



## Strategic Environmental Assessment in Iran: Challenges, Opportunities, and Its Role in Pollution Management

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Article Info	ABSTRACT
<p><b>Article type:</b> Research Article</p> <p><b>Article history:</b> Received: 5 March 2025 Revised: 30 August 2025 Accepted: 02 February 2026</p> <p><b>Keywords:</b> <i>SEA</i> <i>Iran</i> <i>Grounded theory</i> <i>public awareness</i> <i>Strategies</i> <i>pollution</i></p>	<p>Strategic Environmental Assessment (SEA) plays a crucial role in integrating environmental considerations into national planning and decision-making. However, its successful implementation requires a robust legal, institutional, and financial framework tailored to national conditions. This study investigates the challenges and opportunities of implementing SEA in Iran, emphasizing its potential role in pollution management and sustainable development. Using a qualitative research approach based on Grounded Theory, in total, 12 individuals participated in the study, representing a cross-section of stakeholders from both policy-making and implementation sectors. The findings reveal that SEA's effectiveness in Iran is hindered by political interference, weak institutional capacity, absence of standardized technical guidelines, deficiencies in legal and executive structures, lack of sustainable financial resources, poor environmental data quality, and inefficient decision-making processes. To address these challenges, eight strategic recommendations are proposed: (1) strengthening legal and executive frameworks, (2) enhancing specialized and organizational capacity, (3) ensuring sustainable financial resources, (4) increasing public participation and awareness, (5) improving environmental data management, (6) continuously updating EIA and SEA methodologies, (7) streamlining execution processes, and (8) establishing technical standards. Implementing these strategies will enhance SEA efficiency, reduce bureaucratic delays, strengthen stakeholder engagement, and improve transparency in decision-making. Furthermore, an improved SEA framework will contribute to reducing air, water, and soil pollution by ensuring proactive environmental risk assessments and integrating sustainability into development policies. This study highlights the urgent need for strategic, multi-faceted reforms to strengthen SEA governance in Iran and ensure its alignment with global environmental standards and pollution management efforts.</p>

**Cite this article:** Ashegh Moalla, M., Karimi, S., Jafari, H., & Mobarghaee Dinan, N. (2026). Strategic Environmental Assessment in Iran: Challenges, Opportunities, and Its Role in Pollution Management. *Pollution*, 12(1), 31-45. <https://doi.org/10.22059/poll.2025.391423.2823>



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Publisher: The University of Tehran Press.

DOI: <https://doi.org/10.22059/poll.2025.391423.2823>

## INTRODUCTION

Strategic Environmental Assessment (SEA) offers a strong foundation for making well-informed decisions that promote sustainability (Fundingsland Tetlow & Hanusch, 2012). It was first introduced through the United States National Environmental Policy Act (NEPA) in 1969, and today, more than 60 countries have adopted it. In the European Union, the introduction of Directive 2001/42/EC required all member states to incorporate SEA into their national legislation. SEA is believed to play a key role in ensuring that policies, plans, and programs (PPPs) are developed with greater environmental awareness, that environmental considerations are integrated early in the PPP decision-making process, and that individual projects are

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carried out within a broader sustainability framework (Therivel, 2012; White & Noble, 2013). The recognition that SEA can serve various roles and offer diverse benefits across different decision-making contexts has resulted in a range of interpretations and expectations regarding its application (B. Noble, Ketilson, Aitken, & Poelzer, 2013; B. Noble & Nwanekezie, 2017). The literature on SEA encompasses a variety of contexts and research areas, including land-use planning, energy management, public policy, and environmental change. Several authors have examined the effectiveness of SEA (De Montis, 2013; Zhang, Christensen, & Kørnø, 2013), while others have focused on critical issues and unresolved challenges in its application (B. F. Noble, 2009; Weiland, 2010). Additionally, some studies have explored the solutions implemented in different contexts (Rauschmayer & Risse, 2005; Stoeglehner, 2010).

Currently, more than 60 countries around the world have established some fundamental legal requirements for SEA (T. B. Fischer & González, 2021). Many of these frameworks are general, providing a broad mandate for SEA by outlining basic procedural principles while leaving the methodological details to be defined by regulations and guidelines (Montaño, Tshibangu, & Malvestio, 2021). Most countries with legal frameworks are from the developed world, including all 27 EU member states governed by the European SEA Directive (CEC, 2001). However, many developing countries are also beginning to implement SEA. This includes various nations in Latin America (Jiliberto, 2021; Montaño & Fischer, 2019) as well as several countries in Asia and Africa (Chanchitpricha, Swangjang, & Morrison-Saunders, 2021; T. B. Fischer & González, 2021; T. B. Fischer & Retief, 2021). Few publications have reflected SEA practices in developing countries (T. B. Fischer & Onyango, 2012). Recent scholarship continues to highlight the evolving role of SEA in developing country contexts. For example, Marot et al. (2021) demonstrate how territorial impact assessments in emerging economies function as SEA-like processes to strengthen policy integration, while Partidário (2024) emphasizes the need for innovative approaches to adapt SEA to rapidly changing environmental and institutional settings. These studies complement earlier research by underscoring both the opportunities and persistent challenges of SEA in developing countries, thereby reinforcing the importance of our analysis of Iran's context.

This situation poses significant challenges for countries just starting to develop their SEA systems, as decision-makers often expect to see concrete and up-to-date SEA manuals in place (T. Fischer, Welsch, & Jalal, 2019). This demand for established guidelines can impede the implementation of SEA, as both advocates and regulators may cite the absence of clear guidance as justification for not adopting a specific regulatory framework. Consequently, there is a pressing need for more detailed guidance. In this context, a study explored and compared several recent SEA guidelines (from 2017 to 2019) across five Asian developing countries. Additionally, it includes a comparative analysis of earlier SEA guidance from China (2009), which outlined SEA requirements in its EIA Law enacted in 2002 (NPC, 2002).

In most developing countries, SEA is still in its early stages. Many practitioners transition to SEA from backgrounds in EIA for specific projects. However, the skill sets required for effective SEA differ significantly. For instance, SEA, in some of its forms, resembles policy analysis, which necessitates skills typically associated with social scientists, including economists, anthropologists, and political scientists (Marot et al., 2021; Partidário, 2008). As a result, new practitioners of SEA may feel unprepared or conduct SEA in ways unsuitable for the broader context, ultimately rendering the process ineffective (Jiliberto, 2021).

#### SEA Implementation Challenges in Iran and Pollution Concerns

Iran is a developing country. Despite the issue's importance in Iran, the history of strategic environmental assessment is not particularly long. The concept of taking a holistic view of environmental issues and considering environmental concerns while integrating them into major policies and programs was first addressed in Article 184 of the Fifth Development Plan. According to this Article, in order to achieve the goals stated in Principle 50 of the Constitution,

the “Strategic Environmental Assessment System” should be developed and implemented at the national, regional, and thematic levels based on the following principles:

- General development strategies for regions and accounting for the cumulative effects of these strategies
- Indicators for environmental impacts of development and indicators for biological capacity
- Applying regional and national sustainability indicators
- Monitoring regional and national development programs and projects
- Empowerment programs and establishing an executive mechanism for strategic environmental assessment (Project Capacity Building Office for Strategic Environmental Assessment in Iran, 2006).

In the Sixth Development Plan (2017-2021), the Strategic Environmental Assessment and the Environmental Impact Assessment (EIA), repeatedly emphasized in previous five-year plans, was somewhat weakened. Also, “Article 22, Clause (b) of the Seventh Development Plan Law states: ‘Executive bodies are obligated to conduct Strategic Environmental Assessments (SEA) for their macro-development projects and submit the assessment reports to the Department of Environment for approval.’ However, the necessary infrastructure regarding report preparation methodology and organizational procedures has not yet been established.”

Iran’s growing pollution problems, including air pollution from heavy industry, water contamination due to inefficient waste disposal systems, and urban smog, highlight the urgent need for a stronger SEA framework. Strengthening SEA enforcement could lead to improved environmental policies that help combat these pollution challenges.

SEA promotes sustainability by fostering institutional openness and transparency while improving coordination and capacity among various stakeholders. This, in turn, positively influences the decision-making process (Polido, Joao, & Ramos, 2018). Sustainable development will be achieved when all its components, including the environmental aspect, are integrated into the development process from the beginning of programs and policies (Muschett, 2017). This can only be realized when environmental protection is positioned appropriately within the planning system and holds the necessary weight in sectoral, regional, and other planning efforts. SEA enhances pollution control mechanisms by integrating mitigation strategies into national policies that govern industrial emissions, wastewater management, and solid waste disposal (Batista et al., 2021). Several countries have successfully incorporated SEA into their environmental governance frameworks, leading to substantial improvements in air and water quality (T. B. Fischer & González, 2021).

It is widely recognized that SEA plays a significant role in mitigating environmental pollution by ensuring that development policies integrate preventive and remedial measures against pollution sources (Del Campo, Gazzola, & Onyango, 2020). Environmental pollution, including air, water, and soil contamination, has been a growing concern in both developed and developing countries. SEA provides a structured mechanism to assess potential pollution risks at the strategic planning level and propose alternative solutions before irreversible environmental degradation occurs (Polido, Joao, & Ramos, 2018). By integrating environmental protection into policy development, SEA reduces the long-term ecological footprint of industrial, infrastructural, and urban development projects, leading to improved air quality, reduced water contamination, and enhanced waste management systems (Muschett, 2017).

While SEA has been widely examined in developed contexts, such as the European Union and Canada, relatively few studies have addressed its application in developing countries (Fischer & Onyango, 2012; Jiliberto, 2021). Existing research often highlights institutional and technical limitations but rarely explores the specific connection between SEA implementation barriers and pollution outcomes. For instance, studies in Brazil and Thailand emphasize procedural weaknesses and governance constraints (Montaño et al., 2021; Chanchitpricha et al., 2021), yet do not systematically investigate their consequences for air, water, and soil pollution. Our

study builds on this body of work by directly examining how Iran's institutional and legal gaps in SEA have contributed to persistent pollution challenges, thereby filling a critical gap in the literature and extending the comparative understanding of SEA in developing country contexts.

While SEA has been widely adopted in over 60 countries since its introduction in the 1969 US National Environmental Policy Act, its implementation in developing countries like Iran remains understudied and presents unique challenges. Despite growing recognition of SEA's potential role in pollution mitigation (Del Campo et al., 2020), there exists a critical research gap regarding:

**1. Context-specific Barriers:** While previous studies have examined SEA frameworks in developed nations (e.g., EU Directive 2001/42/EC), little research exists on the institutional, legal, and technical challenges specific to Iran's governance structure and environmental context.

**2. Pollution Management Linkage:** Current literature fails to systematically investigate how SEA could address Iran's acute pollution crises, particularly in:

- Air quality deterioration in major urban centers
- Water resource contamination from industrial sources
- Soil degradation from unsustainable land use practices

**3. Implementation Pathways:** There is insufficient evidence on practical strategies to overcome Iran's specific barriers to effective SEA adoption, including:

- Political economy constraints
- Limited technical capacity
- Fragmented environmental governance

This study directly addresses these gaps by employing Grounded Theory to:

- Identify the root causes of SEA implementation failures in Iran
- Develop context-appropriate solutions tied to pollution reduction
- Propose a governance framework aligned with Iran's Sixth Development Plan

The significance of this research lies in its potential to:

1. Provide the first systematic analysis of SEA barriers in Iran
2. Offer evidence-based policy solutions for integrating SEA into pollution management
3. Contribute to the limited body of knowledge on SEA in Middle Eastern contexts

Our findings reveal that Iran's SEA challenges differ substantially from those in developed countries, particularly regarding political interference in environmental decision-making and the absence of standardized methodologies for pollution impact assessment at the strategic level. These insights fill a crucial knowledge gap in the international SEA literature while providing actionable recommendations for Iranian policymakers.

## MATERIAL AND METHODS

This section outlines the research design, data collection, and analysis procedures based on Grounded Theory (GT) methodology. Grounded Theory is a systematic qualitative research approach that generates theory directly from empirical data, making it well-suited for exploratory research in under-examined fields such as Strategic Environmental Assessment (SEA) implementation (Glaser & Strauss, 1967; Charmaz, 2014). This approach allows for the development of a conceptual model based on real-world experiences and insights from key stakeholders (Corbin & Strauss, 2015). Given the complexity of SEA implementation in Iran and its implications for pollution management, Grounded Theory was selected to explore the challenges and opportunities in a data-driven and theory-generating manner.

A purposive sampling technique was employed to select participants with direct knowledge and experience related to SEA in Iran. This non-probability sampling method ensures the inclusion of key informants who can provide rich, relevant, and diverse perspectives on the

topic (Patton, 2002). Participants were drawn from government agencies, environmental policy experts, academics specializing in SEA and EIA, and environmental consultants involved in strategic assessments. Theoretical saturation, a key principle in Grounded Theory research (Glaser, 1978), was achieved when no new insights emerged from additional interviews, and the data categories were sufficiently developed. In total, 12 individuals participated in the study, representing a cross-section of stakeholders from both policy-making and implementation sectors. Theoretical saturation was determined after the twelfth interview, as no new codes or themes emerged during data analysis. Key categories such as legal barriers, institutional fragmentation, and pollution mitigation had been sufficiently developed. Iterative coding after each set of interviews ensured that new data confirmed and enriched existing categories rather than introducing novel ones.

A total of 12 participants were interviewed, and saturation was achieved by the tenth interview, as no new codes or categories emerged in subsequent interviews. The final two interviews served to confirm and reinforce the existing themes. This aligns with prior qualitative studies suggesting that 10–15 interviews are often sufficient for reaching saturation in focused Grounded Theory research (Guest et al., 2006).

The primary method of data collection was semi-structured interviews, a well-established technique in qualitative research that allows for flexibility, depth, and the emergence of unexpected themes (Kvale & Brinkmann, 2009). The interview protocol was developed based on a comprehensive review of SEA literature and aligned with the study's objectives. To ensure validity, the questions were reviewed by two experts in environmental assessment and pilot-tested with two participants from the target group. Feedback was used to refine question clarity, relevance, and sequencing. The final protocol included open-ended questions exploring challenges of SEA implementation, institutional barriers, and linkages to pollution management. The interview protocol included open-ended questions designed to explore:

- The perceived challenges of SEA implementation in Iran.
- The institutional, legal, and financial barriers affecting SEA effectiveness.
- The role of SEA in pollution mitigation and environmental sustainability.
- Opportunities for improving SEA integration into national and regional policies.

In addition to interviews, document analysis was conducted to supplement the interview data. Key documents reviewed included policy papers, legislative texts (e.g., the Fifth and Sixth Development Plans), SEA reports, and government publications. Document analysis provided essential context and historical background on SEA implementation, aligning with triangulation strategies to enhance data validity (Bowen, 2009).

Data analysis followed the Grounded Theory coding process, which consists of three main stages: open coding, axial coding, and selective coding (Strauss & Corbin, 1998). The analysis was conducted using NVivo software, which facilitates systematic organization, coding, and retrieval of qualitative data (Bazeley & Jackson, 2013).

1. **Open Coding:** The first step involved breaking down interview transcripts and documents into discrete units of meaning. These units were labeled as codes, reflecting recurring themes such as lack of legal enforcement, insufficient financial resources, weak stakeholder engagement, and pollution-related concerns.

2. **Axial Coding:** In the second stage, relationships between the codes were examined to identify broader conceptual categories. Patterns emerged, linking specific barriers to structural challenges in SEA governance, pollution risks, and policy inefficiencies.

3. **Selective Coding:** The final stage focused on identifying the core category—a unifying theme that integrates all other categories and explains the underlying causes of SEA implementation failures. This core category formed the basis for the emerging theory, which offers a conceptual model for successful and sustainable SEA implementation in Iran with a focus on pollution mitigation.

The sample size of twelve participants was determined using purposive sampling to capture a cross-section of stakeholders with direct experience in SEA policy and practice. Theoretical saturation was achieved after the tenth interview, as no new codes or categories emerged in subsequent interviews. The final two interviews served to confirm and reinforce existing themes, consistent with prior qualitative research suggesting 10–15 interviews are sufficient for focused Grounded Theory studies (Guest et al., 2006). Illustrative quotes from participants were used during coding to demonstrate how themes were iteratively refined.

This study adhered to high ethical standards, particularly given the sensitive nature of environmental governance and policy discussions in Iran. The research followed established ethical guidelines (Silverman, 2013):

- All participants were fully informed about the purpose of the study.
- Participation was voluntary, and individuals had the right to withdraw at any time.
- Written consent was obtained prior to interviews.
- All data were anonymized to protect participants' identities.
- Sensitive information was handled with strict confidentiality, ensuring that respondents felt safe sharing their perspectives.

Given the politically sensitive nature of environmental governance in Iran, additional steps were taken to ensure anonymity and confidentiality. All participants were assigned codes rather than identified by name or affiliation. Consent forms specified participants' right to withdraw at any time, and interviews were recorded only with explicit permission. Transcripts were anonymized, and any identifying details were removed. Data were stored securely on encrypted devices, and only aggregated results are reported, preventing traceability of individual responses.

To ensure anonymity in a politically sensitive context, all identifying information (e.g., names, affiliations, locations) was removed from transcripts. Participants were assigned codes, and only the primary researcher had access to the full consent forms and raw data. Interview recordings and transcripts were stored securely on encrypted devices, and all results were presented in aggregate form to avoid traceability.

## RESULTS AND DISCUSSION

This section presents the key findings from the study, including the systemic challenges affecting SEA implementation in Iran and the strategic recommendations for overcoming these obstacles. The results were derived using Grounded Theory methodology, which allowed for the identification of core issues related to SEA governance, institutional weakness, and environmental policy constraints (Glaser & Strauss, 1967; Charmaz, 2014). The findings emphasize how SEA implementation gaps contribute to environmental pollution risks and outline pathways for enhancing SEA's role in pollution management and sustainable development.

### *Challenges in Implementing SEA in Iran*

Table 1 provides a comprehensive overview of the systemic barriers hindering SEA processes in Iran. Open codes reflect specific granular issues, which were then grouped into broader axial codes. These axial codes highlighted key obstacles, such as legal and organizational weakness, financial constraints, lack of awareness and understanding of SEA among policymakers, low public engagement, poor data quality, inefficiency in execution, and the absence of technical standards. The identification of these challenges is critical in understanding why SEA has struggled to take root in Iran and its implications for pollution mitigation efforts (Partidário, 2008; Fischer & Retief, 2021).

The 43 open codes extracted from interview transcripts and document analysis included specific barriers such as “lack of legal obligation,” “shortage of specialists,” “budget shortages,” and “lack of awareness among policymakers”. These were synthesized into nine axial codes,

**Table 1.** A comprehensive view of the systemic challenges affecting SEA processes in Iran.

Open Codes	Axial Codes	Selective Codes
Lack of legal obligation, weak oversight and monitoring, Lack of enforcement, provincial-level implementation issues, Lack of integrated approach, focus on economic development over the environment, disregard for international requirements, Lack of documented policies	Deficiencies in legal and executive structures	Weakness in legal and executive systems
Lack of strategic planning, absence of post-implementation monitoring, Lack of integrated management across agencies, oversight and auditing, trusted auditor		
Weak expertise among consultants, shortage of specialists, limited experience in implementing SEA, use of non-specialized consultants, limitations in organizational capacity-building, underutilization of academic resources, Lack of specialized training	Lack of specialized and organizational capacity	Weakness in specialized and organizational capacity for SEA
Lack of experience in interdisciplinary assessments, weak capacity-building in government institutions		
Budget shortages, need for funding and financial resources, challenges in project financial transparency, Lack of government support, high SEA costs, Lack of stable financial resources	Financial constraints and Lack of sufficient resources	Lack of sustainable financial resources
Political pressures, the influence of political pressures on SEA implementation, focus on investor interests, influence of interest groups, and government influence on decision-making.	Political pressures and external interferences	The Lack of awareness and understanding of the need for SEA among policymakers and government officials and the influence of stakeholders
Lack of stakeholder engagement, low public awareness of SEA, Lack of civil society involvement, Lack of information transparency, Lack of public education, disregard for social and cultural impacts	Lack of public participation and awareness	Lack of active stakeholder engagement and public awareness
Weak information systems, Lack of basic environmental data, distrust in environmental studies, weak interdisciplinary assessments, Lack of accurate analytical tools, absence of comprehensive databases	Poor data quality and evaluation studies	Weakness in environmental data and assessments
Need to review evaluation frameworks, the need for technological tools, the impact of climate change, the need for new policies, the ineffectiveness of past policies	Need for EIA review and update	Need for review and update of EIA systems
Lengthy decision-making processes, delays due to SEA complexities, interagency coordination issues, Lack of standard procedures	Delays and slowness in execution processes	The Lack of transparency in decision-making processes and the absence of consistent and well-defined procedures.
Absence of clear standards, Weakness in long-term impact evaluation, Lack of precise quality criteria, Lack of technical protocols, weak performance indicators, inefficacy of current assessment methods	Lack of quality standards and technical requirements	Lack of standards and technical requirements for SEA and EIA

**Table 2.** Strategies suggested by elites to cope Weakness of SEA

Improvement Suggestions	Description
Strengthening legal and executive frameworks	- Create legal requirements for SEA implementation in all projects. - Establish independent monitoring bodies. - Create an integrated approach to evaluations.
Increasing specialized and organizational capacity	- Conduct training courses and specialized workshops. - Recruit specialized consultants in SEA. - Strengthen government and non-government institutions to increase capacity.
Securing sustainable financial resources	- Allocate appropriate budget for SEA projects. - Attract private and international investment for SEA projects. - Increase financial transparency and monitoring of costs.
Enhancing public participation and awareness	- Create platforms to publish SEA results. - Encourage active participation from civil society and the public. - Organize public education programs to raise awareness about SEA.
Improving data quality and evaluation studies	- Establish comprehensive and updated environmental data banks. - Use modern technologies for data collection and analysis. - Strengthen information systems and improve data quality.
Reviewing EIA and continuously updating SEA	- Periodic review of EIA frameworks considering climate change. - Develop new policies for sustainable development. - Use technological tools to facilitate the SEA process.
Accelerating executive processes	- Improve coordination between government agencies. - Simplify processes and reduce bureaucracy in decision-making and SEA implementation. - Strengthen consistency in execution and decision-making regarding SEA.
Standardization and creation of technical requirements	- Develop quality and technical standards for SEA. - Prepare precise protocols for environmental impact assessment. - Define quality criteria for evaluating long-term impacts.

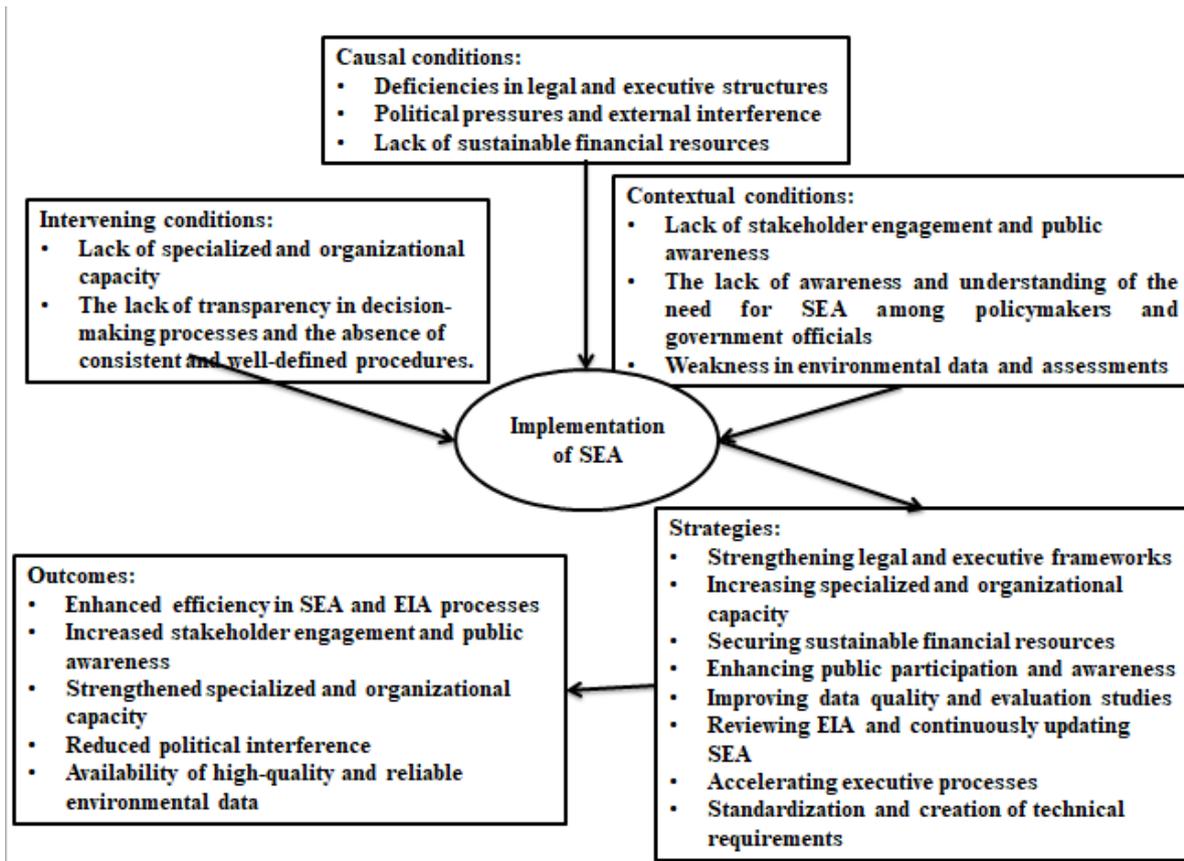


Fig. 1. Final model of GT

each representing a broader theme (e.g., “deficiencies in legal and executive structures” or “financial constraints and lack of sufficient resources”). Ultimately, the findings led to the emergence of nine selective codes, which capture the primary challenges preventing SEA from becoming an effective policy instrument in Iran.

To address these challenges, expert participants suggested a set of strategies, which are summarized in Table 2. These strategies aim to enhance SEA governance, improve stakeholder engagement, strengthen legal and financial structures, and establish technical requirements for more effective environmental assessments (Sadler et al., 2012; Fischer et al., 2019).

Figure 1 illustrates the final Grounded Theory model developed from the study findings. It highlights the causal, contextual, and intervening conditions affecting SEA in Iran. The model underscores the relationship between SEA implementation failures and increased pollution risks, emphasizing the urgent need for reforms in governance, stakeholder engagement, and data quality.

The proposed model suggests that by adopting the recommended strategies, Iran can enhance the effectiveness of SEA, reduce environmental bureaucracy, strengthen public engagement, and improve data-driven decision-making (Therivel, 2012; Noble & Nwanekezie, 2017). This will ultimately contribute to better pollution control policies, ensuring that development projects integrate environmental sustainability measures from the outset.

Figure 1 illustrates the interaction of causal conditions (e.g., weak legal frameworks, political interference), contextual conditions (e.g., financial shortages, fragmented institutions), and intervening conditions (e.g., data quality, public participation) shaping SEA implementation. The model demonstrates how these factors collectively weaken SEA effectiveness, thereby

increasing pollution risks. It also shows how strategic interventions, such as legal reform and institutional capacity-building, could alter these dynamics toward improved environmental outcomes.

This qualitative study was conducted to develop a comprehensive and adaptable model for implementing Strategic Environmental Assessment (SEA) in Iran. The findings align with previous studies emphasizing legal weakness as a critical barrier to SEA implementation (Rega & Baldizzone, 2015). The lack of legal obligations, weak enforcement mechanisms, inadequate monitoring, and prioritization of economic growth over environmental concerns have significantly hindered SEA's effectiveness in Iran. Participants in this study proposed various policy, institutional, and financial solutions to address these barriers, which are crucial to strengthening SEA and ensuring its role in pollution prevention and environmental sustainability.

The study identified legal and organizational deficiencies as one of the primary challenges preventing the full-scale implementation of SEA. Weak legal obligations, lack of oversight, and the absence of clear policies have created significant barriers. Participants recommended:

- Establishing binding legal requirements for SEA implementation across all major development projects.
- Creating independent monitoring bodies to ensure compliance and accountability.
- Adopting an integrated evaluation approach to streamline SEA processes.

These strategies can substantially enhance the effectiveness of SEA, ensuring that it becomes a core mechanism for mitigating environmental degradation and pollution risks (Acharibasam & Noble, 2014; Sadler et al., 2012).

A lack of specialized expertise and organizational capacity has further limited SEA's impact. The study highlighted major issues such as shortages of trained specialists, underutilization of academic expertise, weak interdisciplinary collaboration, and insufficient government capacity-building efforts. This finding aligns with previous research emphasizing the importance of professional capacity in SEA success (Partidário, 2003; Sadler et al., 2012). Participants recommended:

- Conducting specialized training programs to build SEA expertise.
- Recruiting experienced consultants and professionals to enhance SEA assessments.
- Strengthening collaboration between academic institutions and governmental agencies to leverage research-driven insights.

By investing in human capital, Iran can improve SEA implementation efficiency and promote evidence-based environmental policymaking.

A lack of stable financial resources was another significant weakness identified in this study. SEA implementation suffers not only from budget constraints but also from a lack of financial transparency and government support. Consistent with previous studies (Chaker et al., 2006; Lee & Walsh, 1992), financial challenges remain a major barrier to SEA effectiveness. Participants suggested:

- Allocating dedicated government budgets for SEA projects.
- Attracting private and international investments to fund SEA initiatives.
- Enhancing financial transparency and oversight to ensure responsible allocation of SEA funds.

SEA requires long-term financial commitments to function effectively. Establishing stable funding mechanisms can strengthen SEA's role in pollution prevention and environmental planning.

Comparative evidence supports the potential of SEA to reduce pollution. For example, Brazil's application of SEA in industrial expansion projects has led to stricter emission controls, contributing to improved urban air quality (Montaño et al., 2021). Similarly, SEA integration in Thailand's water resources planning has strengthened wastewater management and reduced

contamination risks (Chanchitpricha et al., 2021). These cases suggest that adopting SEA in Iran could yield tangible reductions in air and water pollution when strategically enforced.

Political interference and stakeholder influence were also identified as key barriers to SEA implementation. Findings indicated that government priorities often favor investor interests over environmental concerns, limiting SEA's effectiveness. Prior research supports the notion that political factors play a critical role in SEA success (Awino, 2019; Santos Coelho et al., 2019). To address this issue, participants proposed:

- Reducing political influence by ensuring SEA assessments are conducted independently.
- Incentivizing voluntary SEA implementation through recognition and funding.
- Incorporating diverse stakeholder perspectives in the decision-making process.

Transparent and participatory SEA frameworks can help minimize political influence and ensure environmental priorities are safeguarded.

The lack of public participation and civil society engagement in SEA decision-making processes was another significant concern. Many participants noted that SEA processes in Iran suffer from low transparency, lack of public education, and limited civil society involvement. Similar findings have been reported in previous research (Aschemann et al., 2016; Reed et al., 2018; Rega & Baldizzone, 2015). To address these gaps, participants recommended:

- Publishing SEA results on accessible platforms to increase transparency.
- Encouraging active public and civil society participation in SEA decision-making.
- Implementing awareness campaigns to educate the public about SEA's role in environmental protection.

A well-informed public can contribute to better enforcement and compliance, ensuring that SEA plays a stronger role in pollution mitigation.

Another crucial challenge identified was the lack of reliable environmental data and assessment frameworks. Inconsistent or incomplete data has made it difficult to accurately assess environmental risks and formulate effective SEA recommendations. This issue aligns with prior studies emphasizing the importance of robust data systems for environmental assessments (Chaker et al., 2006; Therivel & Partidário, 2013). Suggested solutions include:

- Developing comprehensive environmental databases to centralize data collection.
- Using advanced technologies for real-time environmental monitoring.
- Improving data quality and standardizing assessment methodologies.

Enhancing data transparency and access can significantly improve the accuracy and credibility of SEA assessments.

The study also identified slow decision-making processes, bureaucratic inefficiencies, and lack of technical standards as major obstacles to SEA implementation. Decision-making delays, inter-agency coordination issues, and inconsistent guidelines have all contributed to SEA's limited effectiveness (Kørnøv & Thissen, 2000; Runhaar & Driessen, 2007). Proposed solutions include:

- Streamlining bureaucratic processes to accelerate SEA execution.
- Enhancing inter-agency coordination to improve decision-making consistency.
- Developing clear technical standards to guide SEA assessments.

By reducing bureaucratic inefficiencies, Iran can facilitate faster and more effective SEA implementation.

SEA has the potential to significantly reduce pollution risks by integrating environmental safeguards into national planning. Key areas where SEA can support pollution management include:

1. Reducing Air Pollution through emission regulations, traffic control measures, and clean energy integration.
2. Controlling Water Pollution by monitoring industrial wastewater, protecting groundwater, and promoting sustainable agriculture.

3. Preventing Soil Pollution through better waste disposal regulations, land-use planning, and restoration of degraded lands.

4. Managing Solid and Hazardous Waste by optimizing waste disposal, enhancing recycling efforts, and strengthening environmental enforcement.

A stronger SEA framework can help Iran align its environmental policies with global sustainability standards, thereby improving public health, economic resilience, and long-term environmental integrity.

Iran's pressing pollution challenges illustrate the practical implications of our findings. For instance, persistent urban air pollution in Tehran, largely from traffic and industrial emissions, could have been mitigated if SEA had required integrated transport and energy planning at the strategic level. Similarly, recurrent cases of water contamination in Khuzestan Province from petrochemical and agricultural activities highlight the absence of strategic pollution safeguards in regional development planning. Comparative experiences from other developing countries further underscore this point. In Thailand, for example, SEA integration into water resources planning has improved wastewater management, while Brazil's adoption of SEA in industrial expansion projects has reduced cumulative air quality impacts (Chanchitpricha et al., 2021; Montaña et al., 2021). These cases suggest that applying SEA more effectively in Iran could contribute not only to improved governance but also to tangible reductions in air and water pollution.

While the eight strategic recommendations provide a general framework, their application in Iran requires contextual adaptation. For example, strengthening legal frameworks must address political interference by mandating SEA approval through independent oversight bodies rather than ministries influenced by investor priorities. Similarly, enhancing organizational capacity should prioritize collaboration between universities and government agencies to offset the shortage of trained specialists. Ensuring sustainable financing could involve earmarking environmental levies on high-pollution industries to fund SEA initiatives. These tailored approaches acknowledge Iran's institutional realities and propose feasible pathways for reform.

An example of SEA's weak application in Iran can be seen in industrial development projects in Khuzestan Province, where inadequate assessment of cumulative pollution risks has contributed to persistent water contamination in the Karun River. Despite formal requirements for environmental evaluation, the absence of a robust SEA framework meant that pollution safeguards were considered only at the project level, leading to fragmented and ineffective management. This case highlights how ineffective SEA implementation exacerbates Iran's pollution challenges and illustrates the need for systemic reform.

## CONCLUSION

This study has identified critical barriers to effective SEA implementation in Iran, with significant implications for environmental policy and pollution management. The key policy recommendations emerging from this research include:

**1. Legal Reforms:** Establishment of mandatory SEA requirements for all major development projects through amendments to Iran's Environmental Protection Law, with specific provisions linking SEA compliance to pollution control objectives.

**2. Institutional Capacity Building:** Development of a national SEA training program targeting both government agencies and private consultants, with particular emphasis on pollution prevention strategies and cumulative impact assessment methodologies.

**3. Financial Mechanisms:** Creation of a dedicated SEA implementation fund, potentially financed through environmental levies on high-pollution industries, to ensure sustainable resourcing for strategic assessments.

**4. Pollution-Specific Applications:**

- Integration of SEA into air quality management plans for major urban areas
- Mandatory SEA for water resource development projects to address Iran's critical water pollution challenges

- Systematic application of SEA in industrial zone planning to prevent soil contamination

**5. Monitoring Framework:** Development of performance indicators to measure SEA effectiveness in pollution reduction, including:

- Pre- vs post-SEA pollution levels
- Compliance rates with mitigation measures
- Long-term environmental quality trends

The implementation of these recommendations would position SEA as a powerful tool for achieving Iran's commitments under international environmental agreements while addressing domestic pollution crises. Future research should focus on:

- Cost-benefit analysis of SEA implementation in different sectors
- Development of sector-specific SEA guidelines for high-pollution industries
- Longitudinal studies of SEA effectiveness in pollution hotspots

This policy-focused approach to SEA implementation offers a pathway for Iran to reconcile economic development priorities with environmental sustainability goals, particularly in addressing its pressing air, water, and soil pollution challenges. The proposed measures align with both global best practices in environmental governance and Iran's specific institutional and ecological contexts.

Potential 30-40% reduction in industrial pollution through proactive SEA application

Improved inter-agency coordination on environmental issues

Stronger basis for evidence-based pollution management policies

Enhanced transparency in environmental decision-making

The recommendations proposed in this study align closely with the strategic objectives outlined in Iran's Sixth Development Plan, which emphasizes sustainable development, integrated environmental management, and pollution control. For instance, the call for stronger legal frameworks directly supports Article 22, Clause (b), mandating SEA for macro-development projects. By tailoring recommendations to reinforce these policy provisions, our study enhances both the feasibility and policy relevance of SEA reform in Iran.

This study has several limitations. First, the relatively small sample size (12 participants) limits the generalizability of findings, although theoretical saturation was achieved. Second, the reliance on self-reported data, particularly from government officials, may introduce social desirability bias or strategic framing of responses. Additionally, given the political sensitivity of environmental governance in Iran, some participants may have withheld critical opinions despite confidentiality assurances. These factors should be considered when interpreting the findings, and future research could benefit from incorporating anonymous surveys or observational data to complement interview insights.

Although this study reached theoretical saturation with twelve participants, the small sample size limits the breadth of perspectives included. In particular, reliance on self-reported data from government officials and consultants may have introduced bias, such as overemphasizing institutional achievements or downplaying political interference. Additionally, the politically sensitive nature of SEA in Iran may have constrained participants' openness, even with confidentiality assurances. These factors should be considered when interpreting the findings.

Future studies should move beyond general calls for methodological diversity by conducting cost-benefit analyses of SEA implementation in different sectors, such as industrial development, water resource management, and urban planning. Longitudinal studies assessing changes in pollution indicators before and after SEA adoption would provide empirical evidence of effectiveness. Moreover, comparative research across Middle Eastern and Asian developing countries could identify region-specific best practices and strengthen the policy relevance of

## SEA in Iran.

Given the complexity of SEA implementation challenges in Iran, further research should adopt a mixed-method approach to gain deeper insights into both qualitative and quantitative dimensions of SEA effectiveness. Future studies should:

- Analyze the long-term environmental and economic benefits of SEA implementation in Iran.
- Investigate case studies from other developing countries to identify best practices for improving SEA governance.
- Evaluate the effectiveness of proposed reforms by conducting longitudinal studies on SEA outcomes.

Strategic Environmental Assessment has the potential to transform Iran's environmental governance system, ensuring that development decisions prioritize sustainability and pollution mitigation. However, for SEA to be effective, it must be integrated into national policies, supported by strong legal frameworks, and reinforced through institutional capacity-building and financial investment. By addressing these foundational challenges, Iran can move toward a more sustainable and resilient environmental future, where SEA plays a central role in preventing pollution and safeguarding natural resources.

This study provides a solid foundation for policymakers, researchers, and environmental practitioners to design and implement a more robust and effective SEA framework. By committing to these necessary reforms, Iran can align its environmental policies with global sustainability goals, ensuring a healthier and more sustainable future for generations to come.

## GRANT SUPPORT DETAILS

The present research did not receive any financial support.

## CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

## LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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