International Journal of Social Science, Educational, Economics, Agriculture Research and Technology (IJSET) | ISSN (e) : 2827-766X
Volumes 4 No. 5 (2025)

ENVIRONMENTAL IMPACT ASSESSMENT IN CIVIL ENGINEERING FOR SUSTAINABLE INFRASTRUCTURE PROJECTS

Dery Mochamad
Teknik Sipil, Universitas Doktor Nugroho, Magetan, Indonesia
derymochamadfadillah@udn.ac.id[1]
Author Corespending: derymochamadfadillah@udn.ac.id

Received	: 30 March 2025	Published	: 29 April 2025
Revised	: 08 April 2025	DOI	: https://doi.org/10.54443/ijset.v4i5.1029
Accepted	: 24 April 2025	Publish Link	: https://www.ijset.org/index.php/ijset/index

Abstract

Environmental Impact Assessment (EIA/EIA) is an important instrument in civil engineering infrastructure project planning to ensure that development runs in line with sustainability principles. This study aims to examine the extent to which the implementation of EIA in civil engineering projects in Indonesia has accommodated environmental and social sustainability aspects. With a descriptive qualitative approach, data was collected through interviews, observations, and documentation studies of several major infrastructure projects. The results show that the implementation of EIA is generally still procedural and has not been fully integrated in the technical design of the project. The aspects of community participation and ecological sustainability are often ignored or implemented in a formality. On the other hand, projects with high public involvement and proper utilization of environmental technologies show better quality of EIA documents. This study suggests the importance of increasing the capacity of actors, integrating EIA from the early stages of planning, and strengthening supervision of the implementation of RKL-RPL. With this strengthening, EIA can play a strategic role in realizing infrastructure that is not only functional and economical, but also environmentally and socially friendly.

Keywords: ***Environmental Impact Assessment, Civil Engineering, Sustainable Infrastructure, Community Participation, EIA.***

INTRODUCTION

Infrastructure development is an integral part of a country's progress. In the context of civil engineering, the development of infrastructure such as roads, bridges, dams, and multi-storey buildings is a symbol of economic growth and human civilization (Siahay et al., 2023). However, behind this progress, development that does not pay attention to environmental aspects can have a significant negative impact on ecosystems, human health, and the sustainability of natural resources. To overcome these potential negative impacts, a systematic approach is needed in identifying, predicting, evaluating, and managing the environmental impact of a project. This approach is known as Environmental Impact Assessment (Environmental Impact Analysis or EIA) (Prakoso & Hardjomuljadi, 2025). This assessment is an important instrument in the planning and decision-making process for a development activity. According to (Glasson & Therivel, 2013), Environmental Impact Assessment is "a tool used to identify the environmental, social and economic impacts of a project prior to decision-making". Thus, EIA (Environmental Impact Assessment) is not just an administrative procedure, but an analytical tool that encourages project development to be more responsible and sustainable (Widaningrum et al., 2024). In practice, the application of EIA in civil engineering still faces a variety of challenges, especially on large-scale projects that are often complex and multidimensional (Asrorudin, 2025). This complexity concerns the interaction between construction activities and the physical, biotic, and social environment that surrounds them. The importance of EIA in civil engineering is even more evident when considering the fact that infrastructure development often causes major changes in land use, affects the hydrological system, and causes air, water, and soil pollution. In the long run, projects that do not consider environmental impacts can result in permanent environmental degradation and economic losses (Marsini & Dwikoranto, 2022).

The concept of sustainable development emphasizes the importance of development that is able to meet current needs without sacrificing the ability of future generations to meet their own needs (Imperatives, 1987). Therefore, EIA is an important tool in bridging the gap between development needs and environmental sustainability. Civil engineering as the field responsible for the design and implementation of infrastructure must integrate sustainability principles in all stages of the project cycle. This includes planning, design, construction, operation, and maintenance. The integration of EIA in each of these stages ensures that environmental impacts can be minimized from an early stage. Sustainable infrastructure projects focus not only on technical and economic aspects, but also on resource efficiency, carbon emissions, biodiversity, and community participation. In this case, EIA plays a strategic role in identifying and evaluating these aspects to be used as a basis for decision-making. According to (Noble, 2010), EIA is not only an impact prediction tool, but also a reflective process that drives the development of planning policies and practices that are more adaptive to environmental and social change. Therefore, the use of EIA must be carried out with a participatory, transparent, and evidence-based approach.

Nevertheless, in practice, EIA is often considered an administrative obstacle by some project actors. In fact, if carried out comprehensively, EIA can actually reduce the risk of project failure, social conflicts, and additional costs due to environmental damage that were not previously taken into account. Studies show that good EIA implementation can increase project accountability, strengthen social legitimacy, and improve the quality of project technical design. This is reinforced by the opinion (Sadler, 1996) which states that EIA is an integral part of effective "environmental planning and management". In the Indonesian context, the obligation to implement EIA has been regulated in various regulations, such as Law Number 32 of 2009 concerning Environmental Protection and Management (Life, 2009). This regulation emphasizes that every business plan and/or activity that has the potential to have an important impact on the environment must be completed with an EIA document. Although regulatively regulated, the implementation of EIA in civil engineering projects still faces various obstacles, such as weak supervision, lack of community participation, and limited technical capacity of project implementers in interpreting EIA results. This shows the importance of strengthening institutional capacity and human resources.

Technological developments such as spatial modeling, geospatial analysis, and geographic information systems (GIS) can support the EIA process to be more accurate and efficient (SIHOMBING, 2025). This technology allows the identification of environmental impacts to be carried out with high precision and on a wide scale. In addition, multi-criteria approaches and risk analysis are now beginning to be implemented in the EIA process to aid in more comprehensive decision-making. Thus, EIA not only serves as an impact prediction tool, but also as part of risk management in civil engineering projects. Recent studies have also emphasized the importance of incorporating social and economic perspectives into EIA analysis, so that this process does not focus solely on biophysical impacts. Projects that are environmentally successful but fail socially often face resistance or conflict that leads to project termination. With increasing global pressure on the issues of climate change, environmental degradation, and energy consumption, the need for sustainable infrastructure projects is even more urgent. Civil engineering must be transformed into a discipline that not only builds physically, but also maintains ecological balance. In this case, the integration of Environmental Impact Assessment is the main prerequisite to ensure that any infrastructure development is in line with sustainability principles, and does not cause externalities that harm the wider community and ecosystem. The importance of EIA in civil engineering projects is also demonstrated through various international case studies that illustrate the success of projects after the EIA process is carried out correctly and transparently. On the other hand, projects that ignore the EIA often lead to conflict, rejection, and even large financial losses. Thus, Environmental Impact Assessment is an integral element of responsible civil engineering practice. The integration between engineering disciplines and environmental approaches through EIA is key in realizing infrastructure projects that are not only functional and economical, but also sustainable in the long term.

RESEARCH METHODS

The research method used in this study is qualitative descriptive (Moleong, 2018), with the aim of in-depth understanding the role, process, and effectiveness of the implementation of Environmental Impact Assessment (EIA/EIA) in sustainability-oriented civil engineering projects. This approach was chosen because it is able to provide a holistic picture of complex and contextual phenomena, especially related to the interaction between technical, social, and environmental aspects in the planning and implementation process of infrastructure projects. The data sources in this study consist of primary data and secondary data (Moleong, n.d.). Primary data was obtained through in-depth interviews with resource persons consisting of civil engineering planners, environmental consultants, government officials in the environmental sector, and community representatives directly involved in infrastructure projects. Interviews are conducted in a semi-structured manner so that researchers can explore various points of view flexibly while still focusing on the main issues that have been formulated beforehand.

Meanwhile, secondary data was obtained through a documentation study of EIA documents from several infrastructure projects that have been implemented in the last five years, including environmental evaluation reports, licensing documents, and environmental audit results from related institutions. In addition, academic literature such as scientific journals, books, and government regulations are used as supporting materials in data analysis. The data collection technique is carried out through participatory observation of the stages of EIA implementation in certain projects, as well as document review to obtain comprehensive information. This approach is expected to be able to uncover the dynamics of EIA implementation in the field, as well as the extent of its integration in civil engineering practice. In the data analysis process, the researcher uses content analysis techniques that aim to identify patterns, themes, and categories that are relevant to the research question. The analysis is conducted inductively, where data obtained from the field is organized, coded, and interpreted to discover new understandings related to EIA practices in the context of infrastructure sustainability.

To maintain the validity and reliability of the data, the researcher triangulated sources and methods. Source triangulation was carried out by comparing information from various informants, while the triangulation method was carried out by combining interviews, observations, and documentation studies. Data validation is also carried out through the member checking technique, which is by asking for confirmation from the informant on the results of the researcher's interpretation to ensure the accuracy and validity of the data produced. This research is framed in a theoretical framework that refers to sustainable development approaches as well as systems theory in civil and environmental engineering. Sustainable development theory is used as a basis for assessing the extent to which a project meets ecological, social, and economic principles. Meanwhile, systems theory helps explain the relationship between components in an infrastructure project and their interaction with the surrounding environment. Using this qualitative method, this study does not aim to produce quantitative generalizations, but rather to provide an in-depth, reflective, and contextual understanding of the implementation of EIA in civil engineering. The results of the research are expected to contribute both practically and academically in an effort to encourage more environmentally friendly and sustainable infrastructure development.

RESULTS OF RESEARCH AND DISCUSSION

1. Implementation of Environmental Impact Assessment on Infrastructure Projects

The results of the study show that the implementation of Environmental Impact Assessment (EIA/EIA) in civil engineering infrastructure projects has generally become a formal procedure that must be carried out before the implementation of construction. However, the effectiveness of its implementation is highly dependent on the commitment of the developer, the quality of the consultant who prepares the EIA document, and the supervision of the local government. In most of the cases studied, EIA is only used as an administrative requirement for obtaining environmental permits, without actually being used as a tool for evaluation and impact control. This is reinforced by the results of interviews with several environmental officials who stated that, "often EIA documents are only prepared to meet the requirements of permits, not to be used in the technical decision-making of projects."

Based on field findings, the implementation of Environmental Impact Assessment (EIA) in civil engineering projects is still largely procedural and administrative, rather than a strategic planning tool. This is in line with criticism from (Noble, 2010) which states that in practice, EIAs are often only run to meet legal requirements, rather than as a reflective process that encourages adaptive and sustainable project planning. In fact, conceptually, (Glasson & Therivel, 2013) emphasized that the EIA should be an important instrument in the decision-making process. When the EIA is only a formality document, then its essence as a tool for evaluation and mitigation of impacts is lost. In the context of civil engineering, this is unfortunate given that the large scale and duration of projects are very vulnerable to long-term environmental impacts. Thus, a paradigm shift is needed where EIA is no longer positioned as a mere requirement of legality, but as a technical and ethical guide in every stage of infrastructure development.

2. Integration of Sustainability Aspects in the Planning Process

Based on the results of observation and analysis of the document, the integration of sustainable development principles in the EIA document has not been fully optimal. Ecological aspects, such as biodiversity conservation and the efficiency of natural resource use, are still not a major concern. Most documents focus more on aspects of air pollution, noise, and waste, which are physical and easy to measure. Social aspects such as community participation also tend to be formal. In some projects, the public consultation process is carried out without providing sufficient space for the public to raise objections or constructive inputs. In fact, public participation is an important element in assessing the social impact and social legitimacy of projects.

Table 1. Comparison between several projects analyzed based on sustainability aspects in the EIA document

Infrastructure Projects	Ecological Sustainability	Community Participation	Technology Utilization	Integration in Design
Project A (Toll Road)	Enough	Low	Low	Separate
Project B (Dam)	Tall	Keep	Keep	Integrated
Project C (Public Building)	Low	Low	Tall	Integrated
Project D (Port)	Keep	Tall	Keep	Slightly Integrated

The table above shows that projects with higher levels of community participation tend to have more comprehensive and contextual EIA outcomes. Meanwhile, projects that ignore social aspects often cause public resistance at the implementation stage. The integration of sustainable development principles into the EIA document is still not optimal, especially in taking into account ecological and social aspects as a whole. In fact, as explained in Our Common Future (Imperatives, 1987), sustainability includes a balance between economic needs, environmental conservation, and social justice. ,The fact that community participation is still symbolic shows that the principles of inclusivity and justice in development have not been fully implemented. This weakens the legitimacy of the project in the eyes of the public and has the potential to cause conflicts in the future. As emphasized (Sadler, 1996), the success of EIA is highly dependent on a transparent and participatory process. Therefore, projects that ignore the voices of local communities have actually missed out on the opportunity to gain important input that can enrich technical design and impact management strategies. Comparison tables between projects show that projects with higher community participation tend to be more successful in drafting contextual EIA documents. This means that the success of the implementation of EIA is also greatly influenced by the quality of social interaction built during the process, not solely by technical capacity.

3. Challenges in the Implementation and Monitoring of EIA

The results of the study also revealed that there are a number of significant challenges in the implementation and monitoring of EIA. The first is the limited technical capacity of the compilers of the EIA document, which in some cases only copies the standard format without conducting an analysis in accordance with field conditions. The second is the weak post-implementation monitoring mechanism, which causes many environmental management and monitoring plans (RKL-RPL) to not be implemented consistently. From interviews with environmental consultants, it was stated that "often the results of the EIA are not a reference in the technical decision-making of the project after the permit is obtained, because there are no firm sanctions if the RKL-RPL is ignored." This shows that there is a gap between planning and implementation in the field. The weak technical capacity of the EIA compilers and the inconsistency of the implementation of the RKL-RPL in the field are recurring structural problems. This reflects the ineffective supervision and accountability system that binds the relevant parties. In fact, as mentioned in systems theory used in civil and environmental engineering, each element in an infrastructure project must work in interrelated coordination including between planning, implementation, and environmental supervision (Darling, 2007). The lack of use of technologies such as spatial modeling and GIS in the preparation of EIAs also weakens the validity and accuracy of the analysis. With the high complexity of civil engineering projects, the use of cutting-edge technology should be a necessity, not an option. When EIA is not supported by accurate spatial data, the potential for errors in predicting and managing impacts is greater. These findings reaffirm the view (Glasson & Therivel, 2013)glaagl, that the success of EIA depends not only on the procedures carried out, but also on the quality of the substance, the methods used, and the capacity of the EIA actors themselves. In this context, strengthening environmental institutions and improving the quality of human resources is an urgent agenda.

4. EIA Strengthening Strategy for Sustainable Infrastructure

As part of the results of the analysis, the study identified several strategies to strengthen the role of EIA in realizing sustainable infrastructure projects. The strategy includes increasing the technical capacity of the EIA preparation team, the application of geospatial technology for environmental impact prediction, substantially increasing community participation, and strengthening the audit and supervision system by environmental authorities. Further, the integration of EIA into the technical design stage of the project must be done from the beginning of planning. This can be realized through an environmentally responsive design approach that places the EIA results as

the main input, not just a complementary document. In addition, the use of quantitative sustainability indicators such as carbon footprint, energy efficiency, and water quality indices can help measure and monitor impacts more objectively (Athaya et al., 2025). Based on the results of the study, the EIA strengthening strategy in civil engineering projects must start from the planning phase. EIAs should be made an integral part of the project's technical design, not placed as a separate activity after the design is completed. This is in line with the environmentally responsive design approach, which places ecological aspects as part of the structural design strategy. The application of quantitative indicators such as carbon footprint, energy efficiency, and environmental quality index is also in line with evidence-based principles of sustainable development. If these indicators are integrated from the outset, then the project will be easier to evaluate objectively, and the impact can be monitored on an ongoing basis. Furthermore, a strong participatory approach can be a bridge to build trust between developers and the community. As explained (Noble, 2010), a successful EIA is an EIA that is able to accommodate local social and cultural dynamics in the technical planning process. In practice, this means opening up a space for dialogue from the beginning, not just during formal public consultations. Thus, the results of this study confirm that the effectiveness of Environmental Impact Assessment is highly dependent on the synergy between technical capacity, planning integration, community engagement, and the courage of regulators to consistently enforce sustainability standards. All of this requires the commitment of all stakeholders to make infrastructure development not only a symbol of physical progress, but also a model of harmony between humans and their environment.

CONCLUSION

This research shows that Environmental Impact Assessment (EIA/EIA) has a very important role in the sustainable construction of civil engineering infrastructure projects. However, in practice, the implementation of EIA in Indonesia still faces various challenges, ranging from an administratively inclined approach, weak integration of sustainability in technical planning, to a substantial lack of community participation. This has the potential to reduce the effectiveness of EIA as a strategic environmental impact control tool. Although regulations already require the implementation of EIAs, many projects make them a mere requirement for legality, not as a living document that becomes a technical and ethical reference in planning. In fact, as Glasson, Therivel, and Chadwick explain, EIA is supposed to be an analytical tool that drives sustainability-oriented decision-making. The findings also show that the integration of ecological and social aspects in the EIA document is still weak, and community engagement is not optimal. This aspect is crucial, given that sustainable development is not only about technical and economic issues, but also social justice and ecosystem sustainability. Projects that involve more serious community participation tend to produce more contextual and applicative EIA documents. To address these challenges, the proposed strengthening strategies include increasing the capacity of EIA drafters, utilizing more advanced environmental analysis technologies, and full integration between EIA results and project technical design from the early stages. In addition, a participatory approach and strict post-implementation monitoring are essential to ensure that commitment to the environment does not stop at the document level. Thus, EIA in civil engineering can no longer be seen as an administrative complement, but must be part of a comprehensive, reflective and responsible planning system for the realization of truly sustainable infrastructure development.

REFERENCES

Asrorudin, U. (2025). *Analisis Manajemen Risiko Pada Proyek Pekerjaan Konstruksi Jaringan Pipa Air Limbah Jakarta Sewerage Development Project (Jsdp) Paket 5 Zona 1 (AREA 2-1)*. Universitas Islam Sultan Agung Semarang.

Athaya, N. S., Tamba, R. R., Safitri, T. N., Panjaitan, G. O., Manao, M. C., & Arnita, V. (2025). Pengukuran Emisi Karbon, Pelaporan Keberlanjutan, dan Pengungkapan Lingkungan terhadap Kinerja Keberlanjutan Perusahaan. *Jurnal Bisnis Mahasiswa*, *5*(1), 341–351.

Darling, N. (2007). Ecological systems theory: The person in the center of the circles. *Research in Human Development*, *4*(3–4), 203–217.

Glasson, J., & Therivel, R. (2013). *Introduction to environmental impact assessment*. Routledge.

Hidup, K. L. (2009). *Tentang Perlindungan dan Pengelolaan Lingkungan Hidup*. Retrieved from Undang-Undang.

Imperatives, S. (1987). Report of the World Commission on Environment and Development: Our common future. *Accessed Feb*, *10*(42,427), 1–223.

Marsini, M., & Dwikoranto, D. (2022). Using Google Meet in Group Discussions to Improve Learning Activities And Students' Problem-Solving Ability During the COVID-19 Pandemic. *IJORER International Journal*

of Recent Educational Research, *3*(5), 584–597. https://doi.org/10.46245/ijorer.v3i5.249

Moleong, L. J. (n.d.). *Metodologi penelitian*.

Moleong, L. J. (2018). Metodologi penelitian kualitatif/penulis. *Prof. DR. Lexy J. Moleong, MA (Edisi Revisi). PT Remaja Rosdakarya*.

Noble, B. F. (2010). Introduction to environmental impact assessment: a guide to principles and practice. *(No Title)*.

Prakoso, A. D., & Hardjomuljadi, S. (2025). Efektivitas Penerapan Hukum Konstruksi pada Proyek Infrastrukstur Nasional: Studi Kasus Ruas Jalan Tol LampungPalembang. *Jurnal Ilmu Hukum, Humaniora Dan Politik (JIHHP)*, *5*(3).

Sadler, B. (1996). *Environmental Assessment in a Changing World. Evaluating practice to improve performance-final report*.

Siahay, M. C., Ahmad, S. N., Gusty, S., Supacua, H. A. I., Ampangallo, B. A., Rachman, R. M., Latupeirissa, J. E., & Maitimu, A. (2023). *Pembangunan infrastruktur di Indonesia*. Tohar Media.

SIHOMBING, N. J. (2025). Analisis Penggunaan Sistem Informasi Geografis (SIG) dalam Perencanaan Lahan Pertanian. *Circle Archive*, *1*(7).

Widaningrum, A., Retnandari, N. D., & Susanto, N. (2024). *Regulatory Impact Analysis (Analisis Dampak Regulasi): Konsep & Penerapannya*. UGM PRESS.