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Applying the Infrastructure and Projects Authority Reference Roadmap Model to Diagnose the Project Management System in Iran's Oil and Gas Projects

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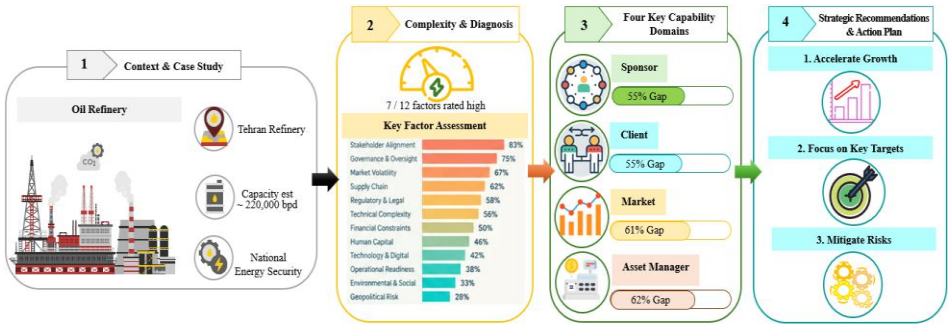
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A B S T R A C T

The oil and gas industry is a main pillar of Iran's economy, yet project failures impose heavy financial and operational losses. Therefore, diagnosing project management systems in this sector is critically important. This study aims to diagnose Iran's oil and gas project management using the Infrastructure and Projects Authority (IPA) reference roadmap model. This applied, descriptive-analytical research was conducted as a case study on a Tehran Refinery project. Data were collected through complexity and capability assessment questionnaires and semi-structured interviews with 16 project experts, then analyzed via the model's ten-step process. Findings reveal high project complexity, with 7 out of 12 complexity factors rated as "high." The current status across all four capability domains sponsor, client, market, and asset manager is significantly distant from the ideal state, with limiting characteristics comprising 55%, 55%, 61%, and 62% respectively. Gap analysis identified the risk management module (sponsor and client domains), procurement module (market domain), and governance module (asset manager domain) as the worst-performing areas. In accordance with model standards, targeted recommendations were developed to bridge these capability gaps, and actionable implementation plans were prepared. As the first application of the IPA reference roadmap model in Iran's oil and gas industry, this research provides a systematic, evidence-based diagnostic framework for large and complex projects, offering practical insights for managers and policymakers to enhance project success rates and reduce national economic losses.



1. Introduction

The oil and gas industry, as one of the main pillars of Iran's economy, plays a decisive role in providing national income and developing the country's infrastructure. With 209 billion barrels of oil reserves, Iran ranks third in the world after Venezuela and Saudi Arabia, and in terms of natural gas reserves, it is the second country in the world after Russia [1,2]. Considering these massive reserves, the activities of Iran's oil and gas industry will continue for decades to come, and numerous projects in the fields of exploration, production, refining, and transportation are under execution or planning. On the other hand, OPEC has estimated the required investment in this industry to be around $10 trillion by 2040, which doubles the intensification of the competitive environment and the necessity of improving productivity in project execution [3]. Projects in the oil and gas industry are inherently large-scale, complex, and expensive, and managing them requires coordination among multiple stakeholders, advanced technologies, and extensive supply chains. Research shows that about 78% of oil and gas projects face problems such as schedule delays and cost overruns [4]. These problems are mainly caused by the inaccurate definition of the project in the initial stages, weak risk management, insufficient documentation, a lack of skilled workforce, and inefficiency in communication between stakeholders [5-7]. External factors such as oil price fluctuations and unstable political and economic conditions also affect the performance of these projects [7]. Therefore, recognizing the existing challenges in the project management system of this industry and systematically diagnosing it not only prevents large financial losses but also paves the way for enhancing the competitiveness of Iran's oil and gas industry

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on the international stage. Organizational and project pathology is defined as a systematic process for identifying existing problems, analyzing the gap between current and desired performance, and providing practical solutions to improve productivity [8]. In project management, pathology helps managers identify the strengths and weaknesses of the management system and, by learning from past experiences, prevent the repetition of similar mistakes in future projects [9]. The effective establishment of management systems, such as the project management system in project-based organizations, depends on meeting software and hardware requirements and accurately understanding the current situation [10]. Despite the importance of this issue, a review of the research background shows that most studies conducted in Iran have focused on organizational pathology using models such as EFQM, BSC, and Weisbord's Six-Box Model [3,11], and the pathology of the project management system, especially in the oil and gas industry, using structured and international standard models has received less attention. The Infrastructure and Projects Authority (IPA) Project Routemap model was developed by the UK government's Infrastructure and Projects Authority and is considered a structured and tested method for setting up large and complex projects for success [5]. Since the publication of its first version in 2014, this model has been used in many of the largest and most complex projects in the UK and has recently been applied to international projects [12]. The second version of this model was published in 2021 and includes a ten-step process that identifies capability gaps and provides operational recommendations to cover them by assessing complexity (with 12 factors) and assessing capability (in four domains: sponsor, client, market, and asset manager). The main advantage of this model over other pathology models is its simultaneous coverage of the entire project system (from the financial sponsor to the supply chain and asset managers), providing tangible lessons learned from previous projects, and creating a common language for stakeholders [5,13-15]. Despite the successful applications of this model in international projects, no research has been conducted in Iran's oil and gas industry using the IPA Project Routemap model. This research gap exists while the complexity and scale of Iran's oil and gas projects make the application of such a comprehensive model essential. Therefore, the aim of the present research is to diagnose the project management system in one of the Tehran Refinery projects using the Infrastructure and Projects Authority (IPA) Project Routemap model (Version 2, 2021). In line with this objective, the main research questions are: (1) How can a project be diagnosed using the IPA Project Routemap model? (2) What factors determine project complexity, and what is the status of the capabilities of the project's key stakeholders? and (3) What are the most important capability gaps and operational recommendations to cover them?

Organizational and project diagnosis (pathology) is a systematic process for identifying existing problems, analyzing the gap between current and desired performance, and providing practical solutions to enhance productivity [9, 16]. In large and complex projects, diagnosis serves as a critical tool for assessing risks, anticipating challenges, and preventing the repetition of past failures [17]. The importance of this process is magnified in the oil and gas industry; projects in this sector are inherently complex, capital-intensive, and involve multiple stakeholders, while being heavily influenced by factors such as oil price fluctuations, unstable political and economic conditions, technical challenges, and risk management [6, 18, 19]. Studies indicate that identifying internal and external factors affecting projects, selecting appropriate contractors, and fostering a collaborative culture among teams are key factors in improving the performance of these projects [19-21].

In the literature of project and organizational management, numerous models have been developed for diagnosis. Models such as SWOT analysis, Balanced Scorecard (BSC), European Foundation for Quality Management (EFQM), McKinsey 7S, and Weisbord's Six-Box Model have each analyzed organizations from various perspectives [22,23]. However, most of these models are designed for organizational-level diagnosis and lack sufficient coverage for large, complex projects with multiple stakeholders. Table 1 provides a comparison of widely used diagnosis models.

Table 1. Comparison of Common Diagnosis Models

Model	Level of Analysis	Main Focus	Strengths	Limitations in Large Projects
SWOT	Organization	Internal and external environment	Simplicity and comprehensiveness	Lacks an executive process framework
EFQM	Organization	Excellence and continuous improvement	Standardized structure	Heavy and complex implementation
BSC	Organization	Four perspectives: financial, customer, process, learning	Balanced perspective	Lack of focus on project specifics
McKinsey 7S	Organization	Seven key organizational elements	Holistic view	Complexity in practical analysis
Weisbord's Six-Box	Organization	Six organizational domains	Identifies hidden issues	Limited application in project environments
IPA Routemap	Project	4 capability domains + 12 complexity factors	Structured, lessons from mega-projects, covers the entire project system	Highly specialized for large/mega projects

Source: Research Findings

The Project Routemap model was developed by the UK Government's Infrastructure and Projects Authority (IPA) in collaboration with industry and academia [24]. It is a structured and tested method for setting up large and complex projects for success. Since the publication of its first version in 2014, it has been applied to many of the UK's largest and most complex projects, and recently to international projects [25]. The second version of the model was published in 2021, based on the collective experience of public and private sector projects in infrastructure and defense. The structure of this model is based on three main pillars:

(a) Complexity Assessment

This assessment measures 12 key factors, which are recurring predictors of project success, across three levels: "Low", "Medium", and "High". These factors include: strategic importance, stakeholders and influencers, articulation of requirements and benefits, stability of the overall context, financial impact and value for money, delivery complexity (including technology), interfaces and relationships, range of disciplines and skills, dependencies, extent of change, organizational capability (performance to date), and understanding of linkages.

(b) Capability Assessment

This assessment evaluates the capability of four key domains of responsibility in the project:

- Sponsor: The organization that initiates and funds the project.
- Client: The organization responsible for delivering the project.
- Market: The supply chain and providers of goods and services.
- Asset Manager: The organization responsible for operating and maintaining the asset post-delivery. Each capability domain is assessed using three levels of characteristics (Limiting, Sufficient, and Optimized), and the gap between the current and desired state is identified.

(c) Eight Specialized Modules

The model includes eight independent modules that provide practical recommendations to cover capability gaps: (1) Requirements, (2) Governance, (3) Systems Integration, (4) Organizational Design & Development, (5) Procurement, (6) Risk Management, (7) Asset Management, and (8) Delivery Planning. Each module has specific pillars and operational considerations.



Figure 1. Modules of the IPA Reference Roadmap Model

Source: Research Findings

In recent years, numerous studies have been conducted in the field of project diagnosis and the application of various models. Purwanto and Iqbal [12] researched the Gedebage-Tasikmalaya-Cilacap toll road project in Indonesia using the Project Routemap model. Their results showed that the project was highly complex, and while stakeholder capabilities were generally adequate, areas for improvement were identified in six domains. This is one of the few direct studies applying the IPA model to a mega-infrastructure project. Reezigt and Boonstra [16] proposed a "Complexity-Predictability Project Diagnosis" model to help project managers understand different project management approaches. Their model evaluates three aspects project content, internal context, and external context across the dimensions of complexity and predictability, serving as a tool to identify risks and propose mitigation measures. In the context of oil and gas projects, Kassem [18] utilized Structural Equation Modeling (PLS-SEM) to assess risk management in oil and gas construction projects, demonstrating that risk management significantly impacts project success. Elhoush and Kulatunga [6] studied the Libyan oil

industry, highlighting poor stakeholder communication and lack of clarity in early stages as major challenges. Tsiglianu et al. [7] also presented a conceptual framework for managing oil and gas engineering projects, emphasizing the need for specialized approaches in this industry [26].

In Iran, Zarei and Chaghouei [26] used the PMBOK standard and the Delphi method to diagnose the Iran Water and Power Resources Development Company, identifying main issues in strategy, systems, structure, personnel, and processes. Atafar and Eghbali [22] investigated delay factors in the Iranian Gas Transmission Company (Region 3), identifying contractor underperformance and lack of accountability as the most critical factors. Ranjbar et al. [9] conducted a pathology of the project management system to increase productivity, prioritizing the improvement of periodic control reports and communication. Jalilizadeh and Nadershahi [24] examined the causes of delay in the Islamabad-e Gharb petrochemical projects, identifying employer payment delays and lack of construction technology as the most impactful factors.

Despite the importance of diagnosis in large and complex projects, a review of the literature reveals that:

1. Most studies conducted in Iran have focused on organizational models like EFQM, BSC, and Weisbord, with less attention paid to specialized project management diagnosis models [20-23].
2. Research in the oil and gas industry has primarily focused on isolated factors such as delay causes or risk management [6, 18, 22, 24], rather than adopting a comprehensive and systematic approach to diagnosing the entire project management system [28].
3. The IPA Reference Roadmap model, despite its successful applications in international projects [29], has never been applied in Iran's oil and gas industry.

Therefore, to fill this research gap, the present study applies the IPA Reference Roadmap Model (Version 2, 2021) to diagnose the project management system in a Tehran Refinery project. This research represents the first application of this model in Iran's oil and gas industry and is expected to provide a systematic framework for diagnosing mega-projects for managers and policymakers in this sector.

2. Materials and Methods

The present study is applied in terms of purpose and descriptive-analytical in terms of data collection, employing a mixed-methods (qualitative-quantitative) approach [29]. The research was conducted as a case study on one of the active projects at Tehran Refinery. The mixed-methods approach was selected because the IPA Reference Roadmap model utilizes both quantitative tools (standardized questionnaires with three-level scales) and qualitative tools (semi-structured interviews with experts) for data collection and analysis. The temporal scope of the research is the Iranian calendar year (Data were collected during 2024–2025). The statistical population of this study comprised experts and decision-makers from one of the active projects at Tehran Refinery. Given the specialized nature of the research and the necessity for participants to have in-depth familiarity with project management processes in the oil and gas industry, purposive sampling was employed. The selection criteria for experts included: (1) having a minimum of work experience in oil and gas projects, (2) familiarity with project management processes, and (3) willingness to participate in the evaluation process. A total of 16 project experts, working at managerial and specialist levels, were selected as the final sample. This number of participants is sufficient for implementing the IPA Reference Roadmap model, which is based on expert judgment [27].



Figure 2. Steps of the IPA Reference Roadmap Model

Source: Research Findings

The demographic characteristics of the participants are presented in Table 2.

Table 2. Demographic Characteristics of Research Participants

Characteristic	Category	Frequency	Percentage
Gender	Male	13	81
	Female	3	19
Age	Under 30	6	38
	30-40	5	31
	40-50	4	25
	Above 50	1	6

Source: Research Findings

Three main instruments were used for data collection:

(a) Complexity Assessment Questionnaire

This standardized questionnaire from the IPA Reference Roadmap model evaluates 12 key factors of project complexity across three levels: "Low," "Medium," and "High" [27]. These 12 factors include strategic importance, stakeholders and influencers, articulation of requirements and benefits, stability of the overall context, financial impact and value for money, delivery complexity (including technology), interfaces and relationships, range of disciplines and skills, dependencies, extent of change, organizational capability (performance to date), and understanding of linkages. Evidence has shown that these 12 factors are recurring predictors of project success [30].

(b) Capability Assessment Questionnaire

This standardized questionnaire evaluates the capability of four key project domains (sponsor, client, market, and asset manager) using a set of observable characteristics at three levels: "Limiting (Type 1)" characteristics that hold the organization back, "Sufficient (Type 2)" characteristics of organizations with acceptable performance, and "Optimized (Type 3)" characteristics of effective and efficient organizations [27]. Each participant specified the "current" and "required" status of the project for each characteristic.

(c) Semi-Structured Interviews

To examine questionnaire responses in greater depth and obtain supplementary information, semi-structured interviews were conducted with participants. This type of interview is suitable for exploring complex and sensitive project issues due to its flexibility in protocol and the possibility of raising new questions based on interviewees' responses.

The validity of the instruments was confirmed through expert opinions and alignment with the official IPA model handbook (Version 2, 2021) [27]. Reliability was ensured by achieving consensus among expert responses (more than 60% agreement in most cases) [30,31].

This research was conducted based on the standard ten-step process of the IPA Reference Roadmap model [27]. Figure 2 visually illustrates these steps, and each step is briefly described below:

- Step 1- Should the Routemap be applied? Using two standard checklists of the model, the necessity and appropriate approach for applying the model to the studied project were determined. Based on the project manager's responses to the second checklist (answering "No" to 6 out of 8 propositions), the "Full Project Review" approach was selected.
- Step 2- When should the Routemap be applied? Through an interview with the project manager, it was determined that the project was at the "Full Business Case" stage, which, according to the model standard, is an appropriate time for diagnosis.
- Steps 3 and 4- Developing the strategy and planning implementation: The scope of the model, participants (16 experts), and instruments (complexity and capability assessment questionnaires, interviews) were specified, and the implementation schedule was determined.
- Step 5- Information collection: First, the model and its steps were explained to participants, then the complexity and capability assessment questionnaires were distributed, and supplementary interviews were conducted.
- Step 6- Gap analysis: The collected data were compiled, reviewed, and analyzed to identify capability gaps between the current and desired states, and critical modules were identified.
- Step 7- Validating findings: The proposed findings were shared with the project manager and participants, and their accuracy was confirmed.
- Step 8- Providing recommendations: For modules with the worst performance, recommendations were developed based on the model standard and lessons learned from previous projects.
- Step 9- Action planning: For the implementation of each recommendation, a detailed operational plan was prepared.
- Step 10 - Integrating improvement plans: The findings and recommendations were communicated to project members and the project manager to be integrated into the project's future planning.

The quantitative data from the questionnaires were analyzed using the Gap Analysis method. For complexity assessment, according to the model standard, the final complexity of each factor was determined based on the highest frequency (maximum) among the three levels of Low, Medium, and High. The overall

project complexity was also determined based on the highest frequency among the 12 factors. For capability assessment, the share of limiting characteristics (Type 1) in each domain was calculated, and the gap between the "current" and "required" states was analyzed. Finally, critical modules in each domain were identified, and appropriate recommendations were developed.

3. Results and Discussion

3.1. Complexity Assessment Results

In the fifth step of the model process, after fully explaining the model and its elements to the participants, the complexity assessment questionnaire was distributed. The results of assessing the 12 complexity factors are presented in Table 3.

Table 3. Project Complexity Assessment Results

No.	Complexity Factor	Low	Medium	High	Final Level
1	Strategic importance	1	7	8	High
2	Stakeholders / Influencers	1	3	12	High
3	Articulation of requirements and benefits	7	6	3	Low
4	Stability of the overall context	3	4	9	High
5	Financial impact and value for money	0	2	14	High
6	Delivery complexity (including technology)	1	10	5	Medium
7	Interfaces / Relationships	1	6	9	High
8	Range of disciplines and skills	1	7	8	High
9	Dependencies	0	8	8	High
10	Extent of change	9	5	2	Low
11	Organizational capability: performance to date	3	9	4	Medium
12	Understanding of linkages	7	6	3	Low

Source: Research Findings

According to the IPA Reference Roadmap model standard [22], the final complexity of each factor is determined based on the highest frequency (maximum) among the three levels of Low, Medium, and High. As shown in Table 3, out of 12 complexity factors, 7 factors are at the "High" level, 2 factors at the "Medium" level, and 3 factors at the "Low" level. Therefore, the overall project complexity was assessed as "High." The factors with the highest complexity levels were: Financial impact and value for money (14 out of 16 votes), Stakeholders and influencers (12 votes), Stability of the overall context (9 votes), Interfaces and relationships (9 votes), and Strategic importance, Range of disciplines and skills, and Dependencies (each with 8 votes). This finding indicates that the studied project faces serious challenges in terms of financial aspects, multiple stakeholders, environmental instability, and inter-project dependencies.

Subsequently, the capability assessment questionnaire was distributed across the four domains of sponsor, client, market, and asset manager. Each domain included characteristics at three levels: "Limiting (Type 1)," "Sufficient (Type 2)," and "Optimized (Type 3)." Participants specified the "current" and "required" status of the project for each characteristic. A summary of the capability assessment results is presented in Table 4.

Table 4. Summary of Capability Assessment Results Across the Four Project Domains

Capability Domain	Number of Type 1 (Limiting) Propositions	Total Current Responses	Percentage of Limiting Characteristics (Current)	Percentage of Limiting Characteristics (Required)	Gap
Sponsor	20	177	55%	57%	Small
Client	14	123	55%	54%	Very Small
Market	13	127	61%	63%	Small
Asset Manager	16	127	62%	60%	Very Small

Source: Research Findings

As shown in Table 4, in all four capability domains, the percentage of limiting characteristics (Type 1) in the current status is above 50%. This means that more than half of the decision-makers observed characteristics that hinder project success in the current state. Specifically:

- In the Sponsor domain, 55% of decision-makers observed limiting characteristics. This does not indicate a good current status for the project. The required (ideal) percentage is 57%, indicating a small gap between the current and desired state.
- In the Client domain, 55% of decision-makers observed limiting characteristics. The required percentage is 54%, indicating a very small gap.
- In the Market domain, 61% of decision-makers observed limiting characteristics, which is worse than the sponsor and client domains. The required percentage is 63%, and the gap is small.
- In the Asset Manager domain, 62% of decision-makers observed limiting characteristics, indicating the worst status among the four domains. The required percentage is 60%, and the gap is very small.

3.2. Gap Analysis and Identification of Critical Modules

After conducting the complexity and capability assessments, the sixth step of the model process (gap analysis) was performed. Figure 3 shows the gap analysis chart.

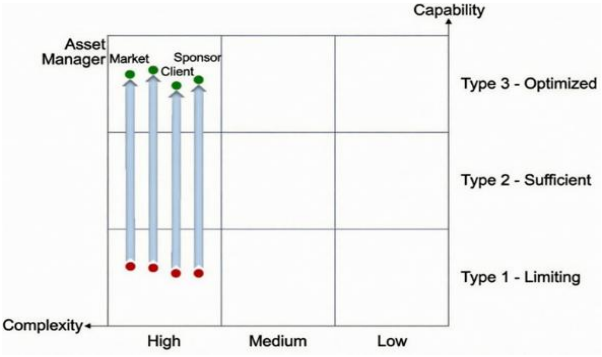


Figure 3. Gap Analysis Chart

Source: Research Findings

According to Figure 3, the overall capability gap of the project is significant, and the project complexity is also high. Subsequently, for each capability domain, the Type 1 (limiting) propositions that were confirmed by more than one-third of respondents were analyzed to determine which module had the most limiting characteristics. The results of this analysis are presented in Table 5.

Table 5. Critical Modules Identified in Each Capability Domain

Capability Domain	Critical Module	Number of Highlighted Limiting Propositions
Sponsor	Risk Management	5
Client	Risk Management	3
Market	Procurement	6
Asset Manager	Governance	3

Source: Research Findings

As shown in Table 5, the Risk Management module in the sponsor and client domains, the Procurement module in the market domain, and the Governance module in the asset manager domain were identified as critical modules. These modules had the most limiting characteristics and require special attention and corrective actions.

3.3. Key Findings in Each Capability Domain

In the following, the key findings (highlighted limiting propositions) in each capability domain are presented in detail.

Table 6. Key Findings in the Sponsor Domain (Risk Management Module)

Finding	Module	Confirmations (out of 16)
The approach to infrastructure investment is reactive rather than based on a long-term plan	Risk Management	9
Alternative solutions are not sufficiently considered	Risk Management	10
Little or no attention is paid to the project sustainability strategy or consensus on sustainability standards, climate risks, or net zero targets	Risk Management	12
Risk is not allocated to the party best able to manage it	Risk Management	8
Development and retention of sponsor project capability is weak	Risk Management	10

Source: Research Findings

Table 7. Key Findings in the Client Domain (Risk Management Module)

Finding	Module	Confirmations (out of 16)
Risk management is compromised by its reactive nature, blame culture, and inappropriate risk allocation	Risk Management	9
There is a highly risk-averse approach that does not take market capability into account	Risk Management	14
The project has not adequately allowed for optimism bias	Risk Management	8

Source: Research Findings

Table 8. Key Findings in the Market Domain (Procurement Module)

Finding	Module	Confirmations (out of 16)

The market is either highly consolidated or extremely fragmented, comprising many small organizations	Procurement	13
Work is normally awarded based on lowest price	Procurement	10
Suppliers do not understand the client business and therefore cannot offer business-oriented solutions	Procurement	13
The supply chain is hierarchical with highly transactional behavior, imposing inappropriate terms on sub-tier suppliers	Procurement	9
Supplier subcontracts have no regard for local employment or social value objectives	Procurement	13
Contract incentives appear misaligned with sponsor's requirements or client model	Procurement	11

Source: Research Findings

Table 9. Key Findings in the Asset Manager Domain (Governance Module)

Finding	Module	Confirmations (out of 16)
Decision-making mechanisms (planning, investment, and operational) fail to consider the whole asset life and value	Governance	8
Poor decision-making, governance structures, and processes undermine asset management plans	Governance	11
It is unclear who is accountable for making key decisions	Governance	7

Source: Research Findings

3.4. Validation of Findings and Development of Recommendations

After conducting the gap analysis and identifying key findings, according to the seventh step of the model process, the findings were shared with the project manager and participants, and their accuracy was confirmed. Then, in the eighth step, recommendations were developed for the identified critical modules based on the model standard and lessons learned from previous projects. A summary of the main recommendations is presented in Table 10.

Table 10. Main Recommendations for Covering Capability Gaps

Capability Domain	Critical Module	Main Recommendations
Sponsor	Risk Management	Reform and develop the organization's risk management plan; hold risk identification training workshops; develop risk control and monitoring guidelines
Client	Risk Management	Develop the risk management plan; adopt a proactive rather than reactive approach; identify and manage opportunities alongside threats
Market	Procurement	Develop the procurement management plan; draft transaction regulations; develop engineering procurement and sourcing guidelines; specify procurement control and monitoring procedures
Asset Manager	Governance	Use the RACI matrix for responsibilities and job descriptions; develop asset management plan, strategic asset management plan, and asset management policy; reform decision-making systems in strategic planning

Source: Research Findings

In the ninth step of the model process, an operational action plan was developed for the implementation of each of the above recommendations. These plans included stages of identification, assessment, response planning, implementation and monitoring, documentation and reporting, and training and awareness-raising. Finally, in the tenth step, the findings and recommendations were communicated to project members and the project manager to be integrated into the project's future planning.

The findings of this research revealed that the studied project at Tehran Refinery has a "High" complexity level (7 out of 12 complexity factors rated as High). This result is consistent with the inherent nature of Iran's oil and gas projects, which typically involve multiple stakeholders, extensive inter-project dependencies, significant financial impacts, and environmental instability. The factors "Financial impact and value for money" (14 out of 16 votes) and "Stakeholders and influencers" (12 out of 16 votes) exhibited the highest complexity levels, reflecting the strategic importance and high sensitivity of these projects in the national economy. In the capability assessment, all four key project domains (sponsor, client, market, and asset manager) showed unfavorable conditions. The market (61%) and asset manager (62%) domains had the worst status in terms of limiting characteristics. This finding indicates that in Iran's oil and gas industry, structural weaknesses in the supply chain and asset management are deeper than the internal project domains. A noteworthy point is that the gap between the "current" and "required" states was very small in all domains, indicating stakeholders' awareness of the unfavorable current situation and a shared understanding of the need for improvement.

3.5. Analysis of Critical Modules

(a) Risk Management Module in the Sponsor and Client Domains

The identification of the risk management module as the most critical module in both the sponsor and client domains is one of the most important findings of this research. Key findings showed that the approach to infrastructure investment is reactive rather than based on a long-term plan (9 votes), alternative solutions are not sufficiently considered (10 votes), and little or no attention is paid to sustainability strategy and climate risks (12 votes). In the client domain, the reactive nature of risk management, blame culture, and inappropriate risk allocation (9 votes), along with a highly risk-averse approach (14 votes), were identified as major problems. These findings are consistent with the results of Elhoush and Kulatunga's research [6] in the Libyan oil industry, which identified weak risk management and stakeholder communication as major challenges in this industry. Kassem [18] also demonstrated in his research on oil and gas construction projects that risk management has a significant impact on project success. Akbari and Amirkhani [4] also identified project risk management processes as one of the most important project management processes in their research on Iranian project-based organizations. The probable reasons for this weakness in Iran's oil and gas industry include: (1) a traditional focus on rapid project delivery rather than comprehensive risk analysis; (2) an organizational culture that does not transmit bad news in a timely manner; (3) the lack of use of advanced risk analysis tools such as scenario planning and sensitivity analysis; and (4) the allocation of risks to parties that lack the ability to manage them, merely for the purpose of transferring responsibility.

(b) Procurement Module in the Market Domain

The research findings showed that the market (supply chain) of the project faces serious challenges in the procurement domain. The market is either highly consolidated or extremely fragmented (13 votes), work is usually awarded based on the lowest price (10 votes), suppliers are unfamiliar with the client's business (13 votes), and contract incentives are misaligned with the sponsor's requirements (11 votes). These findings are consistent with the results of Atafar and Eghbali's research [22] on Iran's gas transmission projects, which identified contractor underperformance and lack of accountability as the most effective factors in project delays. Tripathi et al [17]. also identified problems in tenders and contractor evaluation as major challenges in their research on the project management system of government organizations and provided suggestions for improvement. The root causes of these problems in Iran's oil and gas industry can be found in: (1) the use of traditional tender approaches based on the lowest price; (2) the lack of meaningful market engagement before contract award; (3) the hierarchical and transactional structure of the supply chain; (4) the lack of attention to ESG (Environmental, Social, and Governance) criteria in procurement processes; and (5) international sanctions that have limited access to high-quality global suppliers.

(c) Governance Module in the Asset Manager Domain

In the asset manager domain, the governance module was identified as the most critical module. Decision-making mechanisms fail to consider the whole asset life and value (8 votes), poor decision-making and governance structures undermine asset management plans (11 votes), and it is unclear who is accountable for making key decisions (7 votes). This finding is consistent with the results of Zarei and Chaghouei's research [20] on the Iran Water and Power Resources Development Company, which identified major problems in the structural domain and the need for organizational structure revision. Ranjbar et al. [9] also identified improving communication at different levels as one of the main priorities in their research on the pathology of the project management system. The reasons for this weakness in the asset manager domain include: (1) the structural separation between the project team and the operations team; (2) the lack of involvement of asset managers in the early stages of the project; (3) a focus on capital costs rather than whole-life costs; and (4) the absence of a transparent governance framework for key decisions [32].

Purwanto and Iqbal [12] achieved similar results in their research on the Gedebage-Tasikmalaya-Cilacap toll road project in Indonesia using the IPA Reference Roadmap model. They also assessed the project as highly complex, and although stakeholder capabilities were generally adequate, areas for improvement were identified. The main difference between the present research and Purwanto and Iqbal's study is that in the Iranian project, the capability status was unfavorable in all four domains, while in the Indonesian project, the status was generally assessed as adequate. This difference can be attributed to the specific conditions of Iran's oil and gas industry, including international sanctions, economic fluctuations, and bureaucratic structure. Reezigt and Boonstra [16] proposed a "Complexity-Predictability Project Diagnosis" model for large projects. The findings of the present research are consistent with their approach, which emphasizes that complex projects require special project management approaches and that traditional models are insufficient for them.

3.6. Practical Implications for Iran's Oil and Gas Industry

The findings of this research have important practical implications for Iran's oil and gas industry:

1. The necessity of revising risk management processes: Iran's oil and gas organizations must move from reactive to proactive approaches in risk management. This requires developing comprehensive risk management plans, holding regular training workshops, and creating a transparent organizational culture that promotes open discussion about risks.

2. Reforming procurement processes: Iran's oil and gas industry must move away from traditional tender models based on the lowest price and toward long-term collaboration models with suppliers. Drafting new

transaction regulations, developing engineering procurement guidelines, and paying attention to ESG criteria in procurement processes are essential.

3. Strengthening governance in asset management: A transparent governance framework must be created for key decisions. Using the RACI matrix to define responsibilities, developing a strategic asset management plan, and involving asset managers in the early stages of the project are essential actions.

4. Application of the IPA Reference Roadmap model: This research demonstrated that the IPA Reference Roadmap model is an effective tool for the systematic diagnosis of large and complex projects in Iran's oil and gas industry. It is recommended that this model be used as a standard tool in the early stages of developing large oil and gas projects.

3.7. Research Innovation

This research represents the first application of the Infrastructure and Projects Authority (IPA) Reference Roadmap Model (Version 2, 2021) in Iran's oil and gas industry. The main innovations of this research are:

1. Providing a systematic framework for diagnosing Iran's oil and gas projects using a reputable international model.
2. Identifying critical modules specific to Iran's oil and gas industry (risk management, procurement, and governance).
3. Providing operational recommendations and action plans to cover capability gaps.
4. Creating a foundation for future research in the field of large project diagnosis in Iran.

4. Conclusions

The present study was conducted with the aim of diagnosing the project management system in Iran's oil and gas industry using the Infrastructure and Projects Authority (IPA) Project Routemap Model (Version 2, 2021). This research represents the first application of this international model in Iran's oil and gas industry and provides a systematic framework for evaluating and improving large and complex projects.

The main findings of the research are as follows:

1. The complexity level of the studied project was evaluated as "High" (7 out of 12 complexity factors at the high level), which is consistent with the inherent nature of Iran's oil and gas projects.
2. The current status of the project in all four capability domains (sponsor, client, market, and asset manager) has a significant gap with the ideal state, with the share of limiting characteristics in these domains being 55%, 55%, 61%, and 62%, respectively.
3. The identified critical modules are: Risk Management (in the sponsor and client domains), Procurement (in the market domain), and Governance (in the asset manager domain).
4. Practical recommendations and action plans were developed to cover the capability gaps in each domain.

In response to the first research question (How can a project be diagnosed using the IPA Project Routemap Model?), the findings showed that implementing the model's ten-step process including: (1) determining the necessity of applying the model, (2) determining the timing of application, (3) developing the strategy, (4) planning the implementation, (5) collecting information, (6) gap analysis, (7) validating findings, (8) providing recommendations, (9) action planning, and (10) integrating improvement plans provides a comprehensive and structured framework for project diagnosis.

In response to the second question (What factors determine project complexity and what is the status of key stakeholders' capabilities?), 12 key complexity factors were identified, namely: strategic importance, stakeholders and influencers, articulation of requirements and benefits, stability of the overall context, financial impact and value for money, delivery complexity, interfaces and relationships, range of disciplines and skills, dependencies, extent of change, organizational capability, and understanding of linkages. The capability assessment also showed that all four key project domains (sponsor, client, market, and asset manager) require improvement.

In response to the third question (What are the most important capability gaps and practical recommendations to cover them?), the main gaps were identified in four modules, and the following recommendations were provided:

- For the sponsor and client domains: Reforming and developing the risk management plan, holding risk identification training workshops, and adopting a proactive rather than reactive approach.
- For the market domain: Developing the procurement management plan, drafting transaction regulations, and developing engineering procurement and sourcing guidelines.
- For the asset manager domain: Using the RACI matrix to define responsibilities, developing a strategic asset management plan, and reforming decision-making systems.

4.1. Practical Implications

The findings of this research have important practical implications for Iran's oil and gas industry:

1. Project managers can use the IPA Project Routemap Model as a standard tool for the systematic evaluation of large projects in the early stages.
2. Policymakers in the oil and gas industry can design targeted training and development programs by focusing on the identified critical modules (risk management, procurement, and governance).
3. Project-based organizations can prevent the repetition of past failures and enhance project productivity by implementing the provided practical recommendations.

4.2. Limitations and Future Research

This research faced some limitations that should be considered when interpreting the findings:

1. The research was conducted as a case study on a single project at Tehran Refinery, and the generalizability of the findings to other oil and gas projects in Iran requires further research.
2. The number of participants (16 experts), although sufficient for implementing the model, poses limitations for more advanced statistical analyses.
3. Complete demographic information of the participants (education, job position, and work experience) was not fully accessible.
4. The actual impact of the provided recommendations on project performance over time was not evaluated.

Based on these limitations and the research findings, the following suggestions are proposed for future research:

1. Applying the IPA Project Routemap Model in other oil and gas projects in Iran and comparing the findings with the present study.
2. Developing a native pathology model for Iran's oil and gas projects by combining the IPA Project Routemap Model with other project management models.
3. Applying the model in other large industries in Iran (power, construction, road building) and comparing the results.
4. Evaluating the long-term impact of the provided recommendations on project performance through longitudinal studies.
5. Prioritizing various project pathology models based on the opinions of experts in Iran's oil and gas industry.

Author Contributions

All authors contributed equally to the conception, preparation, and writing of this manuscript.

Conflict of Interest

S.A. Razavi, as a Director-in-charge, had no involvement in the reviewer selection or the peer-review process.

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AI Used Statment

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