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Identification and Prioritization of Key Drivers Affecting the Future of Oil and Gas Resource Exploitation Using the Delphi Approach

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ABSTRACT

The present study was conducted with the aim of identifying and prioritizing the key drivers influencing the future of oil and gas resource exploitation in Iran, employing the Delphi method within the framework of strategic foresight. Given the complexity, uncertainty, and multidimensional nature of transformations in the energy sector, identifying the driving forces shaping the future of this domain is considered a strategic necessity for national decision-making. In this regard, the statistical population of the study consisted of 25 prominent experts in the fields of oil and gas, energy economics, futures studies, and macro-level policymaking, who were selected through theoretical and purposive sampling, using a combination of judgmental and snowball techniques. Data were collected through in-depth semi-structured interviews, expert correspondences, and panel discussions, and the process continued until theoretical saturation was achieved. In the initial phase, 70 potential drivers were extracted through the analysis of documents, specialized reports, and reference texts. Subsequently, through a process of screening, conceptual refinement, and integration of overlapping elements, a final list of 31 drivers was developed across seven strategic domains (economic, technological, political–legal, institutional, social, environmental, and educational–research). In subsequent stages, these drivers entered a multi-round Delphi process to enable evaluation, validation, and expert consensus regarding their importance and impact. The Delphi approach facilitated the integration of diverse expert perspectives and reduced individual biases, leading to the clarification of structural forces affecting the future of hydrocarbon resource exploitation in the country. The findings indicate that drivers related to advanced extraction technologies and digitalization, energy governance and institutional transparency, energy diplomacy, investment management, geopolitical risk management, and environmental requirements hold the highest strategic importance. The results of this study can serve as an analytical framework for macro-level planning, the design of field development strategies, sustainable resource management, and forward-looking policymaking in Iran's oil and gas industry.

Keywords: Key drivers; Delphi method; oil and gas industry; optimal exploitation; energy policymaking; strategic uncertainty.

Introduction

The future of oil and gas resource exploitation has become one of the central strategic concerns of energy-dependent economies, particularly in countries whose fiscal stability, industrial development, and geopolitical leverage remain closely tied to hydrocarbon resources. In such contexts, exploitation can no longer be understood merely as a technical process of extraction and production; rather, it must be conceptualized as a multidimensional strategic system shaped by interdependent economic, technological, institutional, legal, environmental, and geopolitical forces. Contemporary transformations in the global energy landscape, including shifts in demand patterns, the acceleration of decarbonization policies, advances in digital and extraction technologies, volatility in financial markets, and the expansion of regulatory expectations, have fundamentally altered the logic of decision-making in the oil and gas sector [1-3]. The global structure of energy flows itself illustrates how deeply oil and gas remain embedded in production, transportation, industrial value chains, and national energy security architectures, despite the parallel growth of renewable alternatives [4]. Under such conditions, countries possessing large hydrocarbon reserves must move beyond short-term, revenue-oriented extraction models and instead identify the key drivers that shape future exploitation capacity, sustainability, and competitiveness.

The strategic salience of this issue is particularly pronounced in Iran, where oil and gas resources are not only major economic assets but also critical levers of industrial policy, state finance, regional influence, and long-term development planning. Iran's resource base is substantial, yet the country's exploitation trajectory is affected by a complex combination of domestic and external constraints, including sanctions, investment bottlenecks, governance challenges, technological limitations, pricing distortions, and environmental pressures. Prior research on Iran's oil industry has emphasized that the future of this sector cannot be adequately understood through linear forecasting or static planning assumptions, because the industry is exposed to nonlinear changes and interacting uncertainties that require scenario-oriented and foresight-based approaches [5]. Studies on effective financing drivers in the Iranian oil industry have similarly shown that future sectoral performance depends on a set of interconnected structural variables rather than on any single operational reform [6]. At the same time, analyses of the current and prospective condition of Iran's oil and gas sector indicate that the country stands at a critical junction where policy design, institutional adaptation, international engagement, and technological modernization will determine whether its hydrocarbon resources become a foundation for strategic resilience or a source of prolonged vulnerability [7, 8].

A central challenge in this regard lies in the fact that "optimal exploitation" is itself a complex and contested concept. It does not simply imply maximizing extraction volumes or short-term revenues. Rather, optimal exploitation must reconcile economic efficiency, intergenerational sustainability, security of supply, technological feasibility, environmental stewardship, legal robustness, and adaptive governance. Multi-criteria perspectives on energy resource evaluation have long argued that resource decisions must reflect a broader set of strategic and societal criteria, rather than relying only on cost or production indicators [9, 10]. Likewise, decision models for energy allocation and subsidy optimization have demonstrated that rational resource management requires balancing competing priorities across sectors and time horizons [11, 12]. In the Iranian context, this broader understanding is especially relevant because the exploitation of oil and gas resources is deeply linked to domestic energy consumption patterns, fiscal dependency, and the structure of national development. For example, the dynamics of natural gas consumption in residential and commercial sectors reveal how internal demand-side pressures can significantly influence upstream and midstream planning choices [13]. Therefore, identifying the key drivers of future exploitation requires an integrative framework that captures both supply-side and governance-side determinants.

Another major reason for revisiting the future of oil and gas exploitation is the increasing importance of organizational and strategic capabilities in energy-sector performance. The literature on strategy and dynamic capabilities suggests that the ability of firms and systems to sense changes, seize opportunities, and reconfigure assets is a core determinant of long-term competitiveness under uncertainty [14, 15]. In the oil and gas sector, such capabilities are expressed in the ability to redesign operating models, build strategic partnerships, integrate new technologies, and align upstream decisions with changing market and policy conditions [16]. Strategic management scholarship has also emphasized that durable advantage emerges not from reactive adaptation alone, but from deliberate strategic choice, prioritization, and capability alignment [17]. This reasoning is directly applicable to national energy systems as well: countries must identify which drivers most strongly shape future performance and then design policy and investment architectures around those priorities. In this sense, the identification and prioritization of drivers is not merely an analytical exercise; it is a strategic prerequisite for coherent long-term action.

The oil and gas industry is also undergoing a technological transition that directly affects the logic of future exploitation. Advanced drilling techniques, compositional modeling, intelligent reservoir management, digital twins, big data analytics, artificial intelligence, and optimization algorithms are changing how reserves are identified, evaluated, produced, and monetized. Research on large-scale well networks has shown the growing role of advanced equations of state and data-driven fluid property prediction in improving production intelligence and operational precision [18]. Industrial cases have also demonstrated how heavy oil recovery and downstream value extraction increasingly depend on technological innovation rather than on resource abundance alone [19]. More recent developments indicate that machine learning and advanced geomodeling are beginning to reshape optimization in carbon capture and storage within oil and gas reservoirs, thereby linking extraction strategies to environmental transition pathways and emissions management [20]. As a result, future exploitation strategies must account not only for resource endowment but also for the pace and direction of technological adoption, because technology now mediates productivity, sustainability, cost structure, and compliance capacity simultaneously.

Environmental and regulatory considerations add another layer of complexity to the future of hydrocarbon exploitation. The global trend toward stricter environmental governance, sustainability disclosure, impact assessment, and responsible operations has elevated ecological issues from peripheral concerns to central strategic constraints. The implementation of environmental management systems such as ISO 14001 has been associated with improved environmental discipline and organizational responsiveness in industrial settings [21]. Strategic environmental assessment and broader regulatory frameworks similarly shape the feasibility and legitimacy of energy projects by embedding environmental criteria into planning and approval processes [22]. In the oil and gas sector specifically, employee behavior, environmental ethics, and green organizational practices are increasingly recognized as relevant to sectoral performance and legitimacy [23]. Thus, the future of oil and gas exploitation cannot be studied solely through economic or technical lenses; it must also include environmental governance, social legitimacy, and regulatory adaptation as key drivers that influence both the viability and acceptability of sectoral pathways.

In parallel, legal and contractual dimensions have become more important as the sector faces rising complexity in investment structures, cross-border cooperation, dispute resolution, sanctions exposure, and risk allocation. Upstream oil and gas contracts increasingly require sophisticated dispute resolution mechanisms capable of handling uncertainty, political risk, and multi-stakeholder tensions [24]. At the same time, the industry is showing greater interest in mediation and hybrid mechanisms as means of preserving strategic relationships while managing contractual disagreements under volatile conditions [25]. These developments matter because exploitation projects are capital intensive, long-term, and institutionally embedded. If the legal and contractual architecture is weak, even strong geological potential may fail to translate into sustainable production outcomes. For countries like Iran, where geopolitical and institutional variables significantly shape sectoral performance, the legal dimension becomes inseparable from the strategic future of exploitation.

Geopolitics is in fact one of the most decisive forces affecting the oil and gas sector today. Oil and gas continue to shape diplomacy, sanctions regimes, regional alliances, investment flows, and state bargaining power. Contemporary analysis shows that energy is not simply traded in markets; it is also negotiated through political relationships, security calculations, and strategic dependencies [26]. For Iran, this reality is particularly acute. International sanctions, restrictions on finance and technology transfer, and shifting regional energy alignments directly affect the country's ability to develop fields, access markets, and modernize infrastructure [7]. Yet geopolitics is not only a constraint; it can also become a driver of strategic adaptation through energy diplomacy, regional cooperation, and alternative partnership models. Accordingly, any serious effort to understand the future of oil and gas exploitation in Iran must incorporate political stability, sanctions management, diplomatic agility, and institutional resilience as high-order drivers.

Within this broader landscape, financial structure and resource governance remain critical. The long-term viability of exploitation projects depends on financing mechanisms, budgeting systems, investment prioritization, and the ability to reduce structural dependence on oil income. Studies on budgeting feasibility in South Pars Gas Company have highlighted the importance of more rational and activity-based approaches in resource allocation and performance management [27]. Broader analyses of the oil and gas value chain and midstream transformation likewise indicate that sustainable sectoral development requires coherent financing models, infrastructure integration, and value-maximizing organizational design [2, 28]. From another angle, work on measuring earnings quality and decision-useful information underscores the importance of transparency and credible financial management for strategic resource sectors [29]. When these financial and governance elements are weak, even technically sound projects may suffer from underinvestment, inefficiency, or policy inconsistency. Consequently, the identification of key future drivers must consider financial governance as a central analytic domain rather than a secondary implementation issue.

The literature also suggests that state regulation and public policy continue to play a decisive role in strategically important oil and gas enterprises. Recent work on state regulation in the oil and gas sector has emphasized that public authorities shape sectoral resilience through institutional oversight, strategic coordination, and regulatory steering [30]. In shared fields and common resource settings, rational strategic decision-making becomes even more important because legal, competitive, and sustainability considerations intersect directly [31]. Supplier selection, partnership formation, and resource allocation in such environments similarly require structured multi-criteria approaches capable of handling agility, uncertainty, and conflicting priorities [32]. These insights point to a recurring conclusion: the future of oil and gas exploitation will be shaped not only by physical reserves, but by the quality of regulation, coordination, and strategic choice across multiple institutions.

Despite the rich body of research on energy strategy, resource evaluation, environmental governance, dynamic capabilities, and sectoral transformation, an important gap remains in the literature. Much of the existing work addresses isolated dimensions of the problem, such as financing, technology, environmental management, legal arrangements, or geopolitical risk, but fewer studies integrate these dimensions into a single foresight-oriented framework for identifying and prioritizing the key drivers of future oil and gas resource exploitation. This gap is particularly evident in the Iranian context, where resource exploitation is influenced by a uniquely dense combination of domestic structural challenges and international pressures. A driver-based, expert-informed, and future-oriented approach is therefore necessary to move beyond fragmented diagnosis and toward strategic prioritization. The Delphi method is particularly well suited for such a task because it enables the structured aggregation of expert judgment under conditions of uncertainty, complexity, and incomplete data, allowing researchers to identify convergent priorities where conventional forecasting models may be insufficient.

In this sense, the present study responds to both a practical and a theoretical need. Practically, it offers a basis for prioritizing the forces that should guide long-term planning, investment design, policy reform, and institutional adaptation in Iran’s oil and gas sector. Theoretically, it contributes to the literature by linking foresight methodology with strategic resource governance and by showing how future exploitation can be analyzed as an outcome of interacting drivers rather than as a simple function of reserves or market prices. By incorporating economic, political, technological, regulatory, institutional, social, and educational-research dimensions, the study seeks to generate a more comprehensive understanding of the future architecture of oil and gas exploitation in Iran.

Accordingly, the aim of this study is to identify and prioritize the key drivers affecting the future of optimal exploitation of Iran’s oil and gas resources using the Delphi method within a strategic foresight framework.

Methodology

The research methodology of the present study was designed using a qualitative–foresight approach and is based on a combination of in-depth semi-structured interviews, expert panels, and a multi-round Delphi method. The complexity and multilayered nature of future-oriented exploitation of oil and gas resources necessitated leveraging field experience, specialized knowledge, and strategic analyses of energy experts. Accordingly, the study population consisted of a group of distinguished specialists in the fields of oil and gas, energy economics, emerging technologies, and policymaking, who were selected through theoretical and purposive sampling. The selection process continued until theoretical saturation was achieved. Data were collected through in-depth interviews, expert correspondences, and panel sessions, and subsequently coded using qualitative content analysis and categorized into themes and causal patterns. A systematic review of the scientific literature and upstream policy documents also contributed to the extraction of an initial list of drivers. Subsequently, through three Delphi rounds, the drivers were evaluated based on importance, impact, and level of uncertainty, and analyzed using indices such as median, interquartile range, and stability of judgments to achieve theoretical consensus. To ensure validity and reliability, the opinions of academic scholars and senior executives were incorporated, and the results were subjected to multi-layered review. Ethical principles, including data confidentiality, informed consent, and the scientific use of data, were observed throughout the research process. This multi-source methodology enabled the reliable identification and prioritization of key drivers influencing the future of oil and gas resource exploitation and provided a robust framework for strategic policymaking and planning in the industry.

The statistical population of this study consisted of 25 experts and prominent specialists in the fields of oil, gas, energy economics, futures studies, and macro-level policymaking of natural resources. This group included university faculty members, senior managers of the Ministry of Oil and its affiliated companies, and energy policy experts, who were selected with the aim of utilizing their specialized knowledge, executive experience, and forward-looking perspectives regarding optimal exploitation of hydrocarbon resources. Given the qualitative and foresight-oriented nature of the study, which aimed to uncover patterns and explain deep relationships among phenomena, random sampling methods were deemed inappropriate. Therefore, theoretical sampling was employed, organizing the sampling process progressively based on the analytical needs of the study, such that the selection of new sampling units was guided by findings from previous stages and aimed at developing and comparing emerging categories. Data collection continued until theoretical saturation was reached, meaning that additional data no longer contributed new concepts or insights and conceptual stability was achieved. For the initial identification of key drivers affecting the future of oil and gas resource exploitation, a combination of purposive judgmental sampling and snowball sampling was used. In the first stage, experts with the highest level of knowledge and insight into the subject were purposively selected. Subsequently, through the snowball method, additional qualified individuals introduced by the initial experts were added to the sample. This combination ensured the inclusion of key individuals in the research process while also achieving diversity of perspectives across technical, economic, managerial, and environmental dimensions related to the oil and gas industry. The interview process was conducted at three levels: telephone contact, electronic correspondence and professional social networks, and expert panel meetings. These sessions were organized to facilitate discussion and exchange of views on trends, challenges, and future opportunities in the energy sector. The interviews were semi-structured, allowing for a predefined framework of topics and core questions while maintaining flexibility for respondents to elaborate on their perspectives. This flexibility enabled the researcher to guide the interview process based on emerging rich content and to move beyond the constraints of closed questionnaires. Experts were allowed to freely articulate their experiences and specialized views regarding factors influencing the optimal exploitation model of oil and gas resources in the long term. It is noteworthy that a significant portion of the interviews was conducted through virtual tools and electronic correspondence to enhance the efficiency of the research process. All interviews were transcribed, coded, and used as the basis for final analysis and the development of the study's conceptual model.

Findings and Results

Based on the analysis of the demographic characteristics of the oil and gas industry experts examined in this study, a sample of 25 specialists was carefully designed to represent key perspectives across three main occupational categories: academic and futures studies experts (20%), senior managers and policymakers (32%), and executive and technical industry specialists (48%). This composition is predominantly focused on the executive and technical sector, reflecting the need to integrate operational knowledge alongside strategic perspectives. In terms of experience and level of expertise, the sample demonstrates high credibility. Regarding educational qualifications, a substantial proportion of experts (88%) held postgraduate degrees, including 40% with doctoral degrees and 48% with master's degrees. This concentration at higher educational levels enhances the validity of subsequent analytical stages. Additionally, the distribution of work experience indicates that 68% of respondents had 15 or more years of experience, with the majority falling within the 15 to 25-year range (48%). This experience profile provides the historical depth necessary for evaluating current exploitation patterns. Furthermore, the age distribution of experts across three groups (30–40, 41–50, and 51+) is relatively balanced but slightly skewed toward more experienced individuals (40% in the 41–50 age range). Regarding academic disciplines, given the nature of the industry, the largest proportion belonged to petroleum, gas, and petrochemical engineering (48%), while a notable share was allocated to interdisciplinary fields such as energy management and futures studies (collectively 24%), ensuring that a foresight-oriented perspective is reflected across the sample. Overall, the demographic characteristics of the sample were designed to encompass both deep technical expertise and the strategic insight required to develop an optimal exploitation model.

Table 1

Frequency Distribution of Demographic and Professional Variables of Oil and Gas Experts (N = 25)

Variable	Category (Frequency)	Count (n)	Percentage (%)	Cumulative Percentage (%)
Age	30–40 years	6	24	24
	41–50 years	10	40	64
	51 years and above	9	36	100
Work Experience (years)	Less than 15 years	5	20	20
	15–25 years	12	48	68
	More than 25 years	8	32	100
Field of Study	Petroleum, Gas, Petrochemical Engineering	12	48	48
	Industrial Engineering, Project/Energy Management	7	28	76
	Economics, Energy Law, Futures Studies	4	16	92
	Other related technical/managerial fields	2	8	100
Educational Level	Master's degree	12	48	48
	Doctoral degree	10	40	88
	Bachelor's degree	3	12	100
Occupation	Academic and Futures Studies Experts	5	20	20
	Senior Managers and Governmental Policymakers	8	32	52
	Executive and Technical Industry Specialists	12	48	100

This section of the present study was conducted with the aim of extracting and prioritizing strategic drivers influencing the optimal exploitation model of Iran's oil and gas resources using a foresight approach. Given the complex, multidimensional, and forward-looking nature of the research problem—which requires the integration of specialized knowledge from multiple domains (economic, technical, political, and social)—reliance solely on standard quantitative methods or historically based evidence was not feasible. Therefore, the research approach was grounded in a mixed-methods methodology, with its core phase based on the Delphi method. The Delphi method, as a structured technique for collecting and synthesizing group expert judgments, is considered an appropriate tool for addressing future uncertainties and achieving consensus among experts under conditions of uncertainty. The selection of this method is particularly essential in driver analysis studies, where the integration of qualitative and quantitative insights is required. The implementation process of the Delphi method in this study was designed and executed in three distinct and sequential phases, taking into account doctoral-level validation requirements, to ensure the rigor and reliability of the results.

The first phase was conducted with the objective of ensuring comprehensive coverage of the various domains influencing the development of an optimal exploitation model for oil and gas resources from a foresight perspective, as well as reducing the initial list of drivers to a manageable set for Delphi implementation. Prior to initiating this process, a systematic literature review was conducted on key sources related to oil and gas field development strategies, energy risk management, and consumption optimization. This review resulted in the extraction of 70 potential drivers. These drivers were identified through content analysis of key texts, technical reports of organizations, and upstream policy documents of Iran's national industry.

Table 2

Initial Drivers Extracted for Optimal Exploitation of Iran's Oil and Gas Resources (70 Drivers)

Index	Code	Category and Concept
Economic	q1	Investment and financial resource mobilization
	q2	Development of advanced technologies
	q3	Optimal management of natural resources
	q4	Improvement of energy infrastructure
	q5	Expansion of international cooperation
	q6	Reduction of dependency on oil resources
	q7	Increasing productivity and reducing waste in production processes
	q8	Creation of diverse domestic and international markets

	q9	Training and skill development of the workforce
	q10	Risk management and crisis conditions
Political	q11	Domestic political stability
	q12	Supportive policies for the oil and gas industry
	q13	Sanctions management and economic diplomacy
	q14	Development of relations with neighboring countries
	q15	Regulation of domestic pricing policies
	q16	Strengthening governance and transparency in the oil and gas industry
	q17	Establishment of legal mechanisms for attracting foreign investment
	q18	Energy diplomacy and expansion of export markets
	q19	Management of internal and ethnic conflicts
	q20	Structural reforms in the oil and gas industry
Science and Technology	q21	Advanced drilling and oil extraction technologies
	q22	Application of simulation and modeling technologies
	q23	Technologies for storage and recovery of associated gases
	q24	Application of digital technologies and artificial intelligence
	q25	Refining and conversion of oil into value-added products
	q26	Energy consumption reduction technologies in oil and gas processes
	q27	Development of smart energy transmission and storage technologies
	q28	Pollution reduction and environmental management technologies
	q29	Nanotechnology applications for reservoir productivity enhancement
	q30	Data management and big data analytics technologies
Laws and Regulations	q31	Reform and updating of oil and gas laws
	q32	Environmental legislation
	q33	Tax legislation and oil- and gas-based fiscal systems
	q34	Development and updating of incentive laws for foreign investment
	q35	Legislation on ownership and management of shared resources
	q36	Strengthening regulations related to Environmental Impact Assessment (EIA) processes
	q37	Establishment of transparent rules for agency arrangements and oil contracts
	q38	Strengthening occupational safety and health regulations
	q39	Legislation on the use of advanced technologies in extraction
	q40	Enforcement of anti-corruption laws and financial transparency
Social	q41	Public awareness and education
	q42	Recruiting professional employee
	q43	Growth and strengthening of local communities
	q44	Social collaboration and participation
	q45	Improvement of access to social services
	q46	Strengthening corporate social responsibility of oil companies
	q47	Support for the development of indigenous technologies
	q48	Strengthening international relations in the energy sector
	q49	Reduction of social and economic inequalities
	q50	Support for sustainable development and protection of future generations' rights
Institutional	q51	Strengthening and improving energy governance
	q52	Establishment of specialized financial institutions for oil project development
	q53	Strengthening supervisory and executive capacity of governmental institutions
	q54	Encouragement of foreign investment through institutional reforms
	q55	Establishment of independent institutions for evaluation and monitoring of oil contracts
	q56	Support for development and application of advanced technologies through research institutions
	q57	Reform and optimization of the tax structure in the oil industry
	q58	Establishment of legal and institutional frameworks for environmental risk management
	q59	Strengthening energy diplomacy and international partnerships
	q60	Establishment of legal institutions for managing national resources
Education and Research	q61	Development of specialized educational programs in the oil and gas industry
	q62	Support for applied research in the oil industry
	q63	Establishment of research and development centers in the oil and gas industry
	q64	Strengthening international cooperation in oil and gas research
	q65	Support for interdisciplinary studies in the oil industry
	q66	Encouragement of research on optimal utilization of gas resources
	q67	Organization of scientific and research competitions in the oil and gas sector
	q68	Training in project management skills in the oil and gas industry
	q69	Research on the use of advanced technologies and artificial intelligence
	q70	Education and promotion of a culture of conservation and management of natural resources

Following the initial extraction, the list of 70 drivers was subjected to qualitative screening to eliminate redundancies, irrelevant items, and infeasible factors. This screening was conducted by a group of three experts with more than 15 years of experience in the oil and gas industry. The refinement process was based on three key criteria: conceptual overlap (when two drivers represent different expressions of the same underlying force or phenomenon), causal commonality (when multiple drivers originate from a single causal source such as technology, investment, or policymaking), and analytical level with a forward-looking orientation (drivers must remain at a "strategic, future-shaping" level rather than at an operational or routine execution level). Through this qualitative refinement process, overlapping and repetitive elements were integrated via conceptual consolidation. The primary focus of these integrations was on intra-domain conceptual convergence (such as technological, institutional, and social domains) and the refinement of terminology based on scientific and practical standards. The outcome of this process was a final list of 31 key drivers across seven strategic domains, providing a comprehensive yet concise representation of the factors influencing the future of the country's oil and gas industry. This refined list served as the basis for the design of the second-round Delphi questionnaire and the analysis of cross-impacts in subsequent stages of the study. Furthermore, based on expert opinions, detailed and comparative proposals were developed for merging, improving terminology, and eliminating redundant or overlapping drivers. The 10 economic drivers (q1–q10), based on expert evaluations, were ultimately consolidated into 6 key drivers through integration and refinement.

Table 3

Economic Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q1, q5, q17 (from political)	Integrated into a comprehensive driver	"Development of domestic and international financial mechanisms for attracting investment and financing energy projects"
q2, q7	Integrated	"Application of advanced technologies to enhance productivity and reduce losses across the oil and gas value chain"
q3	Retained with revision	"Sustainable and optimal management of natural resources and hydrocarbon reserves"
q4, q8	Integrated	"Development of infrastructure and diversification of domestic and international energy markets"
q6	Retained (independent strategic identity)	"Reduction of fiscal and structural dependency on oil revenues"
q9	Transferred to education domain (overlaps with q61–q68)	—
q10	Retained	"Risk management and crisis conditions"

The 10 political drivers (q11–q20), based on expert evaluations, were ultimately consolidated into 4 final drivers through integration and refinement.

Table 4

Political Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q11, q19	Integrated	"Strengthening political and social stability and cohesion as a prerequisite for investment attraction and energy development"
q12, q15, q20	Strategic integration	"Reform of internal policies and structures governing the oil and gas industry"
q13, q18, q14	Integrated	"Energy diplomacy and sanctions management through the expansion of regional and international relations"
q16	Retained	"Transparency and good governance in the oil and gas industry"
q17	Transferred to economic domain	—

The 10 science and technology drivers (q21–q30), based on expert evaluations, were ultimately consolidated into 4 final drivers through integration and refinement.

Table 5

Technological Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q21, q29, q25	Integrated	"Extraction and productivity-enhancing technologies, including advanced drilling technologies, reservoir performance improvement, and high value-added production"
q22, q24, q30	Integrated	"Digitalization of the oil and gas industry through modeling, artificial intelligence, and big data"
q23, q26, q28	Integrated	"Energy and environmental management technologies, including storage, recovery, and pollution reduction across the energy cycle"
q27	Retained	"Development of smart energy transmission and storage technologies"

The 10 legal and regulatory drivers (q31–q40), based on expert evaluations, were ultimately consolidated into 5 final drivers through integration and refinement, with a focus on avoiding redundancy in regulatory dimensions.

Table 6

Legal and Regulatory Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q31, q35, q37	Integrated	"Updating oil and gas laws with emphasis on contract transparency and shared resources"
q32, q36, q38, q58 (from institutional)	Integrated	"Environmental legislation: strengthening legal frameworks for environmental protection and impact assessment"
q33, q57 (from institutional)	Integrated	"Optimization of taxation and incentive systems in the energy sector"
q34	Retained	"Incentive laws for foreign investment"
q39, q40	Integrated	"Regulation of advanced technologies and enforcement of financial transparency"

Based on expert evaluations, the 10 social drivers (q41–q50) contained considerable conceptual overlap and were therefore refined and consolidated into 3 primary drivers.

Table 7

Social Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q41, q42, q46	Transferred to education and research domain	"Human capital development and skill enhancement"
q43, q44, q49, q50	Integrated	"Sustainable development and corporate social responsibility of oil companies in local communities"
q47, q48	Integrated	"Strengthening international cooperation alongside the development of indigenous technologies"
q45	Retained	"Improvement of access to social services"

The institutional domain (q51–q60), consisting of 10 drivers, was consolidated into 4 final drivers due to extensive overlap, based on expert recommendations.

Table 8

Institutional Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q51, q52	Integrated	"Enhancement of institutional and financial governance in the energy sector"
q53, q55	Integrated	"Establishment of independent supervisory and evaluation institutions for oil contracts"
q54, q59, q60	Integrated	"Development of institutional frameworks for investment attraction and energy diplomacy"
q56	Retained	"Linkage between technology and research institutions"
q57, q58	Transferred to legal/environmental domain	—

The 10 drivers in the education and research domain (q61–q70), according to expert assessments, contained significant potential for consolidation and were therefore structured into 5 key drivers for the Delphi phase, focusing on major educational, research, and knowledge transfer axes.

Table 9

Key Education and Research Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources

Code	Status	Proposed Revision
q41, q42, q46	Integrated and transferred from social domain	"Human capital development and skill enhancement"
q61, q68, q70	Integrated	"Development of skill-based education systems and knowledge management in the oil and gas industry"
q62, q63, q69	Integrated	"Support for applied research based on advanced technologies and artificial intelligence"
q64, q65	Integrated	"Expansion of international and interdisciplinary scientific collaboration in the energy sector"
q66, q67	Integrated	"Promotion of research and innovation in optimal gas resource utilization"

The first Delphi phase was conducted with an emphasis on reducing redundancy and enhancing the conceptual clarity of the drivers, thereby minimizing divergence in expert evaluations. This approach redirected the analytical focus from purely operational policymaking toward the fundamental forces of change and aligned the study with an economic–Islamic foresight framework emphasizing four core principles: efficiency, justice, sustainability, and good governance. Consequently, the final prioritization assigns greater weight to strategic and future-shaping drivers and enables the systematic extraction of robust and meaningful key drivers influencing the optimal exploitation of Iran's oil and gas resources. The outcome of this phase was a refined list of 31 final key drivers across seven domains.

Table 10

Final Drivers Influencing Optimal Exploitation of Iran's Oil and Gas Resources After Refinement and Integration (Reduction from 70 to 31 Drivers)

Domain	Code	Final Driver After Refinement
Economic	ECO OPT1	"Development of domestic and international financial mechanisms for attracting investment and financing energy projects"
	ECO OPT2	"Application of advanced technologies to enhance productivity and reduce losses across the oil and gas value chain"
	ECO OPT3	"Sustainable and optimal management of natural resources and hydrocarbon reserves"
	ECO OPT4	"Development of infrastructure and diversification of domestic and international energy markets"
	ECO OPT5	"Reduction of fiscal and structural dependency on oil revenues"
	ECO OPT6	"Risk management and crisis conditions"
Political	GOV-OPT1	"Strengthening political and social stability and cohesion as a prerequisite for investment attraction and energy development"
	GOV-OPT2	"Reform of internal policies and structures governing the oil and gas industry"
	GOV-OPT3	"Energy diplomacy and sanctions management through the expansion of regional and international relations"
	GOV-OPT4	"Transparency and good governance in the oil and gas industry"
Science and Technology	TECH OPT1	"Extraction and productivity-enhancing technologies, including advanced drilling, reservoir performance enhancement, and high value-added production"
	TECH OPT2	"Digitalization of the oil and gas industry through modeling, artificial intelligence, and big data"
	TECH OPT3	"Energy and environmental management technologies, including storage, recovery, and pollution reduction across the energy cycle"
	TECH OPT4	"Development of smart energy transmission and storage technologies"
Laws and Regulations	REG OPT1	"Updating oil and gas laws with emphasis on contract transparency and shared resources"
	REG OPT2	"Environmental legislation: strengthening legal frameworks for environmental protection and impact assessment"
	REG OPT3	"Optimization of taxation and incentive systems in the energy sector"
	REG OPT4	"Incentive laws for foreign investment"
	REG OPT5	"Regulation of advanced technologies and enforcement of financial transparency"
Social	SOC-OPT1	"Sustainable development and corporate social responsibility of oil companies in local communities"
	SOC-OPT2	"Strengthening international cooperation alongside the development of indigenous technologies"
	SOC-OPT3	"Improvement of access to social services"
Institutional	INST OPT1	"Enhancement of institutional and financial governance in the energy sector"
	INST OPT2	"Establishment of independent supervisory and evaluation institutions for oil contracts"
	INST OPT3	"Development of institutional frameworks for investment attraction and energy diplomacy"
	INST OPT4	"Technology–research institution linkage"
Education and Research	EDUR OPT1	"Human capital development and skill enhancement"

	EDUR OPT2	"Development of skill-based education systems and knowledge management in the oil and gas industry"
	EDUR OPT3	"Support for applied research based on advanced technologies and artificial intelligence"
	EDUR OPT4	"Expansion of international and interdisciplinary scientific collaboration in the energy sector"
	EDUR OPT5	"Promotion of research and innovation in optimal gas resource utilization"

In this phase, an expert panel consisting of 25 specialists was employed to evaluate the strategic importance and likelihood of occurrence of each of the 31 final drivers. The Delphi rounds were designed using a systematic feedback mechanism and statistical measures of agreement (such as Kendall's coefficient of concordance) to reduce the dispersion of opinions and achieve an acceptable level of consensus.

Within the second Delphi phase, which focused on collecting expert judgments, the evaluation of energy sector drivers was conducted in the first round. Expert panel members assessed each driver based on two key criteria: (a) strategic importance and (b) likelihood of occurrence. To measure the degree of alignment and consensus among panel members, Kendall's rank correlation coefficient was employed as the primary statistical indicator. The calculated values of Kendall's coefficient for both criteria (0.313 and 0.349) were below the commonly accepted consensus threshold (typically considered 0.50), indicating a significant divergence of opinions and insufficient convergence among expert judgments in this round. According to the standard Delphi protocol, continuation of the process into a second round is necessary to ensure the validity and stability of the final results and to reduce the variance in perspectives. In the subsequent round, the frequency distributions and mean scores from the first round will be presented to the experts, enabling them to reconsider their responses in light of group feedback and move toward consensus.

Table 11

Results of the First Delphi Round for Strategic Importance and Likelihood of Occurrence of Drivers Influencing Optimal Oil and Gas Resource Exploitation in Iran

Domain	Driver	Strategic Importance (Mean)	SD	Likelihood (Mean)	SD
Economic	ECO OPT1	4.600	0.500	3.800	0.645
	ECO OPT2	4.520	0.586	3.960	0.676
	ECO OPT3	3.760	0.879	3.320	0.627
	ECO OPT4	3.960	0.539	3.280	0.542
	ECO OPT5	4.560	0.712	4.480	0.586
	ECO OPT6	4.400	0.645	3.120	0.833
Political	GOV-OPT1	4.720	0.542	4.520	0.653
	GOV-OPT2	4.440	0.651	3.040	0.735
	GOV-OPT3	4.720	0.458	4.040	0.735
	GOV-OPT4	4.600	0.500	3.680	0.557
Science and Technology	TECH OPT1	4.600	0.577	3.920	0.572
	TECH OPT2	4.680	0.476	4.280	0.678
	TECH OPT3	3.840	0.688	3.280	0.614
	TECH OPT4	3.680	0.900	2.960	0.790
Laws and Regulations	REG OPT1	3.960	0.611	3.720	0.614
	REG OPT2	3.320	0.557	2.760	0.723
	REG OPT3	3.840	0.624	3.040	0.935
	REG OPT4	4.040	0.676	3.840	0.554
	REG OPT5	4.000	0.816	3.600	0.645
Social	SOC-OPT1	3.880	0.781	3.760	0.597
	SOC-OPT2	3.600	0.500	2.920	0.909
	SOC-OPT3	3.400	0.500	2.760	0.779
Institutional	INST OPT1	4.480	0.586	3.840	0.624
	INST OPT2	3.600	0.500	3.720	0.614
	INST OPT3	4.280	0.678	3.760	0.523

	INST OPT4	4.000	0.764	2.800	0.957
Education and Research	EDUR OPT1	3.840	0.624	3.880	0.526
	EDUR OPT2	4.040	0.539	3.640	0.569
	EDUR OPT3	4.520	0.653	3.840	0.624
	EDUR OPT4	3.840	0.554	3.440	0.651
	EDUR OPT5	4.480	0.653	2.880	0.781
—	Kendall's Coefficient	0.313	—	0.349	—
—	Chi-square (p-value)	234.4 (p < 0.001)	—	261.8 (p < 0.001)	—

Following the implementation of the first Delphi round, which revealed the existence of initial disagreement among the experts (as reflected in Kendall's coefficient for both strategic importance and likelihood of occurrence), the process was resumed in the second round through the provision of collective feedback, including the mean scores of the panel's responses. The main objective of this stage was to guide expert judgments toward convergence and to achieve a stable level of consensus. The results obtained from the second round, as documented in the relevant tables, indicate a successful trend in reducing uncertainty. It was observed that the standard deviation for the assessment of all 31 drivers, across both dimensions of strategic importance and likelihood of occurrence, decreased substantially, demonstrating the effective influence of group feedback on the individual decision-making process of the experts. The final Kendall rank correlation statistics at the end of the second round also show a notable improvement in the level of collective agreement. Kendall's coefficient increased to 0.471 for strategic importance and to 0.494 for likelihood of occurrence. These figures are very close to the consensus acceptance threshold of 0.50 and differ substantially from the first-round results (0.313 for strategic importance and 0.349 for likelihood of occurrence), such that the improvement in the likelihood dimension reached the boundary of consensus. This considerable improvement indicates convergence of viewpoints and internalization of the collective findings by the expert panel. However, from the standpoint of rigorous Delphi methodology, which requires achieving the maximum possible level of rank-order alignment to finalize priorities, Kendall's coefficient for both criteria still remained slightly below the standard threshold. This remaining gap, although small, indicates that absolute consensus had not yet been fully achieved and that there was still some potential for final adjustment of opinions. Therefore, based on the scientific principles of the Delphi method, the implementation of a third round was deemed necessary in order to ensure the final validity and robustness of the prioritization of drivers in this study, stabilize the final rankings, and eliminate any remaining uncertainty.

Table 12

Results of the Second Delphi Round for the Strategic Importance and Likelihood of Occurrence of Drivers Influencing the Optimal Exploitation of Iran's Oil and Gas Resources

Domain	Driver	SD Round 1 (Strategic Importance)	Mean Round 2 (Strategic Importance)	SD Round 2 (Strategic Importance)	SD Round 1 (Likelihood)	Mean Round 2 (Likelihood)	SD Round 2 (Likelihood)
Economic	ECO OPT1	0.500	4.840	0.374	0.645	3.800	0.577
	ECO OPT2	0.586	4.760	0.436	0.676	3.960	0.539
	ECO OPT3	0.879	3.800	0.866	0.627	3.120	0.440
	ECO OPT4	0.539	4.000	0.408	0.542	3.280	0.458
	ECO OPT5	0.712	4.920	0.277	0.586	4.640	0.490
	ECO OPT6	0.645	4.640	0.490	0.833	3.160	0.800
Political	GOV-OPT1	0.542	4.920	0.277	0.653	4.800	0.408
	GOV-OPT2	0.651	4.720	0.542	0.735	3.120	0.781
	GOV-OPT3	0.458	4.840	0.374	0.735	4.120	0.726
	GOV-OPT4	0.500	4.720	0.458	0.557	3.720	0.542
Science and Technology	TECH OPT1	0.577	4.800	0.408	0.572	3.960	0.351

	TECH OPT2	0.476	4.920	0.277	0.678	4.400	0.645
	TECH OPT3	0.688	3.960	0.790	0.614	3.240	0.436
	TECH OPT4	0.900	3.880	0.833	0.790	2.840	0.624
Laws and Regulations	REG OPT1	0.611	4.120	0.440	0.614	3.680	0.476
	REG OPT2	0.557	3.600	0.577	0.723	2.680	0.627
	REG OPT3	0.624	4.080	0.493	0.935	2.960	0.790
	REG OPT4	0.676	4.280	0.458	0.554	3.800	0.408
	REG OPT5	0.816	4.160	0.800	0.645	3.640	0.490
Social	SOC-OPT1	0.781	4.120	0.781	0.597	3.760	0.436
	SOC-OPT2	0.500	3.720	0.458	0.909	2.880	0.833
	SOC-OPT3	0.500	3.520	0.510	0.779	2.680	0.627
Institutional	INST OPT1	0.586	4.800	0.408	0.624	3.760	0.523
	INST OPT2	0.500	3.720	0.458	0.614	3.720	0.458
	INST OPT3	0.678	4.400	0.645	0.523	3.840	0.473
	INST OPT4	0.764	4.160	0.746	0.957	2.800	0.816
Education and Research	EDUR OPT1	0.624	4.040	0.200	0.526	3.840	0.473
	EDUR OPT2	0.539	4.000	0.000	0.569	3.680	0.476
	EDUR OPT3	0.653	4.800	0.408	0.624	3.760	0.436
	EDUR OPT4	0.554	4.000	0.289	0.651	3.360	0.490
	EDUR OPT5	0.653	4.760	0.523	0.781	2.792	0.588
—	Kendall's coefficient	0.313	0.471	—	0.349	0.494	—
—	Chi-square statistic (p-value)	—	353.4 (p < 0.001)	—	—	335.4 (p < 0.001)	—

In the third stage of the Delphi method, the final questionnaire, including the reassessment of the two criteria of strategic importance and likelihood of occurrence for the key drivers influencing the optimal exploitation of Iran's oil and gas resources, was sent to the members of the expert panel. The purpose of this stage was to achieve the final level of consensus and confirm the stabilization of expert judgments, reflecting a gradual improvement in the degree of consistency among evaluations compared with previous rounds. Based on the statistical analysis of the data from this stage, the coefficient of concordance increased for both criteria and reached an acceptable level of consensus, such that the coefficient for strategic importance was 0.511 and for likelihood of occurrence was 0.527. These values exceeded the theoretically desirable threshold for consensus and indicate that the expected level of collective agreement among panel members was achieved. At the same time, examination of the standard deviations shows that the dispersion of opinions in this stage decreased relative to the second round; however, this decrease was relatively limited, and the growth in consensus was mainly observable at the level of final stabilization of the results. In other words, although Kendall's coefficient passed the threshold, the trend of improvement in expert agreement had reached saturation, and the changes compared with the previous round were minor. Therefore, based on these findings, it can be stated that additional Delphi rounds were no longer necessary and that the process of synthesizing expert opinions had concluded at a satisfactory level of convergence. Consequently, the output of the third round can be regarded as the final consensus of the expert panel, on the basis of which the key priorities identified for the optimal exploitation of Iran's oil and gas resources were stabilized and will be used for final analyses and the development of the study's scenarios.

Table 13

Results of the Third Delphi Round for the Strategic Importance and Likelihood of Occurrence of Drivers Influencing the Optimal Exploitation of Iran's Oil and Gas Resources

Domain	Driver	SD Round 1 (Strategic Importance)	SD Round 2 (Strategic Importance)	Mean Round 3 (Strategic Importance)	SD Round 3 (Strategic Importance)	SD Round 1 (Likelihood)	SD Round 2 (Likelihood)	Mean Round 3 (Likelihood)	SD Round 3 (Likelihood)
Economic	ECO OPT1	0.500	0.374	4.880	0.332	0.645	0.577	3.800	0.408
	ECO OPT2	0.586	0.436	4.800	0.408	0.676	0.539	3.960	0.351
	ECO OPT3	0.879	0.866	3.840	0.850	0.627	0.440	3.160	0.374
	ECO OPT4	0.539	0.408	4.080	0.277	0.542	0.458	3.320	0.476
	ECO OPT5	0.712	0.277	5.000	0.000	0.586	0.490	4.720	0.458
	ECO OPT6	0.645	0.490	4.640	0.490	0.833	0.800	3.160	0.800
Political	GOV-OPT1	0.542	0.277	4.960	0.200	0.653	0.408	4.800	0.408
	GOV-OPT2	0.651	0.542	4.760	0.523	0.735	0.781	3.120	0.781
	GOV-OPT3	0.458	0.374	4.880	0.332	0.735	0.726	4.160	0.746
	GOV-OPT4	0.500	0.458	4.760	0.436	0.557	0.542	3.760	0.523
Science and Technology	TECH OPT1	0.577	0.408	4.880	0.332	0.572	0.351	3.960	0.351
	TECH OPT2	0.476	0.277	4.920	0.277	0.678	0.645	4.400	0.645
	TECH OPT3	0.688	0.790	3.960	0.790	0.614	0.436	3.280	0.458
	TECH OPT4	0.900	0.833	3.880	0.833	0.790	0.624	2.840	0.624
Laws and Regulations	REG OPT1	0.611	0.440	4.160	0.374	0.614	0.476	3.760	0.436
	REG OPT2	0.557	0.577	3.640	0.569	0.723	0.627	2.640	0.569
	REG OPT3	0.624	0.493	4.160	0.374	0.935	0.790	2.960	0.790
	REG OPT4	0.676	0.458	4.280	0.458	0.554	0.408	3.840	0.374
	REG OPT5	0.816	0.800	4.160	0.800	0.645	0.490	3.640	0.490
Social	SOC-OPT1	0.781	0.781	4.120	0.781	0.597	0.436	3.760	0.436
	SOC-OPT2	0.500	0.458	3.720	0.458	0.909	0.833	2.880	0.833
	SOC-OPT3	0.500	0.510	3.600	0.500	0.779	0.627	2.680	0.627
Institutional	INST OPT1	0.586	0.408	4.840	0.374	0.624	0.523	3.800	0.500
	INST OPT2	0.500	0.458	3.720	0.458	0.614	0.458	3.760	0.436
	INST OPT3	0.678	0.645	4.440	0.651	0.523	0.473	3.880	0.440
	INST OPT4	0.764	0.746	4.160	0.746	0.957	0.816	2.840	0.850
Education and Research	EDUR OPT1	0.624	0.200	4.040	0.200	0.526	0.473	3.880	0.440
	EDUR OPT2	0.539	0.000	4.000	0.000	0.569	0.476	3.720	0.458
	EDUR OPT3	0.653	0.408	4.800	0.408	0.624	0.436	3.840	0.374
	EDUR OPT4	0.554	0.289	4.040	0.200	0.651	0.490	3.360	0.490
	EDUR OPT5	0.653	0.523	4.800	0.408	0.781	0.588	2.720	0.458
—	Kendall's coefficient	0.313	0.471	0.511	—	0.349	0.494	0.527	—
—	Chi-square statistic (p-value)	—	—	383.1 (p < 0.001)	—	—	—	395.3 (p < 0.001)	—

After the stabilization of expert judgments in the third round of the Delphi process, the resulting data from the mean scores of the two principal criteria—strategic importance and likelihood of occurrence—were aggregated using a weighted composite index. In this index, a weight of 0.60 was assigned to strategic importance and a weight of 0.40 to likelihood of occurrence, in order to place greater emphasis on long-term strategic priorities relative to short-term implementation considerations. The resulting calculations formed the basis for the final ranking of the drivers, and the outcomes are presented below.

Table 14

Third-Round Delphi Results for Strategic Importance and Likelihood of Occurrence of Drivers Influencing the Optimal Exploitation of Iran's Oil and Gas Resources

Domain	No.	Code	Mean Strategic Importance	Mean Likelihood of Occurrence	Weighted Composite Index	Priority
Economic	1	ECO OPT1	4.88	3.80	4.448	7
	2	ECO OPT2	4.80	3.96	4.464	6
	3	ECO OPT3	3.84	3.16	3.568	27
	4	ECO OPT4	4.08	3.32	3.776	21
	5	ECO OPT5	5.00	4.72	4.888	2
	6	ECO OPT6	4.64	3.16	4.048	14
Political	7	GOV-OPT1	4.96	4.80	4.896	1
	8	GOV-OPT2	4.76	3.12	4.104	12
	9	GOV-OPT3	4.88	4.16	4.592	4
	10	GOV-OPT4	4.76	3.76	4.360	10
Science and Technology	11	TECH OPT1	4.88	3.96	4.512	5
	12	TECH OPT2	4.92	4.40	4.712	3
	13	TECH OPT3	3.96	3.28	3.688	24
	14	TECH OPT4	3.88	2.84	3.464	28
Laws and Regulations	15	REG OPT1	4.16	3.76	4.000	15
	16	REG OPT2	3.64	2.64	3.240	30
	17	REG OPT3	4.16	2.96	3.680	25
	18	REG OPT4	4.28	3.84	4.104	13
	19	REG OPT5	4.16	3.64	3.952	19
Social	20	SOC-OPT1	4.12	3.76	3.976	16
	21	SOC-OPT2	3.72	2.88	3.384	29
	22	SOC-OPT3	3.60	2.68	3.232	31
Institutional	23	INST OPT1	4.84	3.80	4.424	8
	24	INST OPT2	3.72	3.76	3.736	23
	25	INST OPT3	4.44	3.88	4.216	11
	26	INST OPT4	4.16	2.84	3.632	26
Education and Research	27	EDUR OPT1	4.04	3.88	3.976	17
	28	EDUR OPT2	4.00	3.72	3.888	20
	29	EDUR OPT3	4.80	3.84	4.416	9
	30	EDUR OPT4	4.04	3.36	3.768	22
	31	EDUR OPT5	4.80	2.72	3.968	18

The results of the composite index calculation indicate that the highest levels of priority were assigned to drivers in the political and economic domains. At the top of the ranking, the driver GOV-OPT1, with an index value of 4.896, was identified as the first priority. This driver, titled "Strengthening political and social stability and cohesion as a prerequisite for investment attraction and energy development," reflects the critical role of political foundations in sustaining the country's capacity for energy resource exploitation. In the subsequent positions, the drivers ECO-OPT5 (reduction of fiscal and structural dependence on oil revenues) and TECH-OPT2 (digitalization of the oil and gas industry through artificial intelligence and big data) ranked second and third, with index values of 4.888 and 4.712, respectively, indicating the significance of financial and technological factors in achieving structural reforms in Iran's oil and gas industry.

Following these, GOV-OPT3 (energy diplomacy and sanctions management through the expansion of regional and international relations) and TECH-OPT1 (extraction and productivity-enhancing technologies) ranked fourth and fifth, reflecting the second strategic axis of national energy policy, namely international engagement and technological innovation. The remaining top drivers within the first ten priorities include ECO-OPT2, INST OPT1, ECO OPT1, EDUR OPT3, and GOV-OPT4, all of which are cross-organizational and cross-sectoral in nature and directly influence economic efficiency and governance. The mean score for strategic importance exceeds 4 in most domains, whereas the mean likelihood of occurrence generally fluctuates between 3 and 4. The economic, political, and technological domains achieved the highest composite index values, while the legal-regulatory and social domains received lower scores, suggesting that structural and social challenges have not yet received the same degree of expert attention as economic and technological issues.

The lowest-priority drivers include SOC-OPT3 (improvement of access to social services), REG-OPT2 (strengthening environmental legislation), and TECH OPT4 (development of smart storage technologies). Although these drivers remain substantively important, they were evaluated as having lower likelihoods of occurrence under current conditions. Overall, the highest-ranked drivers indicate that political stability, financial independence, digitalization, and technological innovation are perceived as the four principal pillars of optimal exploitation of Iran's oil and gas resources in the future outlook. The gradual increase in Kendall's coefficient to values above 0.50, together with the relative decline in the dispersion of opinions, further confirms the validity of the results at the level of expert consensus.

Discussion and Conclusion

The findings of this study provide a structured and empirically grounded prioritization of the key drivers influencing the optimal exploitation of Iran's oil and gas resources, revealing a clear hierarchy among political, economic, technological, institutional, regulatory, social, and educational dimensions. The results demonstrate that drivers associated with political stability and governance coherence—particularly GOV-OPT1—received the highest composite index values, indicating that experts perceive political and social stability as the most critical prerequisite for sustainable resource exploitation. This finding aligns with the broader literature emphasizing that energy systems are embedded within complex governance frameworks, where political stability and institutional reliability directly affect investment flows, technological access, and operational continuity [1]. Moreover, the centrality of geopolitical dynamics in shaping energy sector outcomes has been consistently highlighted, particularly in contexts such as Iran where sanctions, diplomatic relations, and regional alignments strongly influence production capabilities and export potential [7, 26]. The prominence of this driver thus reflects a structural reality: without stable governance and cohesive socio-political conditions, even resource-rich systems cannot achieve optimal exploitation.

The second major cluster of high-priority drivers is located in the economic domain, with ECO-OPT5—reduction of fiscal and structural dependence on oil revenues—ranking among the top priorities. This result suggests that experts recognize the paradox inherent in oil-dependent economies, where excessive reliance on hydrocarbon revenues can undermine long-term sustainability and strategic flexibility. The literature on energy economics and policy supports this interpretation, showing that diversification and prudent fiscal management are essential for stabilizing resource-based economies and reducing vulnerability to price volatility [2, 3]. Additionally, the need for efficient resource allocation and subsidy optimization has been emphasized as a key factor in ensuring balanced sectoral development and preventing structural inefficiencies [11]. In the Iranian context, where budgetary dependence on oil revenues remains significant, this finding underscores the importance of reforming fiscal structures and enhancing resilience through diversification strategies.

Technological drivers also occupy a prominent position in the ranking, particularly TECH-OPT2 and TECH-OPT1, which highlight the importance of digitalization, artificial intelligence, and advanced extraction technologies. The high prioritization of these drivers reflects the growing recognition that technological capability is no longer a secondary enabler but a central determinant of efficiency, cost optimization, and environmental performance in the oil and gas sector. Previous studies have shown that advancements in reservoir modeling, data analytics, and intelligent systems significantly enhance production efficiency and decision accuracy [18]. Furthermore, emerging research on machine learning and advanced geomodeling indicates that technological innovation is increasingly linked to sustainability outcomes, including carbon management and resource optimization [20]. The findings of this study are therefore consistent with the broader transition toward technology-driven energy systems, where digital transformation plays a critical role in shaping future competitiveness.

Another important result concerns the role of energy diplomacy and international engagement, represented by GOV-OPT3, which ranks among the top drivers. This finding reflects the importance of external relations in facilitating access to markets, capital, and technology, particularly under conditions of geopolitical constraint. The literature on energy geopolitics highlights that oil and gas are deeply intertwined with diplomatic strategies, and that countries must actively manage international relationships to secure their position in global energy networks [26]. In the case of Iran, where sanctions and political tensions have historically limited external engagement, the emphasis on energy diplomacy indicates a recognition among experts that international cooperation and regional integration are essential for overcoming structural barriers and enhancing exploitation capacity [7].

Institutional drivers also emerged as significant, particularly INST OPT1 and INST OPT3, which relate to governance quality, regulatory coherence, and the creation of frameworks for investment and energy diplomacy. These findings are consistent with research emphasizing the importance of institutional capacity and regulatory effectiveness in managing complex resource sectors. Strong institutions facilitate coordination, reduce uncertainty, and enable the implementation of long-term strategies, while weak institutions can lead to inefficiencies, corruption, and policy inconsistency [30]. In addition, studies on strategic decision-making in shared oil and gas fields have demonstrated that institutional frameworks are critical for balancing legal, economic, and environmental considerations [31]. The prominence of institutional drivers in this study thus reinforces the view that governance quality is a fundamental determinant of resource exploitation outcomes.

In contrast, drivers related to legal-regulatory frameworks and social dimensions received relatively lower priority scores, particularly REG-OPT2 and SOC-OPT3. While these factors are undeniably important, their lower ranking suggests that experts perceive them as secondary constraints rather than primary drivers under current conditions. This does not imply that environmental regulation or social development are unimportant; rather, it reflects a prioritization logic in which immediate structural and strategic challenges—such as political stability, financial reform, and technological advancement—take precedence. Nevertheless, the literature indicates that environmental governance and social responsibility are increasingly central to the long-term legitimacy and sustainability of energy projects [21, 23]. Therefore, the relatively lower prioritization of these drivers may point to a gap between current expert perceptions and emerging global trends, suggesting an area for future policy attention.

The findings also reveal a notable pattern in the relationship between strategic importance and likelihood of occurrence. While most drivers scored highly in terms of strategic importance, their likelihood of occurrence was generally lower, indicating a perceived gap between desired strategic outcomes and practical feasibility. This divergence reflects the structural constraints facing Iran's oil and gas sector, including financial limitations, technological gaps, and geopolitical pressures. Similar discrepancies have been observed in other studies of energy systems, where long-term strategic goals often exceed the immediate capacity for implementation due to institutional and environmental constraints [9, 10]. The weighted composite index used in this study effectively captures this tension by emphasizing strategic importance while still accounting for feasibility considerations, thereby providing a balanced framework for prioritization.

From a methodological perspective, the use of the Delphi technique enabled the systematic aggregation of expert knowledge and the reduction of opinion variance across iterative rounds. The increase in Kendall's coefficient and the convergence of expert judgments indicate that the process successfully achieved a meaningful level of consensus. This outcome is consistent with previous applications of Delphi in complex strategic contexts, where expert-driven approaches are particularly valuable for identifying and prioritizing uncertain and multidimensional drivers [5, 6]. By combining qualitative expert insight with quantitative aggregation, the study offers a robust and context-sensitive framework for understanding the future of oil and gas exploitation.

Overall, the results of this study suggest that the optimal exploitation of Iran's oil and gas resources depends on a set of interrelated drivers that extend beyond traditional operational considerations. Political stability, financial independence, technological innovation, institutional capacity, and international engagement emerge as the core pillars of future strategy. These findings are consistent with the broader literature on energy systems, which emphasizes the need for integrated, adaptive, and forward-looking approaches to resource management [1, 2]. At the same time, the study highlights the importance of prioritization, showing that not all drivers carry equal weight and that strategic focus must be directed toward those factors with the greatest impact on long-term outcomes.

The limitations of this study primarily relate to the inherent constraints of the Delphi method and the context-specific nature of the findings. Although the use of expert judgment provides valuable insights, it also introduces the possibility of subjective bias, particularly in the selection of experts and the interpretation of qualitative inputs. Additionally, the sample size, while sufficient for Delphi analysis, may limit the generalizability of the results to broader populations or different geopolitical contexts. The study is also constrained by the dynamic nature of the oil and gas sector, where rapid changes in technology, policy, and global markets may alter the relevance of identified drivers over time. Furthermore, the reliance on self-reported assessments of likelihood and importance may not fully capture the complex interactions between drivers, suggesting the need for complementary analytical approaches.

Future research should build on the findings of this study by employing mixed-method approaches that integrate Delphi results with quantitative modeling techniques such as system dynamics, structural equation modeling, or scenario simulation. Expanding the scope of analysis to include comparative studies across different countries or regions could provide additional insights into the contextual variability of key drivers. Longitudinal studies examining how driver priorities evolve over time would also be valuable for understanding the dynamic nature of energy systems. In addition, future research should explore the interactions between drivers in greater detail, particularly the feedback loops between political, economic, and technological factors. Incorporating perspectives from a wider range of stakeholders, including policymakers, industry practitioners, and civil society actors, could further enhance the comprehensiveness and applicability of the findings.

From a practical perspective, the results of this study offer several important implications for policymakers and industry stakeholders. Strategic planning in the oil and gas sector should prioritize the strengthening of political stability and governance coherence as foundational conditions for investment and development. Efforts to reduce fiscal dependence on oil revenues should be accelerated through diversification strategies and financial reforms. Investment in technological innovation, particularly in digitalization and advanced extraction methods, should be treated as a strategic priority rather than an optional enhancement. Institutional capacity building and regulatory reform are also essential for creating an enabling environment for sustainable exploitation. Finally, greater emphasis should be placed on energy diplomacy and international engagement as mechanisms for overcoming external constraints and enhancing sectoral resilience.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Written consent was obtained from all participants in the study.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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