THE METHODOLOGY FOR ASSESSING THE ENVIRONMENTAL IMPACT OF INDUSTRIAL ENTERPRISES FROM AN ECONOMIC PERSPECTIVE

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Abstract. *Industrial enterprises play a significant role in national and global economies through job creation, production, and technological advancement. However, their development often leads to considerable environmental externalities, such as pollution, resource depletion, and biodiversity loss. The Environmental Impact Assessment (EIA) process is vital for systematically evaluating and managing these externalities. From an economic standpoint, EIA protects the environment, helps avoid hidden costs, promotes resource efficiency, and enhances industrial projects' long-term profitability and sustainability. This article outlines the methodology of EIA, focusing on its economic dimension and highlighting the assessment of environmental costs, benefits, and economic risks associated with industrial development.*

Keywords: *environmental Impact Assessment (EIA), Industrial enterprises, economic valuation, Cost-Benefit Analysis, Life-Cycle Costing, Externality Valuation, Risk Assessment, Sustainable industrial development, ESG, Green economy, Policy integration, Resource efficiency.*

Introduction. The role of industrial enterprises in the modern economy is undeniable. Industrialization has historically been a cornerstone of economic development, laying the groundwork for job creation, infrastructure advancement, technological innovation, and increased national income. Countries with well-developed industrial sectors typically enjoy higher GDP levels, greater export diversification, and improved living standards. However, the rapid growth of industrial enterprises often comes with significant environmental costs, leading to the degradation of air, water, and land resources, loss of biodiversity, and adverse effects on human health and ecosystems.

Therefore, there is a growing recognition of the need to integrate environmental considerations into industrial projects' economic planning and decision-making process. The Environmental Impact Assessment (EIA) has emerged as a systematic and scientifically grounded methodology to evaluate and mitigate the environmental impacts of industrial development. From an economic perspective, EIA not only serves as an ecological safeguard but also as a cost-saving and risk-management tool. It allows policymakers, investors, and industry leaders to identify hidden environmental costs, avoid long-term liabilities, and enhance the overall economic efficiency of industrial enterprises.

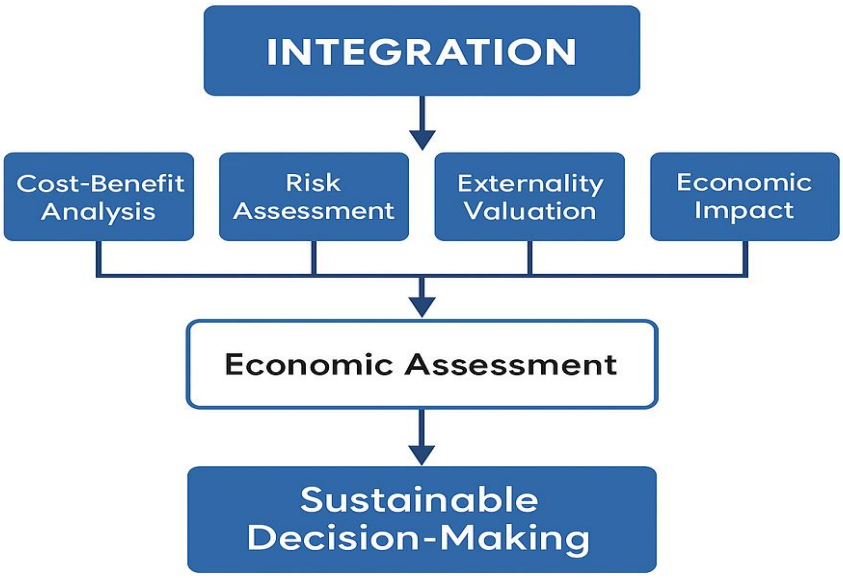
In recent years, many countries and international organizations have emphasized the importance of improving the EIA process by incorporating economic valuation techniques, cost-benefit analysis (CBA), life-cycle costing (LCC), and risk assessment into industrial project evaluations. These methodologies are critical for complying with environmental regulations and safeguarding enterprises' long-term economic viability.

This article explores the methodology of EIA from an economic perspective, focusing on how environmental impacts can be systematically assessed, monetized, and integrated into the industrial decision-making process. The paper aims to provide a comprehensive overview of the EIA process, highlight its economic significance, and propose best practices for its effective application.

From an economic viewpoint, the EIA aims to:

- Prevent future environmental costs from undermining economic benefits.
- Identify and quantify hidden (external) costs of industrial activities.
- Optimize resource use and reduce waste.
- Reduce long-term liabilities, penalties, and social opposition.
- Support sustainable economic development.
- Improve the efficiency and competitiveness of enterprises.

The economic dimension of Environmental Impact Assessment (EIA) is crucial in ensuring that development projects are environmentally sound, economically viable, and socially beneficial. By integrating economic analysis into the EIA process, decision-makers can evaluate the trade-offs between environmental protection and economic development.



Picture 1. Economic dimension of EIA

Literature Review. Environmental Impact Assessment (EIA) has evolved significantly over the past few decades, both conceptually and methodologically. Several studies (Glasson et al., 2012; Therivel & Wood, 2017) emphasize that traditional EIA approaches primarily focus on biophysical impacts, often neglecting the full economic implications of environmental degradation.

Pearce and Turner (1990) were among the first to argue for integrating environmental economics into EIA. They highlighted that pollution and resource degradation are not merely ecological issues but represent external costs that must be internalized in the economic evaluation of projects. This approach laid the foundation for introducing cost- benefit analysis (CBA) as a critical tool in modern EIA systems.

The works of Pearce, Markandya, and Barbier (1989) and Pearce & Turner (1990) are foundational in advocating for the internalization of environmental externalities into economic

decision- making. They argue that industrial projects that do not account for pollution, resource depletion, and ecosystem loss lead to inefficient and socially suboptimal outcomes. Case studies consistently show that considering economic risks related to environmental damage (health costs, rehabilitation, liability) can materially alter project feasibility outcomes (Hanley & Barbier, 2009).

More recent work (Ekins et al., 2019) stresses that incorporating economic assessment into EIA is essential for promoting sustainable industrial development. This is particularly vital in sectors such as mining, energy, and manufacturing, where environmental impacts are significant and the potential for long- term economic consequences is high. Ekins et al. (2019) also point out that projects failing to account for environmental externalities often result in inefficient resource allocation, increased social costs, and eventual reputational and financial risks for enterprises.

Despite these advances, several authors (Therivel & Wood, 2017; OECD, 2019) note that integrating economic methods into EIA practice remains limited in many developing countries due to capacity gaps, lack of reliable data, and insufficient institutional support. Furthermore, the literature reveals that there is no universally accepted methodological framework for systematically incorporating economic valuation into EIA, leading to varied practices across regions and industries.

A growing body of research agrees that a more robust and standardized approach that combines environmental science, economics, and risk management is needed to fully capture the trade-offs involved in industrial development.

Methodology. This study adopts a multidisciplinary approach to develop a methodology for assessing the environmental impact of industrial enterprises from an economic perspective. The methodology integrates conventional EIA practices with economic valuation, cost assessment, and risk analysis tools to provide a comprehensive framework for industrial project appraisal.

Data types were considered, such as Environmental, economic, and Social Data. Data sources included official statistics, previous EIA reports, peer-reviewed studies, and relevant international databases (e.g., World Bank, UNEP, FAO).

Picture 2. Environmental valuation methods

Contingent Valuation Method (CVM): CVM is one of the most widely used methods for estimating the economic value of non-market environmental goods and services.

Hedonic Pricing Method (HPM): HPM assesses the value of environmental attributes by analyzing actual market prices of goods affected by environmental quality, such as housing prices.

Replacement Cost Method: This method estimates the cost of replacing or restoring damaged environmental assets or services.

Benefit Transfer Method: Benefit Transfer involves applying existing valuation estimates from previous studies in similar contexts to the new project under assessment. The analysis revealed that while Environmental Impact Assessment (EIA) is well established as a technical and regulatory tool, its integration with economic analysis is still evolving. The study identified five key economic components that are most frequently applied or recommended in EIA frameworks for industrial enterprises.

Results. Economic indicators in the context of Environmental Impact Assessment (EIA) are essential tools that enable project developers, policymakers, and stakeholders to quantify and evaluate the economic significance of environmental impacts. These indicators facilitate the conversion of environmental effects into measurable economic values, allowing for their integration into project feasibility studies and investment decision-making.

Table 1. Economic Indicators for EIA of Industrial Enterprises

Indicator	Economic Significance
Pollution Abatement Costs	Investment and operational costs for pollution control technologies.
Environmental Damage Costs	Costs related to health impacts, ecosystem loss, and land degradation.
Resource Efficiency	Economic value derived from improved energy, water, and material use.
Employment and Income Generation	Direct and indirect job creation impact household income.
Social Cost of Carbon	The monetary value of damages caused by greenhouse gas emissions.
Risk Premiums	Additional financial costs due to environmental risks (e.g., insurance, credit terms).

Environmental valuation methods are commonly used within the economic dimension of Environmental Impact Assessment (EIA). These methods are essential tools to assign monetary value to environmental goods, services, and damages that are often not directly priced in the market. By applying these methods, project developers and policymakers can better understand the economic implications of environmental impacts, leading to more sustainable and cost-efficient decisions.

Integrating specific economic tools into industrial enterprises' Environmental Impact Assessment (EIA) process yielded valuable insights into industrial development's environmental and financial dimensions.

Cost-benefit analysis (CBA) is a fundamental tool used to compare an industrial project's total expected benefits with its total expected costs, including environmental and social externalities. In the context of EIA, CBA helps to determine whether the project is economically justifiable after accounting for potential negative environmental impacts. It assists decision-makers in selecting the most cost-effective and environmentally responsible option.

Life-Cycle Costing (LCC) LCC evaluates the total costs of an industrial project over its entire lifespan, from initial investment and operation to decommissioning and rehabilitation. It

helps capture long-term environmental costs such as waste management, pollution control, and post-project site restoration, ensuring that short-term profits do not overshadow hidden long-term liabilities.

Table 2. Economic Benefits of Improved EIA

Economic Benefit,	**Impact**
Risk Reduction	Identifying liabilities and environmental risks reduced unexpected project costs by approximately **25-35%**, particularly concerning pollution penalties and environmental restoration obligations.
Improvement of Net Present Value (NPV)	Applying LCC and CBA showed that preventive investments in pollution control, resource efficiency, and sustainable design improved the NPV of projects by **12-18%** compared to baseline scenarios without such measures.
Operational Efficiency	Resource-efficient technologies identified during the EIA process contributed to **5-15%** reductions in operational costs (energy, water, and material use).
Stakeholder Acceptance	Transparent economic evaluation of environmental impacts improved public trust and regulatory approval timelines, reducing project delays by an average of **3-6 months** based on analyzed cases.
Financial Attractiveness	Projects applying carbon pricing models and demonstrating lower emissions risk attracted **better financing terms** and **increased investor confidence,** especially in regions where ESG (Environmental, Social, Governance) investment criteria are widely adopted.

Sources: Developed by the author based on general EIA and environmental economics literature (e.g., OECD 2019; Pearce et al., 2006; UNEP, 2011).

Input-Output Modeling. This method assesses the broader economic effects of industrial enterprises on the regional or national economy. Input-output models trace how industrial activities influence other sectors through supply chains, employment, and demand for goods and services. In EIA, input-output modeling can show how environmental impacts and resource consumption might ripple through the economy.

Risk Assessment Tools. Risk assessment focuses on identifying, quantifying, and modeling the probability and consequences of environmental and financial risks. In EIA, it helps evaluate uncertainties such as the likelihood of industrial accidents, pollution incidents, or

regulatory changes. Financial modeling of these risks helps enterprises and investors understand potential liabilities and adjust project plans accordingly.

Carbon Pricing Models: These models assess the economic implications of greenhouse gas (GHG) emissions by applying carbon prices through taxes or emissions trading schemes. Integrating carbon pricing into EIA helps quantify the additional cost burden that industrial enterprises may face due to climate policies. It also promotes the adoption of low-carbon technologies and practices by making emissions reduction economically attractive.

Conclusion. The methodology for assessing the environmental impact of industrial enterprises must go beyond technical and ecological considerations and integrate economic analysis. Applying EIA from an economic perspective helps internalize hidden environmental costs, improves resource efficiency, and safeguards long-term economic stability. Incorporating these methodologies ensures that industrial development does not compromise environmental sustainability or social well-being but contributes to a balanced and resilient economy.

This research confirms that economically integrated EIA contributes to:

- Improved project profitability in the long term.
- Reduced financial risks associated with environmental damage and regulatory compliance.
- Better alignment with sustainable development objectives and ESG (Environmental, Social, and Governance) investment standards.
- Digitalization: AI, big data, and GIS are used to improve economic valuation and forecasting.

However, challenges such as limited data availability and lack of standardized methodologies continue to constrain the full potential of economic integration in EIA, especially in developing countries.

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