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Evolving Environmental Impact Assessment in the Gulf: Lessons from Saudi Arabia's Mega-Projects and Vision 2030

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Abstract
Environmental Impact Assessment (EIA) is critical to balancing rapid development with environmental protection in Saudi Arabia's Vision 2030 agenda. This study reviews the Kingdom's EIA legal, institutional, and procedural framework, evaluates its effectiveness through policy analysis and two contrasting megaproject case studies—the Red Sea Project and NEOM's "The Line"—and identifies key challenges including limited public participation, fragmented institutional coordination, and weak enforcement. Findings show that successful EIAs rely on comprehensive baseline data, transparent disclosure, and independent verification, while deficiencies stem from inadequate technical capacity and insufficient monitoring. A five-phase reform model is proposed, encompassing regulatory overhaul, digital integration, professional capacity building, strengthened enforcement, and alignment with national and international sustainability goals. The study concludes that adopting this model can shift Saudi Arabia from a compliance-based EIA approach to a proactive, transparent, and sustainability-driven system.
Keywords: *Environmental Impact Assessment (EIA); Saudi Arabia Vision 2030; Saudi sustainable development; EIA public participation; Saudi EIA policies; Saudi EIA regulatory framework.*

1. INTRODUCTION

Environmental Impact Assessment (EIA) is a systematic process used to identify, evaluate, and mitigate the potential environmental effects of proposed projects or developments before they are carried out [1]. The core objective of EIA is to ensure that decision-makers consider environmental consequences alongside economic and technical factors during the planning and approval stages of projects. EIA plays a vital role in environmental management by promoting sustainable development, reducing ecological damage, and enhancing transparency and public participation in environmental decision-making [2]. It helps identify possible negative impacts on air, water, soil, biodiversity, and human health, and recommends measures to avoid, minimize, or compensate for these effects [3, 4]. By integrating environmental considerations early in the project lifecycle, EIA contributes to better project design, regulatory compliance, and long-term environmental sustainability [2]. Globally recognized as a key tool for balancing development with environmental protection, EIA is particularly important in regions undergoing rapid industrialization and urban expansion—such as Saudi Arabia—where it serves as a critical mechanism for safeguarding natural resources and ensuring responsible growth [5].

Environmental Impact Assessment holds growing significance in Saudi Arabia as the Kingdom pursues large-scale economic diversification and infrastructure development under Vision 2030 [6, 7]. With increasing investments in energy, mining, tourism, industrial zones, and megaprojects, such as NEOM and the Red Sea Project, the potential environmental implications of such rapid development have heightened the need for robust environmental governance [8]. EIA serves as a key regulatory instrument to anticipate and manage these impacts, ensuring that development proceeds in a sustainable and environmentally responsible manner. The relevance of EIA in the Kingdom aims to minimize environmental degradation, protect natural habitats, manage scarce water resources, and promote public health [9, 10]. Additionally, EIA enhances decision-making by enabling early identification of environmental risks, promoting transparency, and encouraging stakeholder engagement [11, 12]. As environmental awareness and regulatory enforcement strengthen across the country, EIA is becoming a cornerstone in shaping Saudi Arabia's transition toward a greener and more sustainable future.

A notable shortcoming of the EIA process in Saudi Arabia is the insufficient integration of public participation, which limits transparency and reduces the effectiveness of environmental governance. Although recent reforms have strengthened regulatory frameworks, public consultation is still not a legally enforced or routine component of EIA procedures, especially for high-impact projects. This contrasts with international best practices where community input is critical to identifying social and environmental risks. However, studies have repeatedly shown that EIAs in Saudi Arabia face several challenges hindering their effectiveness [13-15]. These include:

i. Lacks transparency and opportunities for public involvement, which weakens decision-making and public trust. This absence of transparency hampers the effectiveness of EIAs in addressing environmental concerns [16, 17].
ii. The absence of structured stakeholder engagement and limited availability of EIA reports to the public represent major gaps in the Saudi EIA process [5].
iii. The challenge of streamlining procedures without compromising thoroughness remains in the use of technological advancements like Geographic Information Systems (GIS) [5].
iv. Institutional capacity challenges and issues with enforcing regulations [14]. Despite legislative reforms aimed at improving the EIA framework, deficiencies remain in operational aspects, and the enforcement of regulations is often inadequate. These challenges suggest that the current EIA system may not fully address environmental concerns.

These findings underline the need for institutional reforms to formally integrate public participation and improve the quality and accountability of environmental assessments in Saudi Arabia. Therefore, to tackle the limitations in EIA is Saudi, this study sets out the following objectives:

i. Examine the current legal, institutional, and procedural framework of EIA in Saudi Arabia and its alignment with national development goals.
ii. Analyse the effectiveness of existing EIA policies in mitigating environmental risks amid major projects tied to Vision 2030.
iii. Identify the main challenges and limitations in EIA implementation, including public participation, institutional capacity, and regulatory enforcement.
iv. Explore EIA's role in supporting national sustainability initiatives such as the Saudi Green Initiative and the Circular Carbon Economy.
v. Recommend future policy directions to strengthen EIA systems, including digital integration, stakeholder engagement, and alignment with international environmental governance standards.

By addressing these objectives, the paper seeks to contribute to a more comprehensive understanding of how EIA can serve as an effective tool for environmental protection and sustainable development in the Kingdom. The effectively and comprehensively carry out the set objectives, the study is structured into 8 sections. The introduction in section 1 is followed by section 2 - methodology and section 3 – reviews the EIA policies and discusses the regulatory framework, including laws, executive regulations, and sector-specific guidelines governing EIA processes; section 4 - maps out the responsibilities of primary stakeholders—regulatory bodies (NCEC, MEWA), project developers, consultants, communities, and international partners while section - 5 deals with the challenges in EIA implementation in Saudi Arabia. Section 6 – presents two case studies, which compares the Red Sea Project (successful EIA integration) and NEOM's "The Line" (deficiencies in transparency, modelling, and follow-through); while 7 - future directions, proposes a five-phase EIA development model focusing on regulatory reform, digital transformation, professionalization, enforcement, and international alignment. Section 8 – conclusions, synthesises findings and underscores the need for Saudi Arabia to evolve from a compliance-driven EIA model to a proactive, transparent, and sustainability-focused system.

2. METHODOLOGY

The study methodology as depicted in Fig 1, adopts a qualitative, policy-oriented research design, drawing on legislative documents, regulatory guidelines, and official reports to analyse the structure, processes, and governance of EIA in Saudi Arabia. It begins with a review of the national EIA framework, including the General Environmental Law, executive regulations, sector-specific guidelines, and international commitments. Key stakeholders' roles are mapped, including the National Centre for Environmental Compliance (NCEC), the Ministry of Environment, Water and Agriculture (MEWA), project developers, consultants, and communities. A comparative case study approach is applied to assess best practices and shortcomings through two mega-projects: the Red Sea Project, representing a robust EIA model, and NEOM's "The Line," illustrating implementation challenges. The analysis identifies procedural, institutional, and technical gaps, which inform the development of a conceptual five-phase reform model. This model is grounded in Saudi Vision 2030 priorities and international EIA standards, providing a roadmap for phased policy and operational improvements.

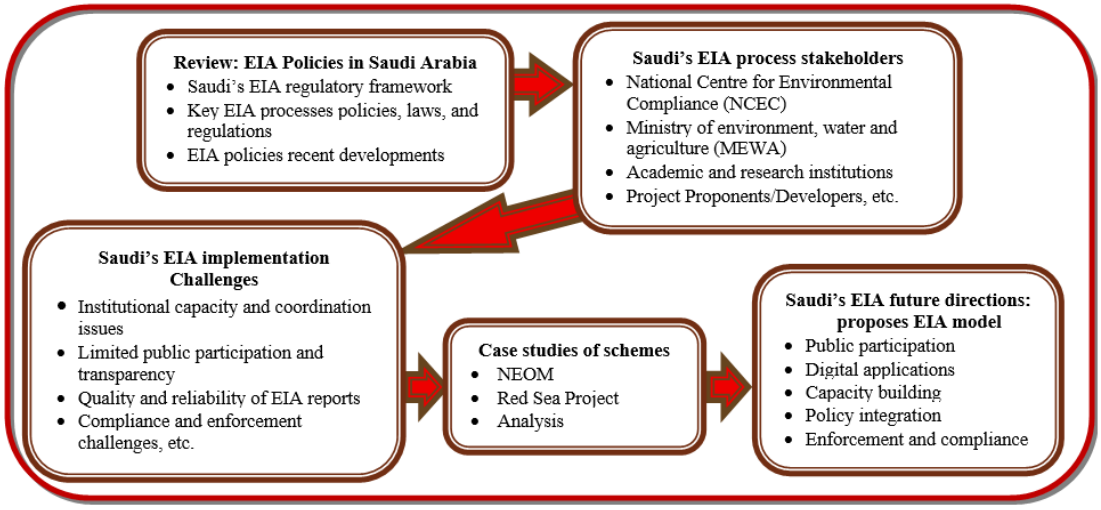

Fig 1: Methodology of the study

3. Review: EIA Policies in Saudi Arabia

3.1. Regulatory framework for EIA in Saudi Arabia

The regulatory framework for EIA in Saudi Arabia is primarily overseen by the National Centre for Environmental Compliance (NCEC), operating under the Ministry of Environment, Water and Agriculture (MEWA) [17, 18]. Formerly known as the General Authority for Meteorology and Environmental Protection (GAMEP), the NCEC is responsible for issuing environmental permits, setting standards, and ensuring compliance across industries [19]. The foundation of EIA regulation in Saudi Arabia is established through the General Environmental Regulations and Rules for Implementation (2001). This outlines the requirement for EIAs prior to the approval and execution of projects that may cause environmental harm. These regulations mandate that all projects with potentially significant environmental impacts must undergo a formal EIA process to receive environmental clearance. Key elements of the Saudi EIA regulatory framework include [20, 21]:

i. Environmental permit system: Developers must obtain an environmental permit before initiating project activities. This process requires submitting an Environmental Impact Report (EIR) detailing the potential environmental impacts and proposed mitigation measures.
ii. Project classification: projects are categorized based on their potential environmental impact (low, medium, or high), with high-impact projects requiring a more detailed EIA study.
iii. Screening and scoping: The NCEC assesses proposed projects to determine whether a full EIA is required and defines the scope of issues to be addressed in the assessment.
iv. Stakeholder involvement: While public participation is not yet a strong feature of the process, regulatory guidelines encourage consultation with relevant stakeholders and authorities.
v. Environmental standards and guidelines: The NCEC provides technical guidance and environmental standards for air quality, water usage, waste management, and emissions, which must be incorporated into EIA reports.
vi. Monitoring and compliance: Post-approval monitoring is required to ensure that mitigation measures are effectively implemented. Failure to comply with approved EIA conditions can result in penalties or project suspension.

Recent regulatory advancements, including the move toward digital permitting platforms and updated environmental codes, reflect Saudi Arabia's effort to modernize and streamline EIA processes. However, implementation remains varied across regions and sectors, highlighting the need for continued regulatory refinement and institutional capacity building.

3.2. Key policies, laws, and regulations governing EIA Processes in Saudi Arabia

Saudi Arabia's EIA processes are governed by a set of interrelated policies, laws, and regulations designed to manage environmental risks and support sustainable development. These legal instruments have evolved to align with national priorities, such as Vision 2030, and global environmental standards. The key regulatory foundations of EIA in the Kingdom are included in Table 1.

Table 1: Some key EIA regulatory foundations Saudi Arabia [19, 22]

EIA regulatory foundation	Highlights

General environmental law (royal decree no. M/165, 2020)	This is the cornerstone of environmental governance in Saudi Arabia. It provides the legal basis for environmental protection, pollution control, and sustainable resource use. The law: ✓ Requires the assessment of environmental impacts before granting project approvals. ✓ Establishes environmental permits as a prerequisite for development. ✓ Assigns responsibility for environmental protection to the Ministry of Environment, Water and Agriculture (MEWA) and its executive body, the National Centre for Environmental Compliance (NCEC).
Executive regulations of the general environmental law (2022)	These detailed regulations operationalize the General Environmental Law by: ✓ Defining procedures for environmental permitting, including EIA requirements. ✓ Classifying projects based on their environmental risk (low, medium, high). ✓ Requiring the submission of Environmental Impact Reports (EIRs) for medium- and high-risk projects. ✓ Outlining guidelines for mitigation, monitoring, and post-implementation audits.
Environmental assessment regulations (Updated 2022)	Issued by the NCEC, these regulations: ✓ Standardize the EIA process including screening, scoping, impact analysis, public consultation (where applicable), and environmental management planning. ✓ Provide technical guidelines for the preparation and review of EIA reports. ✓ Require project proponents to use approved consultants for conducting assessments.
Saudi vision 2030 and environmental strategies	Although not a law, Vision 2030 is a national policy framework that has significantly influenced environmental regulation. It emphasizes: ✓ Sustainable urban development. ✓ Environmental protection as part of economic diversification. ✓ Integration of environmental considerations into national planning. ✓ Supportive strategies include: ✓ Saudi Green Initiative (SGI): Promotes carbon neutrality, biodiversity conservation, and afforestation. ✓ National Environmental Strategy (NES): Aims to strengthen institutional capacity for EIA and environmental monitoring.
Sector-specific regulations and guidelines	Several ministries and authorities, such as the Royal Commission for Jubail and Yanbu (RCJY) and the Saudi Arabian Oil Company (Aramco), have their own EIA procedures aligned with national regulations. These apply particularly to: ✓ Industrial cities. ✓ Petrochemical developments. ✓ Energy and mining sectors.
International environmental commitments	Saudi Arabia is a signatory to several multilateral environmental agreements (MEAs), such as: ✓ The UN Framework Convention on Climate Change (UNFCCC). ✓ The Convention on Biological Diversity (CBD). ✓ The Basel Convention on Hazardous Wastes.

These influence domestic EIA policy by requiring compliance with international environmental standards. Together, these laws and policies form a comprehensive but evolving legal framework for EIA in Saudi Arabia. The shift toward digital platforms, improved guidelines, and greater inter-agency coordination reflects the Kingdom's commitment to strengthening environmental governance and aligning with global best practices. However, full implementation and enforcement remain critical to realizing the goals set by Vision 2030 and Saudi's broader environmental agenda.

3.3. Recent developments in EIA policies in Saudi Arabia

Saudi Arabia has undertaken several significant initiatives to enhance its EIA framework, reflecting its commitment to sustainable development and environmental stewardship. Key recent developments include [5, 23, 24]:

3.3.1. Implementation of executive regulations for environmental permits (2023)

In 2023, the Ministry of Environment, Water and Agriculture began enforcing executive regulations governing environmental permits for the establishment and operation of activities within the Kingdom. These regulations, based on Article 48 of the Environment Law issued by Royal Decree No. M/165, apply to all entities whose operations impact the environment. They classify activities into three categories according to their environmental impact and outline requirements for conducting EIA studies, obtaining approvals for environmental management plans, and adhering to mitigation measures.

3.3.2. Launch of environmental reporting platform (August 2023)

The National Centre for Environmental Compliance (NCEC) introduced a pilot platform in August 2023, mandating establishments with environmental impacts to submit periodic reports. This initiative aims to streamline the reporting process, enhance compliance with environmental regulations, and improve transparency. The platform requires detailed information on activities affecting the environment, including resource utilization, waste management, and emissions.

3.3.3. Unification of environmental investment permits (November 2024)

In November 2024, the NCEC announced plans to unify the issuance of investment permits related to the environmental sector. This initiative involves updating and classifying approximately 3,500 activities based on their environmental impact, with completion targeted for the first quarter of 2025. The goal is to standardize procedures, develop unified models for evaluating environmental studies, and accelerate permit issuance through an electronic platform.

3.3.4. Environmental compliance forum and investment commitments (February 2024)

The inaugural Environmental Compliance Forum was held in Riyadh in February 2024, highlighting the Kingdom's dedication to environmental compliance. During the forum, it was revealed that over SAR6 billion is projected to be invested in environmental compliance projects by 2030, underscoring the integration of environmental considerations into national development plans.

3.3.5. Saudi green initiative announcements (December 2024)

At the Saudi Green Initiative Forum in December 2024, five new initiatives totaling SAR225 million were unveiled, emphasizing the Kingdom's proactive approach to climate action. With total investments reaching SAR705 billion across 86 ongoing initiatives, these efforts aim to reduce emissions, combat desertification, and protect natural ecosystems, aligning with the objectives of the Saudi Green Initiative. These developments reflect Saudi Arabia's ongoing efforts to strengthen its EIA policies, promote environmental sustainability, and align with international best practices.

4. Saudi's EIA process stakeholders and their roles

The EIA process in Saudi Arabia involves a range of stakeholders, each playing a distinct role in ensuring that development projects comply with environmental standards and contribute to sustainable outcomes. These stakeholders include government bodies, project developers, consultants, local communities, and international partners. The success of EIA in Saudi Arabia depends on the collaborative efforts of these stakeholders, with the NCEC serving as the central coordinating body. As environmental governance continues to evolve, especially under the framework of Vision 2030, enhancing the involvement of communities, improving inter-agency coordination, and building institutional capacity will be critical to strengthening the overall effectiveness of the EIA process. The key 3. Saudi's EIA process stakeholders and their responsibilities are presented in Table 2.

Table 2: Saudi's EIA stakeholders and their roles [25, 26]

Stakeholder	Roles
National Centre for Environmental Compliance (NCEC)	Role: Primary regulator and enforcer of EIA regulations. ✓ Reviews EIA reports, issues environmental permits, and monitors compliance. ✓ Develops environmental guidelines and classification criteria for projects. ✓ Conducts inspections and enforces penalties for non-compliance. ✓ Leads initiatives to digitize environmental reporting and unify permit processes

Ministry of environment, water and agriculture (MEWA)	Role: Oversight authority for national environmental policy. ✓ Provides policy direction and coordination among environmental agencies. ✓ Ensures alignment of EIA practices with national strategies such as Vision 2030 and the Saudi Green Initiative. ✓ Supports legislative development and capacity building in environmental management
Project Proponents / Developers	Role: Initiators of the EIA process. ✓ Responsible for commissioning EIA studies and submitting the required documentation. ✓ Work with approved consultants to conduct environmental assessments. ✓ Must implement mitigation measures and comply with the Environmental Management Plan (EMP). ✓ Ensure periodic monitoring and reporting during the construction and operational phases.
Environmental consultants / EIA practitioners	Role: Technical experts and facilitators of the EIA process. ✓ Conduct baseline environmental studies, impact assessments, and risk evaluations. ✓ Develop mitigation strategies and the Environmental Management Plan (EMP). ✓ Must be licensed or approved by the NCEC to prepare and submit EIA reports.
Local authorities and sector-specific agencies	Role: Support and provide input during EIA review and implementation. ✓ Agencies such as the Royal Commission for Jubail and Yanbu (RCJY), Saudi Aramco, and the Ministry of Energy may have their own environmental protocols and oversight responsibilities in specialized sectors. ✓ Coordinate with NCEC on site-specific concerns and enforcement.
Local communities and the public	Role: Emerging stakeholders in EIA participation. ✓ Though public participation is not yet mandated by law in all cases, it is increasingly encouraged, particularly for large-scale or high-impact projects. ✓ Community feedback can help identify social and environmental concerns early in the project cycle. ✓ Stakeholder engagement helps foster transparency, trust, and social acceptance of development activities.
Academic and research institutions	Role: Support with data, research, and capacity development. ✓ Provide scientific input and data that can inform EIAs. ✓ Offer training and certification programs for EIA practitioners. ✓ Engage in environmental research that supports national policy formulation.
International environmental organizations and donors (if applicable)	Role: Advisory and capacity-building partners. ✓ May be involved in technical assistance or funding of environmental initiatives, particularly those aligned with global sustainability frameworks. ✓ Encourage the adoption of international EIA standards and best practices.
Investors and financial institutions	Role: Enablers and influencers of environmental compliance. ✓ Increasingly require robust EIA processes and sustainability commitments as part of investment due diligence. ✓ May condition funding on the implementation of effective environmental risk management practices.

5. Challenges in EIA implementation

Environmental Impact Assessments in Saudi Arabia have evolved significantly under recent regulatory reforms, yet they continue to confront several persistent challenges [27]. Institutional coordination remains fragmented, with overlapping mandates among national and sectoral authorities and insufficient technical capacity to conduct comprehensive reviews and on-site inspections. Public participation is still largely informal, limiting transparency and community buy-in, while licensed consultants often work with outdated or sparse baseline data—particularly in remote or ecologically sensitive regions—undermining the reliability of impact predictions. Finally, post-approval monitoring and enforcement mechanisms are

weak: self-reporting by developers, low penalties for non-compliance, and limited use of digital tools all contribute to gaps between approved mitigation measures and on-ground practice. Together, these issues highlight the need for stronger governance, richer stakeholder engagement, and more rigorous, technology-enabled compliance systems.

5.1. Challenges in the implementation of EIA in Saudi Arabia

Despite significant advancements in environmental governance and regulatory reform, Saudi Arabia continues to face several challenges in the effective implementation of EIAs. These challenges can be categorised into institutional capacity and coordination issues, limited public participation and transparency, quality and reliability of EIA reports, and compliance and enforcement challenges. Others are integration with planning and development processes, evolving legal and regulatory framework, and technological and digital gaps.

5.2. Institutional capacity and coordination issues

Although the NCEC plays a central role, coordination between various ministries, local authorities, and sectoral agencies remains inconsistent. There is a shortage of trained personnel and institutional capacity to carry out inspections, review technical EIA documents, and enforce compliance across regions. Different interpretations of environmental regulations can lead to inconsistencies in EIA quality and approval processes.

5.3. Limited public participation and transparency

Unlike international EIA best practices, Saudi EIA laws do not consistently mandate public hearings or stakeholder consultations, especially for high-impact projects. Communities and civil society organizations often lack awareness of their potential role in the EIA process, leading to limited accountability and community engagement. The EIA documents and project reports are not always publicly available, reducing opportunities for transparency and oversight.

5.4. Quality and reliability of EIA reports

Although only licensed consultants can prepare EIA reports, inconsistent technical capacity and sometimes superficial assessments can compromise report integrity. There is often a lack of reliable, up-to-date baseline environmental data, particularly for remote or ecologically sensitive regions. Many EIA reports do not rigorously assess project alternatives, a key requirement in evaluating environmental trade-offs.

5.5. Compliance and enforcement challenges

Post-approval monitoring of projects is often insufficient, leading to unaddressed environmental degradation or failure to implement mitigation measures. Enforcement measures are not always stringent enough to deter violations or incentivize proactive environmental performance. Many project developers rely on self-monitoring and self-reporting, which may result in biased or incomplete compliance data. In some cases, EIA is treated as a procedural hurdle rather than an integral part of early project planning, limiting its influence on decision-making. Rapid urbanization and large-scale infrastructure projects, such as NEOM, Red Sea Project, often place environmental assessments in tension with economic development goals.

5.6. Evolving legal and regulatory framework

While reforms (like 2023 Executive Regulations) are positive, frequent updates to environmental laws may cause confusion and delay as stakeholders adapt. Different sectors and authorities may apply varying environmental standards, creating duplication or regulatory overlap.

5.7. Technological and digital gaps

Geographic Information Systems (GIS), remote sensing, and other digital tools are not consistently integrated into EIA practices. While the launch of online platforms for permitting and reporting is ongoing, many institutions still face challenges in digital capacity and system interoperability. The challenges facing EIA implementation in Saudi Arabia reflect both structural limitations and the growing complexity of environmental governance in a rapidly developing nation. Addressing these issues will require stronger institutional coordination and technical capacity, legal reforms that mandate public participation, stricter enforcement mechanisms, and improved data management.

6. Case studies

6.1. The Red Sea Project – a model of successful EIA

The Red Sea Project, a US$10-billion regenerative tourism development spanning 28,000 km² of Saudi Arabia's western coast, exemplifies a robust EIA process that has underpinned its environmental stewardship credentials [28]. Key factors in its success are presented in Table 3.

Table 3: The Red Sea EIA project success key factors.

Factor	Description
Comprehensive baseline surveys	Before project approval, Red Sea Global conducted an extensive Environmental Baseline Survey covering over 1,400 coastal and offshore sites to map coral reefs, mangroves, seagrasses, and terrestrial habitats. This dataset formed the foundation for impact prediction and spatial zoning designed to avoid ecologically sensitive areas
Stakeholder collaboration	The developer engaged multidisciplinary experts, local authorities, and international NGOs during scoping to define mitigation measures. Publicly available EIA reports and regular stakeholder workshops fostered transparency and adaptive management.
Environmental management and monitoring	A detailed Environmental Management Plan (EMP) mandates continuous monitoring of water quality, biodiversity indices, and construction emissions. Independent third-party auditors verify compliance, with findings published annually.
ESG performance	In its first Global Real Estate Sustainability Benchmark (GRESB) assessment, the project achieved an overall score of 84/100, reflecting excellence in environmental governance, risk management, and community engagement

The lesson learnt from are early, data-driven baseline studies are critical for accurate impact prediction and zoning; transparent reporting and third-party verification build public trust and investor confidence; and integrating cultural and ecological values into project design strengthens sustainability outcomes.

6.2. Case Study 2: NEOM's "The Line" – challenges in EIA implementation

NEOM's flagship linear city, "The Line," has faced scrutiny for gaps in its EIA practice, illustrating how ambitious megaprojects can outpace environmental assessment frameworks, as presented in Table 4.

Table 4: NEOM's "The Line" EIA project implementation challenges [29, 30]

Challenge	Description
Lack of publicly shared studies	Despite claims of a "net-zero carbons" design, detailed commissioned EIA studies have not been disclosed. The absence of accessible technical reports hampers independent review and undermines transparency
Potential environmental risks	Expert warnings highlight that massive, mirrored structures and artificial islands could alter local weather patterns—affecting wind flow, precipitation, and storm behaviour in surrounding desert ecosystems. These concerns suggest that impact modelling may have underestimated complex climatic interactions
Greenwashing allegations	Critics argue that NEOM's sustainability narrative leans heavily on PR rather than rigorous environmental safeguards. The project's reliance on high-carbon construction materials and limited disclosure of mitigation efficacy underscores weaknesses in both EIA scope and follow-through

The lessons learned in this EIA project include mandating the publication of full EIA reports and modelling data is essential for credibility; complex climate-engineering elements require specialized, transparent modelling to predict unintended consequences; and stronger regulatory oversight and public consultation can guard against greenwashing and ensure environmental claims are substantiated.

6.3. Analysis

These contrasting cases demonstrate that successful EIAs hinge on comprehensive baseline data, transparent reporting, stakeholder engagement, and independent verification, while problematic EIAs often suffer from limited transparency, insufficient modelling of complex impacts, and weak public accountability. Saudi Arabia's future EIA reforms should mandate full disclosure of assessment studies, strengthen climate-impact modelling, and institutionalize public participation to ensure megaprojects truly align with sustainability objectives.

7. Future directions of EIA in Saudi Arabia

Saudi Arabia advances in Vision 2030 goals deepens its commitment to sustainable development, several future directions that strengthen the EIA system. These directives should aim to modernise practices, enhance governance, and align EIA with global standards while supporting the Kingdom's economic diversification and environmental stewardship. Therefore, this study has conceptualised an updatable model that will holistically support the improvement of EIA to an acceptable level as it concerns Saudi's Vision 2030. The required steps, which include taken include - formal integration of public participation, digital transformation and smart tools, capacity building and professionalization, integration with

Strategic Environmental Assessment (SEA), and other significant measures to improve EIA, have been categorised into five-phase model, as shown in Fig 2.

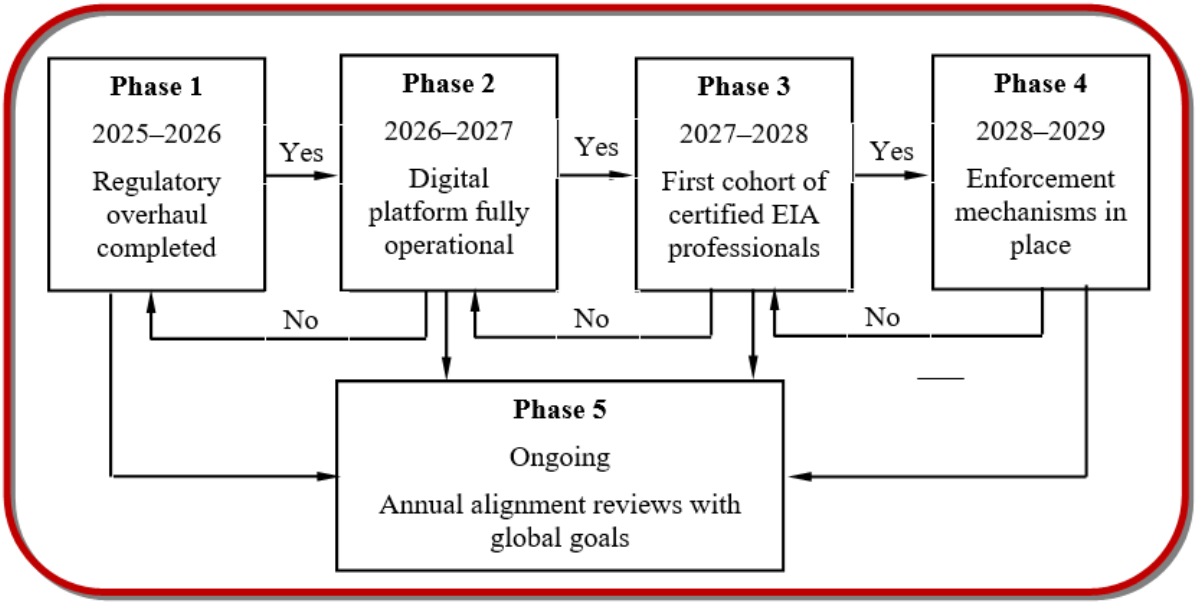

Fig 2: The proposed 5-phase EIA development and management to meet Saudi's Vision 2030.

These future directions will help Saudi Arabia evolve from a compliance-based EIA model to a proactive, transparent, and sustainability-driven system that can better manage the environmental impacts of its rapid development and support its broader transition to a green economy. The Saudi EIA model unfolds in a step-by-step progression, with built-in checks to ensure quality and alignment with global standards. It begins in Phase 1 (2025–2026), where a comprehensive regulatory overhaul is completed. If successful, the process moves forward to Phase 2 (2026–2027), where the digital platform for EIA management becomes fully operational. If any gaps are found at this stage, the process loops back to Phase 1 to address regulatory shortcomings. From there, a successful Phase 2 leads into Phase 3 (2027–2028), when the first cohort of certified EIA professionals is produced. If the certification process falls short, it returns to Phase 2 for improvements. Upon achieving this milestone, the model advances to Phase 4 (2028–2029), which focuses on establishing effective enforcement mechanisms. If enforcement is found lacking, the process reverts to Phase 3 to strengthen professional capacity. Throughout the entire cycle, Phase 5 operates in parallel as an ongoing, annual review process that ensures all phases remain aligned with global environmental goals. These reviews can trigger improvements in any earlier phase, maintaining a dynamic and adaptive EIA system. Further detailed breakdown of the model and its implementation strategies are presented in Table 5.

Table 5: Phase-by-phase breakdown

Phase No	Description	Goal	Actions	Agencies	KPIs
1 (2025-2026)	Regulatory & Policy Framework	Establish enabling regulations and mandates	Amend EIA regulations for public participation. Introduce SEA for policies/plans/programs. Define sector-specific EIA guidelines.	MEWA, NCEC, Ministry of Municipal & Rural Affairs, Shura Council. Resources: Legal teams, workshops, consultants.	New regulation published. % of projects with public consultation.
2 (2026-2027)	Digital & Technological Transformation	Deploy smart tools for EIA management	GIS & remote sensing for baseline studies. Upgrade NCEC digital platform.	NCEC, SDAIA, MEWA	% of EIA processes online.

			Automate monitoring with IoT & AI.		Number of automated systems deployed.
3 (2027-2028)	Capacity Building & Professionalization	Build a skilled EIA workforce.	Launch national training programs. Develop certification & CPD schemes. Establish regional resource Centre	MEWA, universities, vocational bodies	% of certified practitioners. Number of programs delivered.
4 (2028-2029)	Compliance, Enforcement & Auditing	Strengthen oversight and enforcement	Create independent audit bodies. Enforce stricter penalties. Require third-party verification.	NCEC, MEWA, Ministry of Justice	% reduction in non-compliance. Verified mitigation measures
5 (2025-2030)	Integration with National & International Goals	Align with global standards	Align with Saudi Green Initiative & CCE. Adopt IFC/World Bank/UNEP practices. Harmonize with climate/biodiversity treaties	MEWA, Economy & Planning, Foreign Affairs.	EIAs aligned with treaties. Global recognition in reports

8. CONCLUSIONS

Saudi Arabia's current EIA system, though strengthened by recent regulatory reforms, remains hampered by limited public engagement, inconsistent enforcement, and inadequate integration of advanced digital tools. The case studies reveal that successful EIA outcomes depend on robust baseline data, transparent disclosure, and strong stakeholder collaboration, while weak EIAs suffer from poor transparency, insufficient modelling, and unverified environmental claims. To meet Vision 2030's sustainability objectives, the Kingdom must institutionalize public participation, build technical capacity, and align EIA processes with global standards. The proposed five-phase model offers a structured pathway to achieve these goals, moving from regulatory modernization to digital transformation, professional certification, rigorous enforcement, and continuous alignment with international environmental frameworks. Implementing these reforms can position EIA as a proactive driver of sustainable development, ensuring that mega-projects contribute to, rather than compromise, the Kingdom's environmental and economic future.

Declarations

Conflict of interest: The authors declare no conflict of interest.

Human and Animal Rights**:** This article does not contain any studies with human participants or animals performed by any of the authors.

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