stakeholders. This helped in proper monitoring of the executed works, mitigation of impacts supported by follow-up study. The legal provision for the monitoring and auditing plans were least practices and no necessary actions were found to be taken to control it [9]. It had three values: 0, 0.5 and 1 based on disclosure of EIA related documentation and consideration of monitoring/auditing activities during and after the construction of project with follow-up study.

2.2.3 Uncertainty Factor (UF)

Environment is complex dynamic in nature. An accurate prediction of impacts is always challenging. Hence, uncertainty is almost unavoidable in the EIA study [8]. Therefore, a weightage factor of 0.5 was considered through the consultation of field experts to incorporate the complexity and uncertainty of environment.

2.3 Data Collection and Interpretation

In order to determine the relative weightage coefficient of each variable, a questionnaire survey was carried out using AHP method [6]. A set of thirteen questions was prepared for this survey. This survey was done using online platform – google forms and in person interview. It is not mandatory for the AHP method to sample a large number of subjects, since a large sample size might include respondents who respond to cold calls and have the tendency to provide arbitrary responses, leading to a high degree of inconsistency [10]. To test the comparability of critical success factors for construction partnerships, nine experts were participated to complete an AHP survey [10]. Twenty one individuals were selected from concern stakeholders like ministries officials, CAAN members and related consultants were considered for the questionnaire survey. Responses of the survey were analyzed individually using "Super Decisions" software, version 2.8.0.0 to determine the weightage coefficient value. The final corrected coefficient value was determined by taking the average of the calculated value for each parameter.

2.4 Substantial Effectiveness

In order to evaluate the substantial effectiveness, compliance of mitigation measures for physical environment in three major airports was determined. Since, EIA study at NIA was approved but the construction has not started yet. Therefore, only GBIA, PRIA and TIA was considered.

Compliance check for environmental impact through monitoring was challenging and one type of monitoring was also not sufficient for such analysis [11, 12]. However, monitoring of the application of mitigation measures was crucial for improving the effectiveness of any project [11].

2.4.1 Data Collection

A review study of EIA reports of these airports was carried out. The study was focused on the mitigation measures of physical environmental parameters for the construction and operation phase of airport projects because high adverse impacts were caused to physical environmental parameters. Then, a compliance checklist was prepared for field monitoring which included the mitigation measures to be checked and its level of compliance.

A field survey was conducted from July to August, 2022. In the survey, direct observation of implementation of mitigation measures, informal interviews and consultation with concerned authorities was carried out.

2.4.2 Data Interpretation

Obviously, the implementation of proposed mitigation measures take time and is a continuous work. Hence, the implementation percentage was calculated to

determine the portion of implementation of measures [13]. The results from the field observation were categorized on each category as given in table 1 on the basis of level of implementation of those measures.

Table 1: Level of compliance of mitigation measures [13]

Level of compliance	Description
Non – compliance (NC)	when the mitigation measured are implemented less than 25% or not implemented at all
Partial– compliance (PC)	when the mitigation measures are implemented between 25% to 75%
Compliance (C)	when the mitigation measures are implemented greater than 75%

Total score of compliance under each category was determined separately for respective airports. High level of compliance ensures that the EIA study is effective and its results are reliable.

3. Results and Discussion

On the basis of analysis and findings in the questionnaire using AHP, the value of (α) and (β) was observed as 0.72 and 0.28 respectively. Similarly, the calculated average value of weightage coefficient for basic variables is given in table 2.

Table 2: Coefficient value for basic variables

Variable	Coefficient	Value
Comprehensiveness	γ	0.43
Stakeholder confidence	δ	0.24
Attestation	η	0.23
Accuracy	λ	0.10

It was observed that comprehensiveness variable had relatively high coefficient value because it considers all the aspects of the environment that are likely to be impacted due to project. For the operative variables of PEI of EIA study, calculated average value is given in table 3. It was observed that interdisciplinary variable had relatively high coefficient value because it helps to dilute decision making by integrating personal from different background for rationale, unbiased and structural evaluation of EIA study.

Table 3: Coefficient value for operative variables

Variable	Coefficient	Value
Interdisciplinary	θ	0.49
Review capacity	ω	0.25
Participation	σ	0.17
Accountability	ϕ	0.09

3.1 PEI value of major airports

For the determination of PEI value, three out of four major airports were considered. They were PRIA, GBIA and NIA. On the basis of analysis, review study of EIA report, consultation with CAAN and ministry officials, the value of each parameter was determined. The value of basic and operative values of those airports is summarized in table 4.

It was observed that the level of effectiveness of all three airport was high. It means that the study presents a rigid procedural structure. However, it needs to improve some aspects of the study to produce reliable outcome. The PEI value of these airports is shown in Figure 3.

Table 4: Calculated value for major airports

Airport	BP value	OP value	PEI value
PRIA	0.835	0.830	78%
NIA	0.595	0.955	65%
GBIA	0.835	0.830	78%

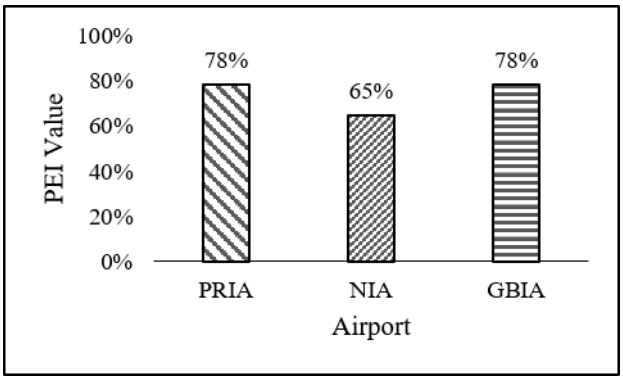

Figure 3: PEI value of major airports

3.2 Substantial Effectiveness of major airports

The substantial effectiveness of EIA study of major airports was evaluated through the implementation

of proposed mitigation measures during and after the construction of proposed airport project. On the basis of field visit and consultation with key personnel of CAAN and consultant, the compliance for each airport is presented in following sections.

3.2.1 Compliance at PRIA

A field visit was carried out in July, 2022. The airport has not come in operation yet. A total of 19 mitigation measures were assessed in the field for physical environment impact mitigation measures during the construction phase of the project. The observed compliance level of those mitigation measures is given in figure 4.

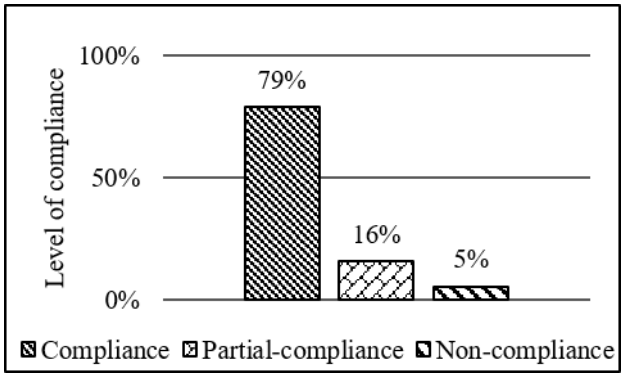

Figure 4: Mitigation compliance of physical environment at PRIA

3.2.2 Compliance at GBIA

A field visit was carried out in August, 2022. The airport was inaugurated on 16th May, 2022. Total of 28 mitigation measures during construction stage and 7 mitigation measures during operation stage for physical environment impact were proposed in the EIA study. The observed level of compliance of mitigation measures during con-struction and operation stage is given in figure 5 and 6 respectively.

3.2.3 Compliance of ATCEP at TIA

A field visit was carried out in August, 2022. Under ATCEP, construction of parallel taxiway and international apron at TIA has not completed yet. So, the compliance check of mitigation measures for physical environment during construction stage was only considered.

Total of 24 mitigation measures were considered at the time of visit for physical environment during construction stage of project. The project had not completed. Therefore, the final level of compliance during construction stage was remaining. however, the level of compliance with the progress of project was found to be satisfactory. Proper handling of materials and machines was observed. The crusher plant was not found to be operated since 2015 so, no sound and air pollution due to crusher plant was observed. The level of compliance of mitigation measures is given in figure7.

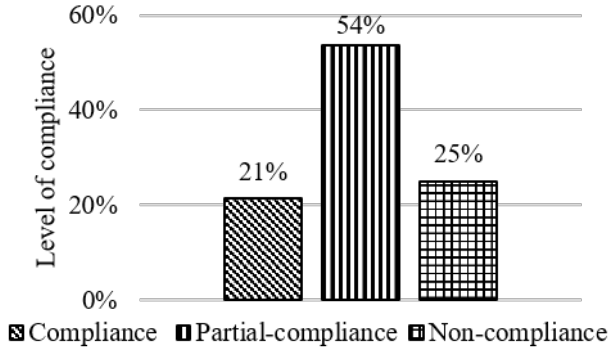

Figure 5: Mitigation compliance during construction stage of GBIA

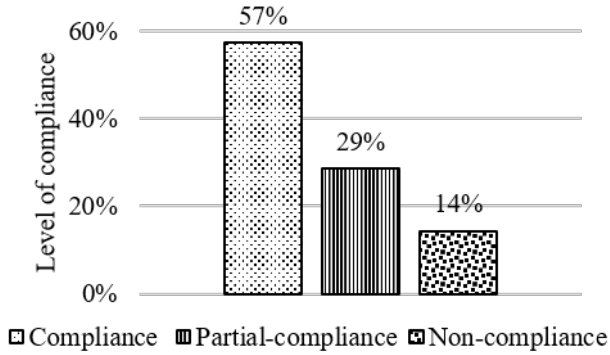

Figure 6: Mitigation compliance during operation stage of GBIA

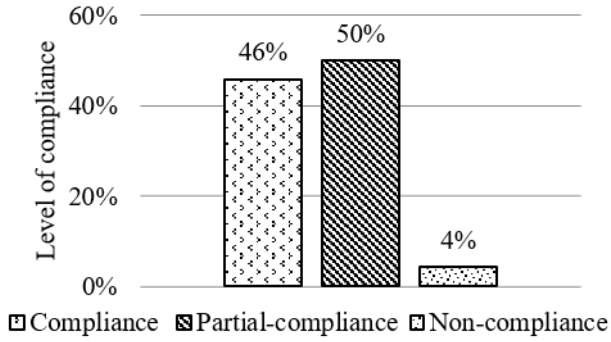

Figure 7: Mitigation compliance during construction stage of ATCEP at TIA

It was observed that the level of compliance was maximum for (PC), followed by (C) and (NC). Fair compliance of the mitigation measures were observed during the visit. Monitoring and environmental audit was carried out at predetermined interval to check the level of environmental impact.

4. Conclusion

An index value for procedural and transactive effectiveness of EIA has been determined for major airports in Nepal through mathematical relationships between different decisive parameters. The PEI value of PRIA, GBIA and NIA was obtained to be 78%, 78% and 65% respectively which indicates "high" level of procedural and transactive effectiveness of EIA. The substantial effectiveness of EIA during construction stage at PRIA and GBIA was 79% and 54% respectively. The compliance during operation stage at GBIA was 57%. These values indicated that the EIA study of those airports could not succeed to fully comply with environmental safeguard. Lack of follow-study, ambiguity in objective of project, lack of necessary and sufficient evidence of evaluation and review capacity constraints were some of the major aspects that was observed for correction. The monitoring of mitigation compliance was found little in practice. Therefore, better necessary actions are needed to improve the compliance level during construction and operation of airports.

This study showed "high" level of effectiveness index of EIA. However, the impact of EIA in safeguarding the environment is felt little in practice. Therefore, funnel assessment on different sub-parameters of environment like extinction of species, change of wetland, land cover change effects should be carried out during EIA study to understand long term impact caused due to proposed project.

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