Foresight Scenarios for the Iran's Petrochemical Industry

Mohammad Amin Ghalambor
Lecturer, Faculty of Management, Ghalambor@ut.ac.ir

University of Tehran, Shanzdah-e-Azar (Engelab Avenue), Tehran, Iran

Abstract

Iran's vast oil and gas reserves and strategic location present a unique opportunity for its petrochemical industry. However, the industry faces a dynamic future influenced by rapid and complex economic, political, technological, and regulatory changes. This study presents the findings of a foresight research project on the Iranian petrochemical industry in collaboration with Tehran's industry chambers (TCCIM and APEC), utilizes scenario planning — a methodology grounded in the established Global Business Network (GBN) model — to explore various potential futures. Extensive data collection forms the foundation of this study. Primary and secondary data are gathered through a rigorous multi-method approach encompassing in-depth library research, benchmark analyses of similar industries around the world, and insightful interviews with industry experts. By employing this approach, the research identifies the key factors that will determine the future trajectory of Iran's petrochemical industry. Following the data collection phase, a comprehensive analysis categorizes these factors based on their importance and degree of uncertainty. This analysis allows researchers to prioritize the most critical drivers that will ultimately define the industry's future.

Drawing upon this understanding, the research then constructs four distinct scenarios, each depicting a unique narrative for the industry's potential trajectory. These scenarios — "Phoenix" (potential resurgence), "Glimmer" (moderate growth), "Swamp" (stagnation), and "Amphibian" (struggle for survival) — offer a comprehensive spectrum of possibilities. Additionally, the research establishes leading indicators to anticipate the specific conditions that might trigger each scenario. The research does not stop at simply outlining these potential futures. It transcends this by engaging a select group of industry executives in scenario simulations. Through these simulations, the research identifies the key opportunities and threats inherent in each potential future. This comprehensive approach empowers stakeholders with a deeper understanding of the various paths the industry might take, allowing them to formulate informed policies and strategies for a successful future in the ever-changing global landscape.

Keywords: petrochemical industry; scenario planning; futur; Foresight; Iran; oil and gas; scenario simulation

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Introduction

Understanding the future trajectory of the Iranian petrochemical industry is crucial not only for industry participants but also for broader economic and political stakeholders. This study was conducted by ARA Consulting Company in collaboration with the Tehran Chamber of Commerce, Industries, Mines and Agriculture (TCCIM) and the Association of Engineering and Contracting Companies in Oil, Gas and Petrochemical Industries (APEC) in 2023. The TCCIM, with over 33,000 members, is the largest chamber of commerce, industries, mines and agriculture in Iran. APEC, currently with 268 members, is one of the TCCIM's important petrochemical industry associations, comprising private sector companies active in engineering and project implementation in the oil, gas, and petrochemical industries. The industry's influence extends far beyond its own operations, significantly impacting the supply chains and the value of numerous sectors such as automotive, construction, and pharmaceuticals.

However, the industry faces significant challenges, including currency fluctuations, environmental regulations, attracting foreign investment, and knowledge transfer restrictions. These challenges hinder strategic decision-making. Iran boasts a prominent position in the global petrochemical landscape (Figure 1). It holds 24% of the Middle East's oil reserves and 12% of the world's total.[1] Additionally, it was the fifth-largest producer in OPEC in 2021. Iran's position is further bolstered by holding the second-largest natural gas reserves globally by the end of 2021 and ranking as the third-largest producer in 2020. Despite its vast energy reserves, Iran's petrochemical production has declined noticeably since 2017. This decline is primarily attributed to reduced investments and increased international sanctions.[2]

Investment is a recognized driver of economic growth, and attracting both domestic and foreign capital is vital for the Iranian petrochemical industry's growth and development (Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020). Successfully securing the necessary investments and allocating them effectively across various sectors will pave the way for sustainable development (Farashah et al., 2021). Foreign direct investment (FDI) plays a particularly crucial role by influencing financing, access to technology, and export opportunities (Blomstrom et al., 2000; Anwar, Nguyen, 2010). Due to privatization, the industry cannot rely solely on government funding. Consequently, attracting private and foreign investors is crucial for its future.

However, sanctions and unfavorable economic indicators present significant challenges in this area. To gain a deeper understanding of the industry's future, it is essential to examine relevant Iranian policies and high-level documents. This analysis will help define the research scope, objectives, and the approach to identifying future trends and uncertainties. An analysis of high-level documents in the oil, gas, and petrochemical sector reveals the ambitious goals set for the industry. These include reducing energy intensity, maintaining a leading position in OPEC oil production, and achieving regional dominance in gas production and refining capacity. While these goals highlight the industry's importance, their achievement will be challenging due to the complex and volatile economic environment. This research aims to identify the factors impacting the future of the Iranian petrochemical industry. By developing and simulating future scenarios, we will explore potential opportunities and threats in each scenario, providing a comprehensive understanding of the industry's future trajectory.

Literature Review

In today's rapidly changing world, characterized by ambiguity, uncertainty, and resource scarcity (Richter et al., 2018), futures research emerges as a crucial discipline for navigating complexity (Brem, Utikal, 2019; Walsh, Winsor, 2019; Van de Ven, 2017). The intricate nature of the environment underscores the need for innovative perspectives and tools to formulate strategic responses and uncover opportunities for success (Renwick et al., 2019; Goldsby, Zinn, 2016; Kieser et al., 2015).

A growing number of researchers and forward-thinking businesses are embracing the power of futures research and foresight, employing this knowledge systematically (Sarin et al., 2018). Futures studies, a systematic approach to exploring possible, probable, and preferable futures (Nagy et al., 2016; Murayama et al., 2015), offer valuable insights.

Given the inherent uncertainties and complexities within the Iranian petrochemical industry, a foresight approach is employed to map and explore its potential future trajectory. As the first step in examining the industry's future, we must identify and analyze the critical factors shaping its direction and potential transformation. To achieve this, Porter's PESTEL framework, which investigates political, economic, social, environmental, technological, and legal factors, will be utilized. The following section will delve into the most significant factors identified through a combination of literature reviews, benchmarking, and expert interviews. Political changes and developments, both domestically and internationally, have always exerted a significant influence on Iran's economy and industries. These developments can manifest as political and economic sanctions, regional conflicts and wars, international agreements, and new domestic policies.

[1] https://www.ogj.com/ogj-survey-downloads/worldwide-production/document/14302750/worldwide-reserves-and-production, accessed 11.06.2024.

[2] www.eia.gov/international/analysis/country/IRN, accessed 11.06.2024.

Sun (2023) examined the consequences of war and military conflicts (specifically, the conflict between Russia and Ukraine) on the oil, petrochemical, and renewable energy industries. The study revealed a positive impact of rising oil prices on stock returns for renewable energy companies, while the effect on petroleum product stock returns was negligible. In another relevant study, Farashah et al. (2021) explored the factors influencing the development of the petrochemical industry. They modeled the mechanism for creating a capacity increase budget, a proposed policy, using a system dynamics approach. This model was used to simulate variables related to each product, such as production capacity value, production rate, domestic sales revenue, and exports. Based on the simulation results, Iran's petrochemical product capacity could reach approximately 104 million tons by 2025, a scenario deemed undesirable. This research suggests program improvement and budget allocation as the most effective solutions for achieving development in the petrochemical industry. By implementing this policy, the model predicts a 4% and 13% improvement in production capacity and total income, respectively, in 2025 compared to the baseline scenario. Financial risks and a complex regulatory environment pose significant challenges for the continued development of Iran's petrochemical industry.

Shafiei Nataghi et al. (2023) employed a research model to identify and categorize these financial strategic risks. Their study, utilizing expert interviews, literature reviews, and thematic analysis, revealed a network of interconnected risks. These include sanctions risk, government financial decision-making risk, credit risk, liquidity risk, production area financial risks, macroeconomic risk, product and market risk, insurance sector risk, and strategic management risks (Shafiei Nataghi et al., 2023). Beyond financial considerations, effective regulations are crucial for the sustainable growth of any industry. Mirjalili's (2003) report for the Majlis Research Center highlights the critical role of regulations in fostering a balanced and sustainable development trajectory for the petrochemical value chain. The report identifies the lack of a coherent industrial and sectoral development strategy as a key challenge. This ambiguity in policymaking and targeting hinders progress within the industry (Mirjalili, 2003).

Economic developments also significantly influence the performance of the petrochemical industry. Golshen et al. (2022) investigated the impact of exchange rate fluctuations on Iran's petrochemical and oil product industries. Their analysis of Tehran Stock Exchange data revealed a positive correlation between exchange rate changes and the price index of companies in these sectors (Golshen et al., 2022). Furthermore, Mamarzadeh et al. (2019) examined the effects of global crude oil market shocks on the Iranian petrochemical stock index. Their findings suggest that market demand increases have a positive impact on the index, while supply-side increases have a negligible effect. Additionally, the dollar exchange rate and inflation positively affect the index, whereas increased liquidity exerts a negative impact (Mamarzadeh et al., 2019). Similarly, Zarei (2020) explored the influence of inflation and exchange rates on the Iranian petrochemical stock index. The study concluded that exchange rate fluctuations have a greater long- and short-term impact on the industry compared to inflation. This can be attributed to the industry's reliance on international trade for product exports and raw material/technology imports. Additionally, essential inputs like subsidized natural gas are less susceptible to general price level changes (Zarei, 2020). The potential economic impact of foreign direct investment (FDI) on Iran's oil and gas sector

Figure 1. **Largest Proven Reserves of Oil and Natural Gas in World and Iran Position**

Source: author.

was explored by Nejati and Bahmani (2020). Their research suggests that FDI can have negative consequences if it does not lead to increased productivity. This could result in a significant rise in raw material consumption (oil and gas) within the Iranian economy, potentially leading to decreased production and employment in tradable sectors, with a corresponding increase in non-tradable sectors (Nejati, Bahmani, 2020). The text also acknowledges the growing global trend toward renewable energy sources.

Studies by Hwangbo et al. (2022) and Heo et al. (2024) examine the potential of artificial intelligence (AI) in decarbonization efforts and minimizing the environmental impact of the petrochemical industry. Additionally, Wu et al. (2023) explored the impact of environmental laws and regulations on China's petrochemical industry. Their research suggests that three types of environmental laws positively affect the financial performance of petrochemical companies: fines for environmental protection violations, pollution discharge costs, and environmental protection taxes. Public environmental concerns in areas with petrochemical companies were also found to have a positive influence (Wu et al., 2023). Environmental sustainability and energy conservation have become paramount concerns in the petrochemical industry, driven by growing environmental awareness, regulatory pressures, and economic incentives. Minimizing waste and reducing pollutant emissions are crucial measures for achieving these goals (Kiet, 2023; Rao, 2002; Zhu et al., 2005; Lee et al., 2012).

Iran's current electricity generation capacity stands at 90,900 megawatts (MW), with over 80% derived from thermal sources reliant on natural gas. This heavy dependence on natural gas has rendered the power sector vulnerable to supply disruptions, posing a significant challenge to meeting the country's growing energy demands. The lack of diversity in Iran's electricity generation portfolio, coupled with its excessive dependence on natural gas and limited fuel supply constraints, necessitates a strategic shift toward renewable energy sources to ensure a sustainable and secure energy supply for economic growth. Iran boasts an estimated renewable energy potential of 124 GW, with solar energy accounting for 71 GW and wind energy contributing 49 GW. Despite the recognition of renewable energy's importance in national laws, regulations, and policies, their share in the country's total electricity generation remains below 0.5%. This stands in stark contrast to the global average, where renewable energy sources account for approximately 12.8% of electricity production. International projections indicate that global electricity demand will increase by about 60% by 2050, with renewable energy sources poised to play a dominant role, contributing 43% of the total electricity generation. Iran's transition to a renewable energy-driven future is not merely an option but a necessity. The Seventh Development Plan provides a roadmap for this transformation, emphasizing the need for a concerted effort from all stakeholders to harness the immense renewable energy potential of Iran (Saberi et al., 2023).

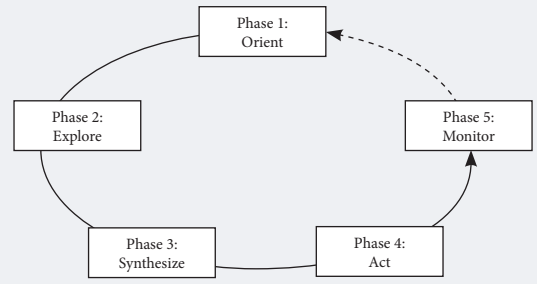
Technology and knowledge are recognized as the driving forces behind industrial growth and productivity enhancement. Allahi and Shavalpour (2019) examined the significance of local knowledge networks in the oil, gas, and petrochemical industry of Iran's Khuzestan Province. Ghaithan et al. (2021) investigated the impact of Industry 4.0 technologies and lean manufacturing on the sustainable performance of petrochemical companies in Saudi Arabia. Their findings revealed a positive and coherent relationship between Industry 4.0 technologies and sustainable development performance, confirming a causal link between lean manufacturing and Industry 4.0 technologies. Min et al. (2019) explored the application of machine learning-based digital twins for production optimization in the petrochemical industry. Their study proposed a framework and approaches for constructing an industrial Internet of Things (IIoT)-based digital twin in the petrochemical sector, incorporating machine learning and a feedback loop to exchange information between the physical plant and a virtual digital twin model for achieving production control optimization. Fayez et al. (2021) studied public-private partnerships (PPPs) in the downstream industries of Iran's oil sector. Their findings revealed that political and legal factors have the most significant influence on PPPs. Additionally, the study emphasized the importance of strengthening transparency in PPPs. Malik et al. (2020) examined the impact of disruptive events, with a focus on the COVID-19 pandemic, on the petrochemical industry in a McKinsey & Company report. The report delineated the impact of pandemic-induced disruptions – namely, declining demand and oil prices – on the short-term, medium-term (second half of 2020 to 2023), and long-term (post-2023) outlook for the petrochemical industry. The study concluded that chemical industry leaders and financial investors alike need to update their perspectives and management plans to focus on recovery scenarios, regional supply chains, and capital efficiency.

As evident, numerous factors influence the petrochemical industry. Some of these have positive impacts, while others have negative consequences. Some can be considered threats, while others can be considered opportunities. Building upon the identified factors from the literature review and comparative studies, we proceed to code them and determine their impact intensity using an importance-uncertainty matrix. Subsequently, the positive and negative effects of the most significant factors in each scenario are narrated. Finally, the threats and opportunities arising from their interactions are identified and explained.

Methodology

Scenario planning is a widely recognized and valuable approach to futures studies. Due to the inherent ambiguity, complexity, and uncertainty associated with the petrochemical industry, numerous studies have employed this method (Rubio et al., 2023; Guivarch et al., 2017; Khosala et al., 2021; Parajuli, 2015; Matsumoto,Voudouris, 2015; Paltsev, 2014). This research employs a mixed-methods approach to develop scenarios for the future of Iran's petrochemical industry. To ensure coherence throughout the research process, the Global Business Network (GBN) model (Scearce, Fulton, 2004) is utilized. This model comprises five key phases: orient, explore, synthesize, act, and monitor (Figure 2).

Figure 2. **GBN Scenario Planning Process**



Source: author.

Scenario Planning Process Based on the GBN Method

Phase 1: Orient

The orientation phase establishes the objectives of scenario planning for the future of Iran's petrochemical industry. This stage aims to clearly define the problem under consideration to guide the subsequent four stages. The orientation stage commences by discussing the most significant challenges facing the industry and progress toward identifying assumptions regarding these challenges and their potential future roles. The most effective approach in this stage involves asking key questions of decision-makers, senior managers, and primary stakeholders through semi-structured interviews. Additionally, the time frame of the scenarios can be determined either prior to the interviews or based on their findings. The outcomes of this phase are elucidated through document reviews and expert interviews.

Phase 2: Explore

This phase identifies the key factors that shape the central issue. Key factors can be both internal and external, influencing the future of the petrochemical industry in predictable and unpredictable ways. Key factors can also be categorized as predictable factors and uncertainties. Predictable factors are change forces that effectively and relevantly impact the future timeframe, such as political changes, changes in people's and government income, and technological advancements. Uncertainties are unpredictable forces that can have significant impacts, such as changes in societal values, public opinion, or the role of government in the petrochemical industry. The literature comprehensively identifies and describes predictable factors in the petrochemical industry's macro-environment. Uncertainties are identified and determined based on previous studies, in-depth interviews, and questionnaires.

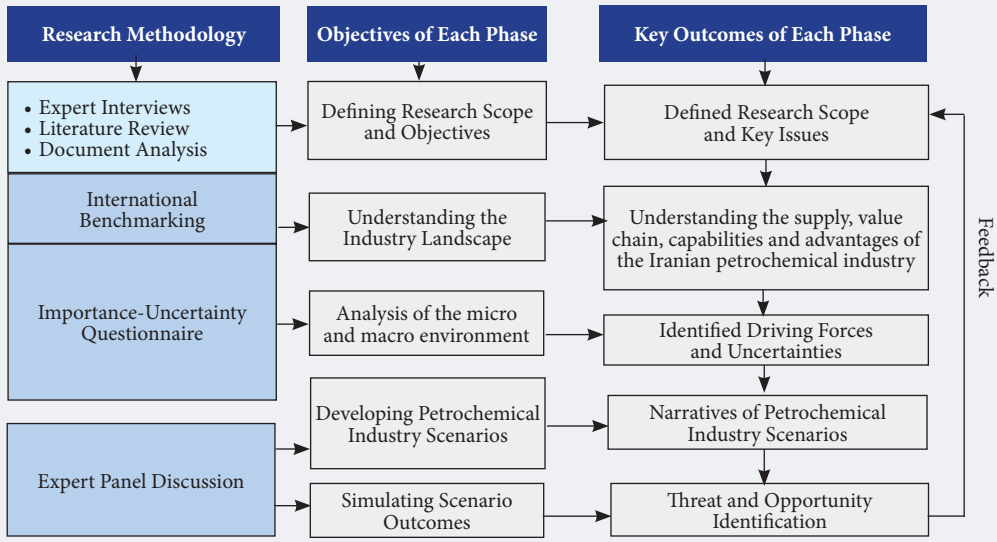
Phase 3: Synthesize

In phase three, the effective forces identified in the preceding phase are combined and integrated to construct scenarios. While numerous factors may have been identified in the previous phases, they may also differ meaningfully; although all factors may be important, their significance is not equal. This phase involves differentiating the identified factors and selecting the key drivers for scenario development. The goal of prioritization is to identify two or three forces that have the most significant impact and influence on the central question or issue. These factors represent critical uncertainties and form the foundation of the scenarios. Eliminating certain factors may create the perception that the value of the work is diminished; however, there are opportunities to revisit the factors identified in the preceding phases in subsequent processes.

Phase 4: Act

Scenarios are employed in phase four to inform and encourage activities. Experimenting with a group of scenarios does not imply reaching precise conclusions about the future but rather empowers petrochemical industry stakeholders to learn, adapt, and select more effective activities. After developing each scenario, one must deeply envision working with it and ask: What if this scenario unfolds in the future? What actions should be taken today to prepare? Responses to such questions constitute the reactions of key decision-makers and industry stakeholders to the scenarios. Subsequently, their reactions in each scenario must be analyzed: Were the reactions effective? Did the reactions in each scenario differ effectively? Can any of these differing reactions be adopted as a strategy? The patterns and insights gained from reactions to the scenarios serve as frameworks for building strategies. Predictable factors identified and determined in the preceding phases can also be utilized to inform strategic planning.

Figure 3. **Research Process and Methodology**



Source: author.

Phase 5: Monitor

The objective of this phase is to establish key indicators for evaluating the accuracy and validity of scenarios as real-world events unfold. Additionally, this phase establishes a mechanism for enabling industry stakeholders to navigate the environment and adapt strategies. Effective forces may exist that have the potential to exert greater influence over time and should be identified as guiding indicators.

The research process, including the methodology, goals, and achievements of each stage, is depicted in the Figure 3 below. Following the established process, the first step involved defining the research territory, limitations, and needs. Subsequently, macro-trends, trends, events, challenges, and opportunities were identified within this domain to construct a basket of factors influencing the future of the petrochemical industry. Next, an uncertainty and importance questionnaire was employed to investigate the factors impacting Iran's petrochemical industry specifically. The key drivers were then selected to serve as the foundation for scenario formulation. The research team, along with a panel of experts in the field, subsequently developed the logic, structure, and narrative of these scenarios. Finally, to enrich the scenarios and gain a deeper understanding of the implications for key players, a scenario simulation panel was conducted. This panel aimed to identify opportunities and threats associated with each scenario. Importantly, the experts prioritized the most critical opportunities and threats based on their insights. By employing this structured research methodology, the study provides a robust and insightful analysis of the Iranian petrochemical industry's future, enabling informed decision-making and strategic planning for industry stakeholders.

To gain a deeper understanding of the identified key factors and explore a broader range of potential influences, the research team consulted with subject matter experts during the exploring phase. Their perspectives further informed the completion of the importance-uncertainty questionnaires. Interviews were conducted with 43 experts associated with Iran's petrochemical industry. To ensure the development of well-crafted questions and the evaluation of high-quality responses, a semi-structured interview protocol was designed for the present study following the format of the RAND Corporation's semi-structured interview protocol (Harrell, Bradley, 2009). The respondents whose demographic characteristics are presented in the Table 1 were asked about:

- The most important challenges and issues facing the industry
- The most important economic, political, technological, legal, social, and environmental factors affecting the industry by 2030
- The most attractive markets for the industry in the future
- The main competitive advantages of the industry
- The biggest transformation that the industry will undergo in the future.

Results

As mentioned in previous sections, to explore the future trajectories of the petrochemical industry, we examined historical trends, key events, strategic documents, comparative studies, and conducted in-

Table 1. **Experts demographic characteristics**

Category	**Share** (%)
Education Level of Experts (total 100%, including)	
Bachelor's Degree	11.8
Master's Degree	47
Doctoral Degree	41.2
Work Experience (total 100%, including)	
Less than 5 years	17.6
More than 5 and less than 10 years	26.6
More than 10 and less than 20 years	35.3
More than 20 years	20.5
Organizational Position (total 100%, including)	
Engineer	23.6
Middle Manager	32.3
Senior Manager	44.1

Source: author.

terviews with experts to identify a basket of the most critical factors influencing the future of this sector. Table 2 presents a list of 36 key factors affecting the future of the petrochemical industry.

After identifying the factors influencing the industry's future, we analyzed these factors using an importance-uncertainty matrix, distributed through a questionnaire among the identified experts. This matrix serves as a tool for classifying the factors identified in the previous stages. The dispersion of factors in this matrix reflects their status and position in scenario design and development, as the interpretation of each quadrant of the matrix shapes the structure and narrative of each scenario (Figure 4).

Table 3 and Figure 5 below show the dispersion of key factors and average expert opinions affecting the future of Iran's petrochemical industry, based on the results of the importance-uncertainty matrix.

Scenarios for Iran's Petrochemical Industry by 2030

In this section, to develop scenarios for Iran's petrochemical industry, the identified key factors are classified into categories of drivers based on expert opinions. The drivers that shape the scenarios are selected based on the highest level of importance and uncertainty for scenario development. Figure 6 below illustrates the constellation of key factors affecting the future of this sector.

It is crucial to acknowledge that the impact of each factor mentioned below can vary depending on the specific scenario being analyzed. Not all variables will have a uniformly positive or negative influence. For instance, while sanctions may impose challenges and restrictions on Iran, they can also lead to more strategic domestic investments and the expansion of ties with countries outside the sanctions regime, fostering a focus on internal capabilities and alternative partnerships.

As determined by the importance-uncertainty matrix and analysis of the research team, the set of factors encompassing Iran's foreign policy (extensive relations with the world, limited relations with the world) and government economic policies (intelligent policies, unstable policies) represent the most important and uncertain drivers shaping the scenarios for the petrochemical industry. At this stage, based on the matrix logic, the upper limits of two drivers are determined in two directions, toward improvement and deterioration of the current situation, and four scenarios are drawn from their interaction (Figure 7).

Next, we present the narratives of the four scenarios: Phoenix, Glimmer, Swamp, and Amphibian, based on the identified drivers (Figure 8). It is important to note that the scenario narratives are based on the status of the identified key factors constellation, and in each scenario, in addition to depicting the overall future picture, the occurrence of these factors is explained.

The Phoenix Scenario: A Bright Future for Iran's Petrochemical Industry

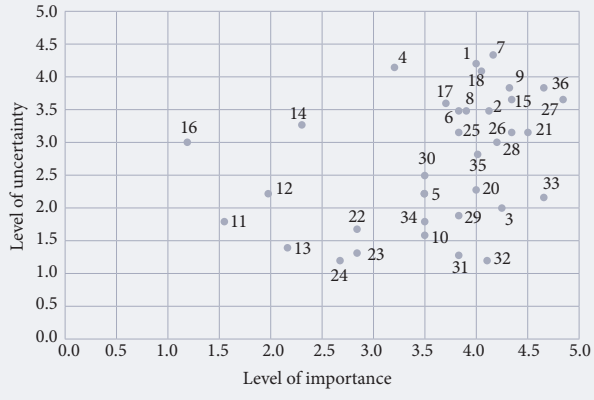
The Phoenix scenario depicts a future where improved foreign relations with other countries have opened

Figure 4. **Position of identified factors in Importance-Uncertainty Matrix**

High Uncertainty	Zone two **Surprise Potentials**	Zone one **Critical Uncertainties**
Low Uncertainty	Zone three **Context**	Zone four **Key Trends**
	Low Importance	High Importance

Source: author.

Figure 5. **Importance-Uncertainty Matrix of factors influencing Iran's Petrochemical Industry**



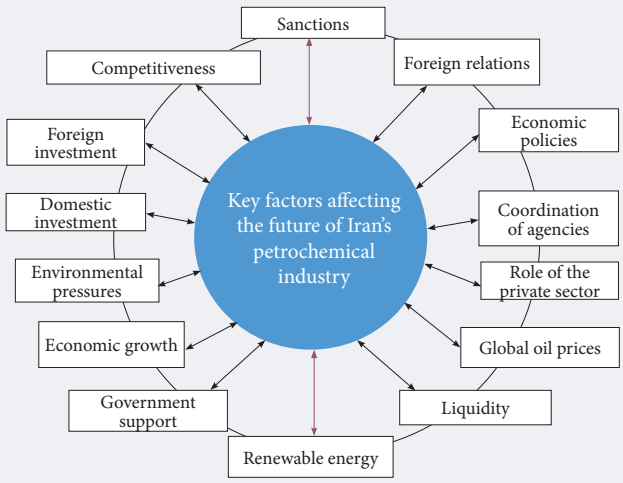
Note: Deciphering of Factor Numbers see in Table 2.
Source: author.

Table 2. **Prioritization of Factors Affecting Iran's Petrochemical Industry by Importance-Uncertainty**

Row	Key Factor	Degree of Importance	Degree of Uncertainty
1	Sanctions (banking, technology, etc.)	4.67	3.83
2	Technological advancements	4.11	3.50
3	Replacement of fossil fuels with renewable energy sources	3.50	2.22
4	Foreign relations with regional countries	3.20	4.17
5	Foreign relations with Russia and China	4.25	2.00
6	Foreign relations with European countries	3.83	3.50
7	Foreign relations with the United States	4.16	4.33
8	Domestic economic policies	3.98	4.00
9	Domestic laws and regulations	4.33	3.83
10	E-government	3.50	1.58
11	Incoherence and conflicts between domestic organizations and agencies	1.55	1.78
12	Limited involvement of the private sector in policymaking	1.96	2.23
13	Rentier factors (subsidized exchange rates, informal relationships, etc.)	2.15	1.40
14	COVID-19 and unforeseen events	2.30	3.30
15	International competitiveness	4.36	3.66
16	Global political and trade conflicts	1.20	3.00
17	Regional military conflicts	3.70	3.60
18	2021 presidential election	4.00	4.17
19	Exchange rate	4.05	4.11
20	Inflation rate	4.00	2.30
21	Global oil prices	3.89	3.50
22	Climate and environment	2.83	1.70
23	Global standards	2.83	1.30
24	Environmental pressures	2.67	1.20
25	Ability to export crude oil	3.83	3.17
26	Domestic investment	4.33	3.17
27	Foreign investment	4.83	3.67
28	Economic growth rate	4.21	3.00
29	Domestic infrastructure (roads, etc.)	3.83	1.90
30	Government support for the private sector	3.50	2.50
31	Skilled workforce	3.83	1.30
32	Companies' managerial capabilities	4.10	1.20
33	Companies' financing and liquidity	4.67	2.15
34	Indigenous technical know-how	3.50	1.78
35	Private sector claims on the government	4.00	2.83
36	Degree of government budget dependence on oil	4.50	3.17

Source: author.

Figure 6. **Constellation of Key Factors Affecting the Future of the Iranian Petrochemical Industry**



Source: author.

doors to enhanced economic ties. The government's adoption of intelligent economic policies has fostered a healthier and more competitive environment for players in the petrochemical industry. The short-term reduction of some financial sanctions, coupled with minimal fluctuations in others, has instilled optimism for improved economic indicators. These factors, combined with better relations between branches of government and the implementation of more informed laws and regulations that support industry participants, have created favorable conditions for increased domestic and foreign investment. In this scenario, chambers of commerce and economic associations play a more prominent role in decision-making. Government policies and strategies, informed by the collective wisdom and experience of the private sector, are geared toward strengthening national competitive advantages. However, improved relations with the West, while paving the way for faster economic growth, have also introduced new limitations and conditions imposed by international regulations. Compliance with global standards and environmen-

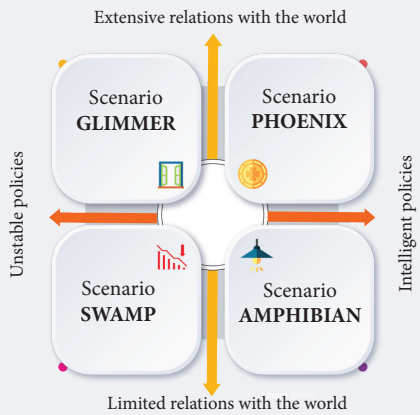
Figure 7. **Constellation of Key Factors Affecting the Future of the Iranian Petrochemical Industry**

Source: author.

tal pressures presents additional challenges. Additionally, the rise of renewable energies, a key global trend, poses a potential disruption, albeit not a significant one in the next decade. Companies that fail to monitor their environment and adapt to technological advancements risk being caught off guard. One of the significant opportunities in this scenario is the facilitation of large-scale oil sales. As the macro-trends suggest, the value of oil in the Phoenix scenario is no longer solely based on its direct sale, a strategy now employed by many energy source owners globally. The key here lies in the government's intelligent investment of the generated liquidity in infrastructure development and private-sector empowerment. Reduced demands from the private sector, coupled with improved financial resources and liquidity for oil, gas, and petrochemical contractors, has opened doors for wider investments in both upstream and downstream industries.

Companies have expanded their reach into larger regional and global markets by establishing bilateral and multilateral agreements with international counterparts. The diversification of their activity portfolios has mitigated the potential damage caused by reduced demand due to the adoption of renewable energies. Industry pioneers in research and development have also made significant contributions to global innovation. Improved government

Figure 8. **Scenarios for Iran's Petrochemical Industry by 2030**



Source: author.

structure has led to a more efficient supply chain in downstream industries, satisfying industry players by providing timely, adequate, and cost-effective raw materials, thus facilitating value creation. The establishment of stability and predictability in economic indicators has not only increased the attractiveness of the petrochemical industry but has also intensified competition. Enhanced relations with regional and global players have opened new markets for industry participants, creating opportunities for novel services and products. This has spurred the emergence of new knowledge-based companies and the development of established ones. The rising demand for energy in South and East Asia, coupled with the Middle East's energy needs and Iran's oil and gas export potential, presents a golden opportunity for regional and global development. By investing in and collaborating with international companies, domestic firms have rapidly increased their LNG and CNG exports, leveraging their geopolitical advantages to secure their position in this sector. The increasing global integration and development of advanced platforms require agility and adaptability from consulting and contracting companies in the oil, gas, and petrochemical industries. Companies that can quickly adapt to new standards and regulations will have a significant advantage on this evolving market. Overall, the Phoenix scenario paints a promising picture for the future of Iran's petrochemical industry, but success will hinge upon careful planning, strategic decision-making, and continuous adaptation to a changing global landscape.

The Glimmer Scenario: A Glimpse of Opportunity Amid Missed Chances

The Glimmer scenario portrays a future where improved foreign relations have compelled the world to ease sanctions. However, due to a lack of coherence and intelligence in domestic economic policies, a favorable environment for the growth of domestic economic actors has not materialized. International companies in the oil, gas, and petrochemical sectors show interest in investment and participation in contracting and consulting projects. However, the lack of coordination, conflict management, and a coherent policy among governing institutions leads to a situation where the benefits from relaxed sanctions disproportionately favor rent-seekers and intermediaries, with minimal value creation. In this scenario, the focus shifts toward purchasing existing technologies and equipment to keep the petrochemical industry operational, rather than acquiring and transferring essential technologies. The lifting of sanctions facilitates the sale of raw materials, but due to liquidity constraints and accumulated challenges, industry leaders prioritize this strategy to address financial issues and increase sales volume and liquidity. This short-term approach is further reinforced by the high turnover of managers. The global shift toward renew-

Table 3. **List of Key Factors Affecting the Future of the Iranian Petrochemical Industry and Their Positioning in the Four Quadrants of the Importance-Uncertainty Matrix**

Key Factors	Zone	References
1. Sanctions (banking, technology, etc.)	One	Shafiei Nataghi et al., 2023; Hoshdar, 2017; Bonyani, 2018; Bollino, 2019; Kaveh, 2021; Ziyae, 2020; Experts Panel
2. Technological advancements &	One	Allahy, Shavalpour, 2019; Ghaithan et al., 2021; Min et al., 2019; Doulabi, 2022; Ziyae, 2020; Mottaghi, 2019
3. Replacement of fossil fuels with renewable energy sources	Four	Hwangbo et al., 2022; Heo et al., 2024; Shokouhi, 2024; Fartash, Ghorbani, 2023; Mottaghi, 2019
4. Foreign relations with regional countries	One	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
5. Foreign relations with Russia and China	Four	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
6. Foreign relations with European countries	One	Bonyani, 2018; Bollino, 2019; Mottaghi, 2019; Experts Panel
7. Foreign relations with the United States	One	Hoshdar, 2017; Bonyani, 2018; Bollino, 2019; Ziyae, 2020; Mottaghi, 2019; Experts Panel
8. Domestic economic policies	One	Farashah et al., 2021; Zarei, 2020; Mamarzadeh et al., 2020; Mottaghi, 2019
9. Domestic laws and regulations	One	Mirjalili, 2023; Mottaghi, 2019; Experts Panel
10. E-government	Four	Shafiei Nataghi et al., 2023; Experts Panel
11. Incoherence and conflicts between domestic organizations and agencies	Three	Fayez et al., 2021; Hoshdar, 2017; Experts Panel
12. Limited involvement of the private sector in policymaking	Three	Fayez et al., 2021; Shafiei Nataghi et al., 2023
13. Rentier factors (subsidized exchange rates, informal relationships, etc.)	Three	Shafiei Nataghi et al., 2023; Ziyae, 2020; Experts Panel
14. COVID-19 and unforeseen events	Two	Malik et al., 2020; Experts Panel
15. International competitiveness	One	Bonyani, 2018; Bollino, 2019; Experts Panel
16. Global political and trade conflicts	Two	Shafiei Nataghi et al., 2023; Bollino, 2019
17. Regional military conflicts	One	Sun, 2023
18. 2023 presidential election	One	Experts Panel
19. Exchange rate	One	Mamarzadeh et al., 2020; Zarei, 2020; Ziyae, 2020; Mottaghi, 2019
20. Inflation rate	Four	Zarei, 2020; Mamarzadeh et al., 2020; Mottaghi, 2019
21. Global oil prices	One	Mamarzadeh et al., 2020; Shokouhi, 2024; Ghandi, 2017; Bollino, 2019; Ziyae, 2020; Mottaghi, 2019
22. Climate and environment	Four	Hwangbo et al., 2022; Heo et al., 2024; Mottaghi, 2019
23. Global standards	Four	Hwangbo et al., 2022; Heo et al., 2024; Shokouhi, 2024
24. Environmental pressures	Four	Wu et al., 2023; Hwangbo et al., 2022; Heo et al., 2024; Mottaghi, 2019
25. Ability to export crude oil &	One	Nejati, Bahmani, 2020; Bollino, 2019; Mottaghi, 2019; Experts Panel
26. Domestic investment	One	Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020; Shokouhi, 2024; Ziyae, 2020; Mottaghi, 2019
27. Foreign investment	One	Sternberg, Lubart, 1991; Sazvar, Sepehri, 2020; Nejati, Bahmani, 2020; Shokouhi, 2024; Ghandi, 2017; Mottaghi, 2019
28. Economic growth rate	One	Blomstrom et al., 2000; Anwar, Nguyen, 2010; Mottaghi, 2019
29. Domestic infrastructure (roads, etc.)	Four	Blomstrom et al., 2000; Anwar, Nguyen, 2010
30. Government support for the private sector	One	Fayez et al., 2021; Experts Panel
31. Skilled workforce	Four	Allahy, Shavalpour, 2019; Ghaithan et al., 2021; Min et al., 2019; Doulabi, 2022; Hoshdar, 2017; Bonyani, 2018
32. Companies' managerial capabilities	Four	Shafiei Nataghi et al., 2023; Hoshdar, 2017; Bonyani, 2018; Doulabi, 2022; Ziyae, 2020; Experts Panel
33. Companies' financing and liquidity	Four	Shafiei Nataghi et al., 2023; Shokouhi, 2024; Bonyani, 2018; Mottaghi, 2019; Experts Panel
34. Indigenous technical know-how	Four	Allahy, Shavalpour, 2019; Min et al., 2019; Bonyani, 2018; Doulabi, 2022
35. Private sector claims on the government	One	Farashah et al., 2021; Shafiei Nataghi et al., 2023
36. Degree of government budget dependence on oil	One	Farashah et al., 2021; Experts Panel

External factors: Internal factors:

Source: author..

able energy presents an investment opportunity that is missed due to the absence of long-term policies and strategies. Iran not only fails to become a player in this sector, but also gradually loses its competitive edge derived from its oil and gas resources.

The lack of intelligent support for domestic companies, coupled with the entry of multinational and international firms, threatens the survival of many Iranian contracting and consulting companies. The burden of global regulations, environmental pressures, and the absence of government support significantly disadvantage domestic companies in a more competitive landscape. The presence of international companies, further bolstered by a lack of government support, creates an uneven playing field for Iranian engineering and contracting firms. The relatively cheaper Iranian workforce initially attracts international companies to projects. However, Iranian companies are gradually outcompeted due to technological deficiencies, outdated systems, and financial limitations, ultimately becoming mere shells of their former selves. To ensure their survival and growth on future markets, Iranian engineering and contracting companies should act swiftly upon recognizing the signs of this scenario. Forming memorandums and cooperation agreements with multinational and international companies can establish them as business partners, ensuring their place on future markets. Despite a less than ideal national business environment, improved political relations with regional countries offer opportunities to penetrate lucrative regional markets. Engineering and contracting companies in the petrochemical industry should prioritize actions such as establishing regional offices, monitoring tenders, forming cooperation agreements, attending exhibitions, and developing business relationships. Improved relations also present a golden opportunity for technology transfer and localization. Engineering and consulting companies that have already identified technological challenges and needs can quickly enter the market and generate sustainable income by providing solutions. The accumulated needs and infrastructure wear and tear within the industry will create a short-term demand for equipment, technical knowledge, and other resources. Companies that have already established relationships with suppliers will be well-positioned to capitalize on this demand and achieve high profit margins. The Glimmer scenario presents a future with mixed prospects. While improved foreign relations offer opportunities, the lack of a robust domestic economic policy could hinder long-term growth for Iran's petrochemical industry. Taking advantage of the opportunities requires proactive measures by industry players, particularly in terms of technology transfer and strategic partnerships.

The Swamp Scenario: Stagnation and Decline in a Tense Global Landscape

The Swamp scenario depicts a future characterized by peak tensions in foreign relations, particularly with the United States and European countries. This climate, coupled with a lack of coherence, tact, and intelligence in domestic economic policies, has led to widespread bankruptcies and a decline in petrochemical industry players. The accumulation of years of challenges, compounded by limited global interactions, has not only stifled growth and development but also endangered infrastructure and the survival of some supply chain actors. Weak private sector participation in policy, strategy, and regulatory development, along with discord between executive, legislative, and judicial branches, has severely impacted ease-of-doing-business indicators, causing a sharp decline. The adoption of burdensome new laws, unreasonable government expectations regarding private sector taxation, and restrictive and interventionist views toward industry players have created significant barriers for new entrants and discouraged existing companies from remaining operational. The decrease in oil export volumes and difficulties in global financial transactions have led to a drastic decline in government funding, particularly for construction projects. Additionally, the diminished ability of the private sector to engage in economic activities has further weakened tax revenue potential. Economic volatility has fueled currency depreciation and inflation, which might initially incentivize exports. However, this advantage is negated by global pressures and limitations on financial exchanges. In this scenario, contracting and consulting companies heavily reliant on government contracts face significant liquidity challenges due to mounting unpaid claims. The government, facing funding constraints, has reduced construction and development projects. The limited remaining projects, coupled with a shrinking market, have intensified unhealthy competition among engineering and contracting companies in the petrochemical industry.

A vicious cycle emerges - reduced construction projects lead to unhealthy competition, which in turn increases demands from companies. This, coupled with limited liquidity, drives many companies to bankruptcy and exiting the market. The financial and technological decline of these companies erodes their competitive advantages, effectively shutting them out of not only global markets but also regional competition. While petrochemical companies possess some awareness of major industry trends and transformative events, their inability to invest in research and development forces them to either exit the industry entirely or shift focus toward other markets and industries for survival. As the domestic market con-

tracts and domestic companies lose liquidity and competitiveness, skilled personnel are drawn to regional and global firms. This exodus, over time, will erode the human capital advantage of Iran's petrochemical engineering and contracting sector. The Swamp scenario paints a bleak picture for Iran's petrochemical industry. A combination of strained foreign relations, incoherent domestic policies, and a declining business environment creates a stagnant and declining landscape. The industry's future hinges upon resolving these issues and fostering a more conducive environment for growth and innovation.

The Amphibian Scenario: Limited Progress in a Constrained Environment

The Amphibian scenario portrays a future where domestically implemented smart economic policies have eased the operating environment for economic actors. However, escalating tensions and restricted relations with European and American countries create significant hurdles in attracting investors, transferring technology, and facilitating financial transactions. While the government has adopted laws and regulations formulated with the private sector's input, creating platforms for domestic economic activity, limitations in interactions with developed countries dampen investments and development initiatives. The lack of robust competition at the national level has shrunk the market for engineering and contracting companies in the petrochemical industry. This has fostered unhealthy competition, reduced liquidity, and inflated demands, ultimately eroding their competitiveness on the global stage. The contracting market has diminished the financial strength of engineering and contracting companies, hindering their ability to attract and retain skilled personnel. This exodus of human capital, the industry's most vital competitive advantage, further weakens these companies. As this process continues, domestic companies not only lose their edge but also lack the capacity to undertake domestic projects. In a vicious cycle, this situation leads to the deterioration and eventual obsolescence of equipment and infrastructure.

The insular nature of activities within the rapidly evolving global petrochemical industry has not only squandered opportunities for investments in renewable energy and transformative technologies but has also gradually exhausted and challenged the industry's supply chain. The vast regional market, upon which Iranian engineering and contracting companies could have capitalized, has gradually slipped away, leaving them without a strong regional position. While the government has attempted to establish market order and stability through well-crafted economic policies, global trends and developments like declining oil and gas demand, coupled with sanctions-induced restrictions, have minimized revenue streams from oil and gas sales. This downward trend is likely to continue due to the increasing adoption of renewable energies and the emergence of new technologies. The limitations on technology exchanges, reduced research and development capacity, along with the wear and tear of assets, equipment, and infrastructure within the petrochemical industry's supply chain, will ultimately slow down or even halt the engine of growth in other industries. The Amphibian Scenario presents a future of stagnation for Iran's petrochemical industry. While domestic policies show signs of improvement, the industry remains constrained by its inability to fully engage with the international community. This isolation hinders access to critical resources, technologies, and markets, ultimately limiting the industry's potential for growth and innovation.

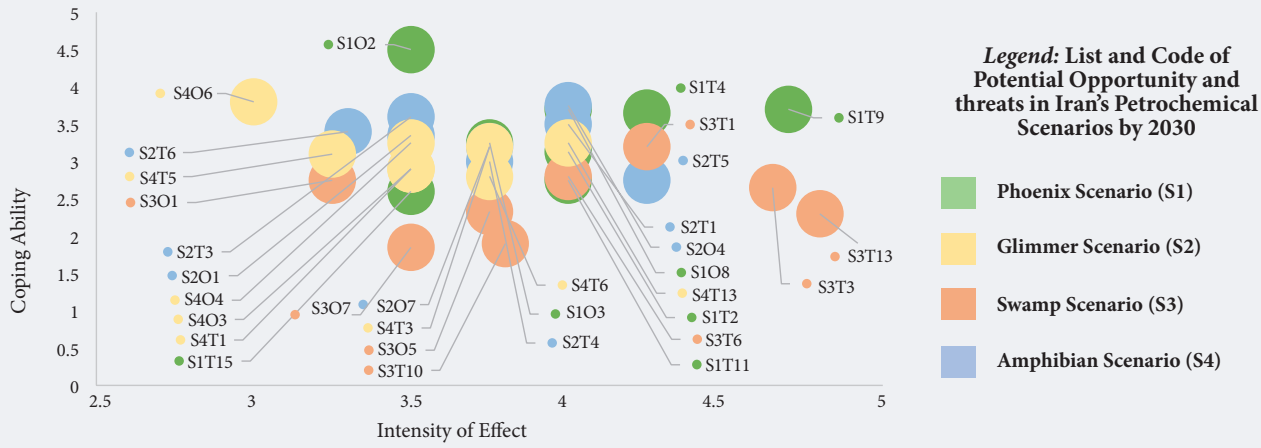
Simulating the Futures of Iranian Petrochemical Players up to 2030

To gain insights into the future of Iran's petrochemical industry, a panel discussion was held with 11 industry experts (e.g., chemical engineers, economists). The discussion focused on analyzing key challenges, opportunities, and advantages facing engineering and contracting companies. The four developed scenarios were presented to facilitate a deeper understanding of potential futures and enable decision-makers and industry players to develop informed strategies and operational plans. The first section of the panel simulated and visualized the futures depicted in the four scenarios: Phoenix, Glimmer, Swamp, and Amphibian. This exercise helped identify crucial challenges, threats, and opportunities. Subsequently, in the second section, experts evaluated these opportunities and threats based on their intensity of effect and coping ability. The findings of the panel discussion are summarized in the figure 9 below, which represents the average evaluations of the expert panelists.

Conclusion

Iran's petrochemical industry, fueled by its vast oil and gas reserves and a focus on high value-added products, plays a pivotal role in the nation's economic landscape. However, a complex and dynamic global environment presents significant challenges to strategic decision-making. This research addresses this challenge by employing scenario planning, a robust methodology for mapping out potential futures of the industry. By providing a long-term perspective, scenario planning empowers managers and decision-makers to navigate this uncertain landscape. The research findings reveal that the interplay between international political relations and domestic economic

Figure 9. **Map of Key Opportunities and Threats in 4 Scenarios for the Iranian Petrochemical Industry by 2030**



Threats and Challenges (T)

1 - Exodus of Skilled Personnel; 2 - Unhealthy Competitive Landscape; 3 - Liquidity and Financing Constraints; 4 - Dominance of International Companies; 5 - Small Size of Domestic Companies; 6 - Macroeconomic Conditions; 7 - Tax and Insurance Issues; 8 - COVID-19 and Unforeseen Events; 9 - Global Competition; 10 - Low Private Sector Participation in Policymaking; 11 - Environmental Pressures; 12 - Project Delays; 13 - Financial and Technology Sanctions; 14 - Contractual Terms; 15 - Renewable Energy Substitution

Opportunities and Advantages (O)

1 - Intelligent Empowerment; 2 - Access to Skilled Personnel; 3 - Collaboration with International Companies; 4 - Regional Comparative Advantage; 5 - Upgrading Product Portfolio; 6 - Economic Diplomacy; 7 - Smart Research and Development; 8 - Creating New Markets

Source: author.

policies acts as a critical driver shaping the future trajectory of Iran's petrochemical industry. Building upon this understanding, the research constructs four distinct scenarios: Phoenix (potential resurgence), Glimmer (moderate growth), Swamp (stagnation), and Amphibian (struggle for survival). These scenarios provide a comprehensive spectrum of possibilities for the industry's future. Furthermore, the research goes beyond simply outlining these scenarios. It establishes a practical framework to track the likelihood of each scenario unfolding. This framework functions as a dynamic tool, continuously monitoring the status of key indicators across different timeframes. This allows stakeholders to proactively adapt their strategies based on the evolving landscape.

The research's innovation lies in its application of scenario simulation. This technique facilitated the identification of forthcoming opportunities and threats, thus enriching the scenarios and providing a practical roadmap for industry strategy development (Table 4).

The analysis yielded a comprehensive picture, identifying 15 potential threats and eight opportunities mapped according to their impact intensity and the industry's ability to address them. By gaining a clear

Table 4. **Roadmap for the Occurrence of Scenarios in the Iranian Petrochemical Industry by 2030**

Parameters	Scenarios			
	I	II	III	IV
International competitiveness				
Government support				
Renewable energy				
Economic growth				
Foreign investment				
Domestic investment				
Ability to export crude oil				
Environmental pressures				
Companies' financing and liquidity				
Role of the private sector				
Coordination between government agencies				
Economic policies				
Foreign relations				
Sanctions				

Scenarios: I – Phoenix; II – Glimmer; III – Swamp; IV – Amphibian.

Color Coding: Very Favorable to Favorable ( ), Neutral ( ), Very Unfavorable to Unfavorable ( )

Source: author.

understanding of these factors, industry stakeholders are empowered to efficiently allocate resources, leverage existing capabilities, and capitalize on existing advantages. Success in this dynamic global industry hinges upon the ability to decipher emerging trends through proactive environmental monitoring and scanning. Furthermore, industry players can transform from passive observers to key drivers of change by strategically investing in various supply chain technologies. By maintaining a vigilant watch on the evolving environment and recognizing the early signs of each scenario's emergence, industry actors can anticipate future developments and actively pursue their interests on the global stage.

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