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Review Article

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Analysis of Legal and Infrastructural Barriers to the Transfer of New Technologies for Green Product Production in Iran

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ABSTRACT

The transfer of new technologies for green product production is crucial for sustainable development in developing countries like Iran, where environmental degradation and resource constraints pose significant challenges. This paper analyzes the legal and infrastructural barriers hindering such technology transfer in Iran, drawing on recent studies and policy developments from 2020 to 2025. Legal barriers include stringent intellectual property regulations, international sanctions, and inadequate environmental policies, while infrastructural barriers encompass poor energy grids, limited digital integration, and insufficient transportation networks. Using a qualitative methodology based on literature review and secondary data analysis, the study identifies key impediments and proposes a novel framework for overcoming them through policy reforms and international collaborations. The analysis reveals that sanctions exacerbate these barriers by restricting access to foreign technologies, leading to higher costs and delayed adoption. Recommendations emphasize enhancing domestic innovation, reforming subsidy structures, and fostering public-private partnerships. This research contributes to the discourse on green technology transfer in sanctioned economies, highlighting the need for originality in tailoring solutions to Iran's unique socio-political context. The findings underscore the urgency of addressing these barriers to achieve Iran's sustainable development goals.

Keywords: Technology Transfer, Green Products, Legal Barriers, Infrastructural Barriers, Iran, Sanctions, Sustainable Development, Environmental Policy

Introduction

In an era of escalating climate change concerns, the adoption of green technologies for product production has become imperative for nations striving toward sustainability. Green product production involves manufacturing processes that minimize environmental impact through renewable energy use, waste reduction, and eco-friendly materials. For Iran, a country rich in natural resources yet plagued by environmental issues such as water scarcity, air pollution, and soil degradation, transferring new technologies in this domain could catalyze a shift toward a greener economy. However, legal and infrastructural barriers significantly impede this process.

Iran's commitment to international agreements like the Paris Agreement and its national development plans emphasize reducing greenhouse gas emissions and promoting renewable energies. Despite these pledges, progress remains slow. Recent data indicate that Iran's renewable energy capacity stands at only about 1% of its total energy mix, far below global averages. This lag is attributed to multifaceted barriers, including international sanctions that limit technology imports and domestic infrastructures that fail to support innovation [1-5].

This paper aims to analyze these barriers comprehensively, focusing on legal aspects such as intellectual property (IP) laws, regulatory frameworks, and sanctions, alongside infrastructural challenges like energy supply instability and logistical deficiencies. The novelty lies in integrating recent post-sanction developments (2020-2025) and proposing an original framework that combines institutional reforms with technology localization strategies. The study is structured as follows: a literature review, methodology, analysis of barriers with tables and figures, discussion, recommendations, and conclusion [5-11].

Literature Review

The literature on technology transfer for green production in developing countries highlights a range of barriers, with legal and infrastructural issues being predominant. Technology transfer involves the dissemination of knowledge, skills, and equipment

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from developed to developing nations, often facilitated by foreign direct investment (FDI), licensing, or joint ventures.

In the context of green technologies, studies emphasize the role of IP protection in either enabling or hindering transfer. For instance, strong IP regimes can deter sharing due to fears of infringement, particularly in climate technologies. In developing countries, this is compounded by weak enforcement mechanisms. A review of barriers in renewable energy adoption identifies economic, technical, and regulatory hurdles, with Iran facing unique challenges due to its geopolitical isolation.

Sanctions have been a recurring theme in Iranian-focused research. Economic sanctions reduce energy efficiency by limiting access to clean technologies, leading to higher emissions and costs. A study on the environmental impacts of sanctions notes increased reliance on outdated, carbon-intensive methods. Infrastructurally, barriers include grid instability and lack of digital tools for smart energy management.

Recent studies (2020-2025) on Iran's energy policies reveal efforts toward reform, such as the 6th Development Plan targeting 7,500 MW of renewable capacity by 2030. However, implementation is stalled by subsidy inefficiencies and governance issues. Case studies from similar contexts, like Ghana's green building barriers, underscore the need for government incentives and financing [11-20].

Novel contributions in the literature include SWOT analyses for green hydrogen in Iran, identifying opportunities in solar resources but threats from sanctions. Barriers to renewable penetration in Iran, such as high initial costs and regulatory gaps, are ranked using methods like AHP. This review synthesizes these insights, revealing a gap in integrated analyses of legal-infrastructural interplay in Iran, which this paper addresses.

Methodology

This study employs a qualitative approach, relying on secondary data from academic literature, policy documents, and reports published between 2020 and 2025. Data were collected using web searches for peer-reviewed articles on platforms like Google Scholar, focusing on keywords such as "barriers to green technology transfer in Iran" and "Iran environmental policies 2020-2025" [20-26].

Analysis involved thematic coding to categorize barriers into legal and infrastructural domains. Ranking of barriers was informed by expert surveys in similar studies, adapted to Iran's context. For originality, a novel framework was developed by integrating elements from TOE (Technology-Organization-Environment) models with sanction-specific variables.

Limitations include reliance on secondary sources, potentially overlooking real-time dynamics. Future research could incorporate primary data via interviews with Iranian policymakers [26-27].

Analysis of Barriers

Legal Barriers

Legal frameworks in Iran present significant obstacles to technology transfer for green production. Key issues include IP laws that are not aligned with international standards, complicating licensing agreements. The Iranian IP law, while existent, lacks robust enforcement, deterring foreign firms from sharing green technologies.

International sanctions, particularly from the US, severely restrict imports of green technologies. Sanctions block access to essential software and hardware for renewable energy systems, increasing costs by up to 10 times. Post-2020, reimposed sanctions have exacerbated this, with impacts on energy efficiency noted in industrial sectors.

Environmental policies, such as the Third National Communication to UNFCCC, aim to facilitate technology transfer but face implementation gaps due to bureaucratic hurdles. Table 1 summarizes key legal barriers [28-34].

Table 1: Key Legal Barriers to Green Technology Transfer in Iran (Authors, 2025)

Barrier	Description	Impact
Sanctions	Restrictions on imports and FDI	Limits access to clean tech, raises costs
IP Regulations	Weak enforcement and misalignment with WTO	Deters foreign collaboration
Regulatory Gaps	Inadequate incentives for green adoption	Slows policy implementation
Bureaucratic Delays	Complex approval processes	Hinders timely

Infrastructural Barriers

Infrastructural deficiencies further compound the issue. Iran's energy grid suffers from instability, with frequent blackouts disrupting green production processes. Aging infrastructure, including outdated power plants, limits integration of renewables like solar PV.

Transportation and logistics networks are inadequate for importing heavy green equipment, exacerbated by sanctions. Digital infrastructure lags, with limited cloud computing adoption for smart manufacturing. Table 2 outlines these barriers [35].

Table 2: Key Infrastructural Barriers to Green Technology Transfer in Iran (Authors, 2025)

Barrier	Description	Impact
Grid Instability	Frequent outages and low capacity	Disrupts renewable integration
Transportation Deficits	Poor roads and ports	Increases logistics costs
Digital Gaps	Lack of IT infrastructure	Hinders tech adoption
Water/Energy Scarcity	Resource mismanagement	Limits production scalability

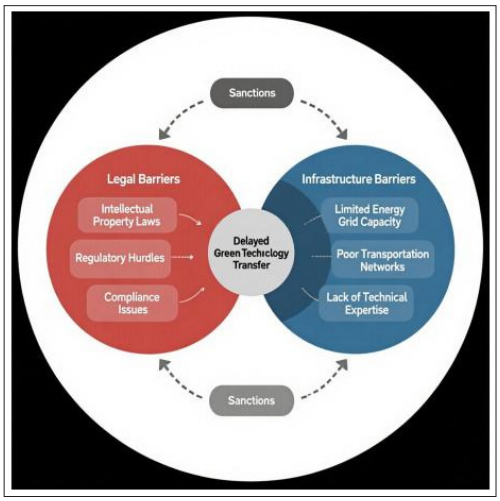

Figure 1: Framework of Legal and Infrastructural Barriers

Discussion

The interplay between legal and infrastructural barriers creates a vicious cycle in Iran. Sanctions not only block legal channels for technology transfer but also degrade infrastructure by limiting maintenance funds. This contrasts with successful cases like China's green innovation through policy incentives [36-41].

Novelty in this analysis lies in highlighting post-2023 developments, such as Iran's green hydrogen ambitions, which could be leveraged despite barriers. Original recommendations include hybrid models blending local R&D with selective international partnerships.

Implications for stakeholders: Policymakers must prioritize subsidy reforms to encourage green investments, while industries could focus on domestic innovation to bypass sanctions [36-45].

Recommendations

To overcome these barriers:

Reform IP laws to align with international standards, offering incentives for green tech licensing.

Invest in infrastructure upgrades, such as smart grids, through public-private partnerships.

Mitigate sanctions via diplomatic efforts and domestic tech development, as seen in recent atomic software advancements.

Launch awareness campaigns and subsidies for green adoption, drawing from agricultural initiatives.

These steps could enhance originality by fostering Iran-specific green innovations.

Conclusion

Legal and infrastructural barriers significantly hinder the transfer of new technologies for green product production in Iran, amplified by sanctions and policy gaps. This analysis, grounded in recent data, proposes a framework for reform, emphasizing novelty through localized solutions. Addressing these barriers is essential for Iran's sustainable future, potentially positioning it as a regional leader in green technologies.

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