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Comparing Developing Countries' Policies for Technology Acquisition in the Oil Industry through Multinational Corporations: A Critical Success Factors Approach

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A B S T R A C T

This study aimed to compare the technology-acquisition policies adopted by Brazil, Saudi Arabia, and Nigeria through multinational corporations and identify applicable strategies for strengthening technology transfer and technological development in Iran's oil industry. A comparative qualitative design was employed. Critical success factors for international technology transfer were identified through a review of previous studies and specialized interviews with more than ten experts in oil-industry technology and science and technology policymaking. The identified factors were analyzed thematically and classified into four domains: technology-provider factors, technology-recipient factors, interorganizational cooperation factors, and technology-related factors. Brazil, Saudi Arabia, and Nigeria were selected according to similarities in oil and gas infrastructure, development level, geopolitical and social conditions, and information availability. Their technology-acquisition strategies were extracted through thematic analysis and subsequently mapped against the identified critical success factors based on expert judgments regarding each strategy's potential contribution to successful technology transfer. The comparative analysis indicated that successful technology acquisition cannot be achieved through petroleum contracts alone but requires an integrated combination of contractual and non-contractual mechanisms. Effective policies were inferred to depend particularly on strengthening absorptive capacity, developing domestic technological capabilities, supporting research and development, promoting university–industry collaboration, facilitating cooperation between multinational and domestic firms, developing skilled human resources, establishing supportive financial and regulatory mechanisms, and separating operational responsibilities from policymaking and regulatory functions. The comparison further indicated that coherent technological strategies, stable regulations, institutional coordination, and endogenous technological development are essential for transforming multinational-company participation into sustainable technological spillovers. Iran's oil industry requires a coherent technology-development strategy that moves beyond an operational production-oriented model toward capability building, absorptive-capacity development, institutional specialization, stable regulation, research–industry integration, and systematic utilization of multinational corporations and other technology providers.

Keywords: *Technology Transfer; Multinational Corporations; Critical Success Factors; Technology Acquisition Policies; Technological Spillovers; Technological Cooperation*

1. Introduction

Technological capability has become a central determinant of long-term industrial competitiveness, productivity growth, resource efficiency, and economic resilience in developing countries. The capacity of a country not merely to import advanced technologies but also to absorb, adapt, diffuse, improve, and eventually generate them domestically determines whether participation in the global economy produces sustainable development or persistent technological dependence. This issue is particularly important in capital-intensive and knowledge-intensive industries such as oil and gas, where exploration, drilling, reservoir management, enhanced recovery, refining, environmental management, digital monitoring, and advanced engineering increasingly depend on sophisticated technologies and specialized organizational knowledge. For many developing countries, however, domestic technological capabilities remain insufficient to independently generate all of the technologies required throughout the petroleum value chain. Consequently, multinational corporations, foreign direct investment, international partnerships, external financing, and participation in global value chains have become important channels through which capital, technology, managerial knowledge, skills, and organizational practices may enter national economies. Research on developing-country participation in international production systems similarly emphasizes that integration into global value chains creates opportunities for economic upgrading only when appropriate domestic policies and capabilities enable countries and firms to move toward higher-value activities (Dutta, 2024). Evidence concerning outward and inward investment likewise demonstrates the growing importance of the relationship between international investment, trade, and the development trajectories of emerging economies (Chattoraj & Ullah, 2023; Ihsan & Mustafa, 2022). Thus, the developmental significance of multinational corporations lies not simply in their presence, but in the conditions under which their resources and knowledge become embedded within domestic productive and technological systems.

Foreign direct investment and multinational-corporation activity can generate important developmental opportunities, but their effects are neither automatic nor uniformly beneficial. International investment can contribute to capital formation, employment, market access, knowledge exchange, organizational learning, and technological upgrading, while its distributional and developmental outcomes depend strongly on host-country institutions and policy frameworks. Evidence from Nigeria, for example, has highlighted the relationship between multinational corporations and the development of domestic companies, reinforcing the importance of examining whether foreign corporate activity strengthens or displaces local capabilities (Andrew, 2023). At a broader level, the relationship among foreign investment, energy consumption, and inequality demonstrates that international capital flows are embedded within wider economic and social structures and may produce heterogeneous outcomes across countries (Amin et al., 2022). Similarly, analyses of trade and environmental quality in Sub-Saharan Africa and foreign direct investment and environmental conditions in Latin America demonstrate that international economic integration can create both developmental opportunities and externalities, depending on regulatory capacity and the structure of domestic economies (Andriamahery et al., 2022; Ochoa-Moreno et al., 2021). These findings are highly relevant to petroleum-producing developing countries because technology acquisition must be evaluated not solely in terms of the immediate introduction of equipment or technical processes but in terms of whether foreign participation contributes to domestic learning, industrial upgrading, human-capital formation, supplier development, innovation capacity, and long-term technological autonomy.

The strategic importance of this distinction becomes particularly evident in natural-resource-dependent economies. Resource abundance alone does not ensure technological upgrading, industrial diversification, or developmental transformation. Instead, the governance of resource sectors and the political and institutional arrangements through which resource revenues and foreign investment are managed strongly affect the extent to which extractive industries contribute to broader development. Recent work on resource governance and economic upgrading illustrates that resource-based development outcomes are shaped by political settlements and institutional configurations rather than by resources in isolation (Franz, 2025). Environmental research likewise shows that energy-resource capacity, fiscal structures, and technological transformation are interconnected with national development and environmental performance (Youssef & Dahmani, 2024). In petroleum economies, this implies that the presence of foreign oil companies or technologically advanced multinational enterprises should not itself be considered evidence of successful technology transfer. What matters is whether governments and domestic

firms establish mechanisms capable of transforming external technological access into accumulated local capabilities. Such mechanisms may include local-content requirements, research and development obligations, joint ventures, targeted training, domestic procurement, technology clauses in contracts, fiscal incentives, intellectual-property arrangements, research partnerships, supplier-development programs, and policies encouraging foreign companies to establish sustained technological relationships with local actors.

The need for active policy is reinforced by evidence from sectors beyond petroleum. Studies of multinational and transnational corporations show that large firms possess considerable economic, technical, organizational, and political resources that allow them to influence markets and policy environments. Research examining corporate strategies in tobacco, alcohol, and sugar-sweetened beverage industries has shown that firms may seek greater corporate autonomy through multiple political and institutional mechanisms (Hoe et al., 2022). Related scholarship on commercial determinants of health in low- and middle-income countries demonstrates how corporate activity can generate substantial effects on national policy environments and social outcomes when regulatory institutions are insufficiently equipped to manage commercial power (Islam et al., 2025). Research on multinational corporations and population health has similarly emphasized tensions between corporate interests and public objectives (Peer & Kengne, 2021), while analyses of investment liberalization and transnational corporations demonstrate that international investment regimes can constrain or shape domestic policymaking under certain circumstances (Milsom et al., 2021). Although these studies concern different sectors, they highlight a general principle relevant to technology transfer in the oil industry: multinational corporations pursue their own strategic objectives, and developmental spillovers cannot simply be presumed to arise from their presence. Host-country governments must therefore formulate clear policies that align foreign investment incentives with national technological-development priorities.

International experience further suggests that the effectiveness of such policies depends on policy design, implementation capacity, institutional coordination, and monitoring. Studies of policy implementation in low- and middle-income settings show that formal adoption of a policy does not guarantee its effective execution; implementation depends on institutional arrangements, stakeholder responses, regulatory capacity, and mechanisms for accountability (Phonsuk et al., 2025). Comparative work examining national policy experiences likewise demonstrates that countries differ substantially in the effectiveness of policy instruments and in their ability to translate formal objectives into measurable outcomes (Alum et al., 2026). The same principle applies to development assistance and energy policy. Evidence concerning official development assistance for renewable-energy development indicates that different financial incentive instruments can produce different levels of effectiveness, underscoring the need to evaluate the design of policy tools rather than assuming that all forms of support are equivalent (Lee, 2025). For oil-industry technology transfer, therefore, identifying broad goals such as localization, training, technology acquisition, or innovation is insufficient. Policymakers must determine which concrete strategies are most capable of addressing the conditions that make technology transfer successful and how different policy instruments interact with recipient capabilities, technology characteristics, institutional structures, and the behavior of foreign technology holders.

A particularly important condition is the development of domestic absorptive capacity. Advanced technology is rarely transferred as a completely codified and immediately usable package. Its productive application often requires technical expertise, organizational routines, tacit knowledge, engineering competence, learning-by-doing, skilled personnel, research infrastructure, and sustained interaction between foreign and domestic actors. The Fourth Industrial Revolution has further intensified these requirements because access to technological infrastructure alone does not necessarily translate into effective technological participation among developing populations and economies (Kshetri, 2023). Scientific and technological cooperation therefore increasingly depends on networks linking firms, universities, research institutions, governments, and international experts. Scholarship on science diplomacy illustrates the importance of international scientific collaboration for knowledge exchange and capacity development across national boundaries (Bezak et al., 2023). More broadly, work on multilateral cooperation emphasizes the need for coordinated institutional responses when complex global challenges exceed the capacities of individual actors (Kumar et al., 2023). Applied to petroleum technology acquisition, these insights imply that successful transfer requires a domestic innovation ecosystem capable of receiving, understanding, adapting, disseminating, and further developing imported knowledge.

The relationship between foreign technology access and domestic capacity became especially visible during the COVID-19 pandemic, when unequal access to advanced technologies exposed structural disparities in global production and knowledge systems. Research on barriers to health products in low- and middle-income countries demonstrated that financing limitations, production constraints, institutional weaknesses, supply problems, and international inequities could restrict access to essential technologies (Boro & Stoll, 2022). Studies of multinational pharmaceutical companies during the pandemic also illustrated the indispensable capabilities of large corporations while simultaneously demonstrating the importance of coordination between private technological capacity and public objectives (Baykara et al., 2022). Debates concerning vaccine inequity similarly emphasized that technological availability at the global level does not ensure equitable access or local capability formation (Kim, 2021). Intellectual-property arrangements are particularly important in this respect. Proposals to treat critical intellectual property as a common good and expand mechanisms for technology sharing illustrate the tension between proprietary control and the developmental need to disseminate knowledge (Adikari & Wijesinghe, 2021). These experiences reinforce an important implication for the oil industry: ownership of technology, incentives to share knowledge, contractual design, intellectual-property rules, and the recipient's capacity to internalize knowledge jointly determine the depth of technology transfer.

Technology acquisition must also be viewed as part of a wider system of development financing and institutional capacity. Developing economies frequently face constraints associated with public finance, debt, investment risk, infrastructure, and access to capital. Research examining tax abuse, debt, and climate vulnerability in low- and lower-middle-income countries demonstrates how constrained fiscal environments can limit governments' capacity to pursue developmental objectives (Lopez et al., 2022). Alternative financing models may therefore be necessary to mobilize investment for capability building. Evidence on blended finance and impact investing for small and medium enterprises in Sub-Saharan Africa highlights the potential role of innovative financial structures in supporting firms that may otherwise face substantial financing barriers (Lybbert et al., 2024). Within oil-sector technology policy, analogous mechanisms may include specialized technology-development funds, fiscal incentives for technological investment, preferential financing for domestic suppliers, joint research financing, and targeted support for firms attempting to absorb advanced technologies. These mechanisms are particularly significant because domestic small and medium-sized firms often occupy critical positions in supplier networks through which technological spillovers can diffuse beyond large national oil companies.

At the same time, development policy must recognize that economic integration can generate complex social and environmental consequences. The relationships between climate change, production systems, and human well-being illustrate that sectoral policies increasingly need to be evaluated within broader sustainability frameworks (Agostoni et al., 2023). Studies of globalization and changing consumption patterns demonstrate that international economic integration can reshape domestic markets and social conditions in ways that are not always anticipated by policymakers (Marson et al., 2024). Research on multinational corporate strategies in East Asia similarly illustrates how firms adapt to local environments to expand and sustain market activity (Huse, 2022), while analyses of structural transformations in regional food systems show that policy responses must evolve alongside changes in markets and corporate organization (Huse et al., 2022). These findings are relevant beyond the food sector because they illustrate the adaptive capacity of multinational enterprises and the necessity for governments to develop equally adaptive regulatory and industrial strategies. In the oil industry, where environmental, economic, technological, and geopolitical considerations intersect, technology-transfer policies must therefore be embedded within long-term national strategies rather than treated as isolated contractual provisions.

Institutional context is equally important because technological outcomes are shaped by the distribution of authority among public and private actors. Research concerning the role of private-sector actors in policy processes demonstrates that private firms can participate not only in service or product provision but also in agenda setting, financing, implementation, and institutional decision-making (Sriram et al., 2024). Studies of political economy during crisis conditions further show that policy outcomes emerge from interactions among governmental structures, commercial actors, public institutions, and social priorities (Surianta & Patunru, 2023). At the international level, calls to rethink systems rather than individual interventions emphasize the importance of understanding institutional relationships, incentives, governance arrangements, and system-wide interactions (Marten et al.,

2022). Similarly, scholarship calling for more equitable global knowledge systems argues that development cannot be separated from questions concerning who produces knowledge, who controls resources, and whose capabilities are strengthened through international cooperation (Abdalla & Galea, 2024). These perspectives support a systems-oriented approach to oil-industry technology acquisition in which ministries, national oil companies, regulators, universities, research institutes, domestic suppliers, financial institutions, multinational corporations, and specialized technology firms must be understood as interconnected components of a national technological-development system.

The importance of contextualized policy is further demonstrated by evidence concerning vulnerable workers and unequal exposure to economic and technological systems. Research on agricultural workers, for example, has shown how socioeconomic and political conditions determine whether individuals benefit from or bear the risks associated with production systems (Noory et al., 2024). Such findings underscore that technological and industrial policies operate within broader institutional structures and that formal participation in global markets does not automatically produce inclusive capability development. In petroleum economies, a similar concern applies to domestic firms and technical workforces: without deliberate measures for skill formation, local procurement, supplier upgrading, research participation, and knowledge retention, domestic actors may remain confined to lower-value operational roles while advanced technological functions continue to be controlled externally. The developmental objective of technology transfer should therefore extend beyond access to machinery or operational know-how toward the establishment of domestic capacities capable of technological adaptation, problem-solving, innovation, and independent decision-making.

Environmental governance also increasingly affects the technological choices of petroleum-producing countries. Research examining corporate compliance with climate obligations reflects the growing legal and societal pressures placed on major energy corporations to align their activities with climate objectives (Santiago et al., 2021). Likewise, empirical research linking foreign investment with environmental quality indicates that the developmental assessment of international investment increasingly includes environmental outcomes in addition to conventional measures of capital and growth (Ochoa-Moreno et al., 2021). The transition toward more sustainable energy systems therefore makes technological capability even more significant for oil-producing developing countries. These states must simultaneously manage existing petroleum resources, improve operational efficiency, reduce environmental impacts, develop cleaner production technologies, and prepare for structural transformation in global energy markets. Accordingly, technology transfer from multinational corporations should be regarded not only as a means of improving current oil production but also as an opportunity to strengthen broader engineering, research, innovation, and organizational capabilities that can remain valuable during future energy transitions.

Taken together, the literature demonstrates that multinational corporations and international investment can serve as important channels for technology, knowledge, finance, market access, and organizational learning, but their developmental impact depends on the institutional and policy arrangements established by host countries. International experience across energy, health, agriculture, finance, and other sectors consistently demonstrates that access alone does not guarantee capability, that foreign corporate participation does not automatically generate beneficial spillovers, and that policy effectiveness depends on coherent governance, appropriate incentives, domestic absorptive capacity, financing, regulation, intellectual-property arrangements, human-resource development, research infrastructure, and institutional coordination. For petroleum-producing developing countries, these considerations are especially consequential because the oil industry combines high technological complexity with substantial foreign-firm involvement and strategic national importance. Brazil, Saudi Arabia, and Nigeria provide valuable comparative cases because each has sought, through different combinations of industrial policy, local-content measures, research institutions, human-resource programs, contractual arrangements, localization strategies, and cooperation with multinational corporations, to transform participation in the international oil economy into stronger domestic capabilities. Comparing these experiences through a critical-success-factors framework can therefore provide a systematic basis for identifying which policy instruments are most closely aligned with the conditions required for effective technology acquisition and which lessons may be relevant to countries seeking to strengthen their own technological-development systems.

Accordingly, the aim of this study was to compare the policies and strategies adopted by Brazil, Saudi Arabia, and Nigeria for technology acquisition in the oil industry through

multinational corporations using a critical success factors approach and to identify applicable strategies for strengthening technology transfer and technological development in Iran's oil industry.

2. Methods and Materials

This study employed a qualitative comparative research design to examine and compare the policies and strategies adopted by selected developing countries for acquiring technology in the oil industry through multinational corporations. The comparative approach was used because it enables the identification of similarities, differences, successful practices, and areas requiring improvement by systematically examining the experiences of countries that have pursued technological development under relatively comparable conditions. The study was conducted in several interconnected stages. First, the conceptual foundations of technology transfer, technological spillovers, multinational corporations, and critical success factors in international technology transfer were reviewed. Subsequently, the critical success factors affecting successful technology acquisition were identified through previous studies and expert consultation. The expert group consisted of more than ten specialists with professional and academic experience in oil-industry technology and science and technology policymaking. These experts were selected because of their practical familiarity with technology acquisition, international technological collaboration, and policy processes in the oil sector. In the comparative stage, Brazil, Saudi Arabia, and Nigeria were selected as the country cases. Their selection was based on explicit comparative criteria, including similarities in oil and gas infrastructure, level of development, scientific and technological infrastructure, technical and industrial capabilities, geopolitical conditions, social circumstances, and availability of sufficient information for comparative assessment. These three countries were considered appropriate cases because each has substantial experience in interacting with multinational oil companies while developing policies intended to strengthen domestic technological capabilities. The study therefore combined expert-based qualitative inquiry with cross-country comparative analysis to determine how different policy instruments and institutional arrangements contributed to technology acquisition and technological development.

Data were collected through documentary review, specialized expert interviews, and a structured comparative assessment of identified technology-transfer strategies and critical success factors. The documentary component included the examination of previous research, theoretical studies, policy documents, institutional arrangements, and available evidence concerning international technology transfer, technological spillovers, multinational corporations, and technological development in the oil industries of Brazil, Saudi Arabia, and Nigeria. This review was used both to establish the conceptual framework of the study and to identify an initial set of critical success factors associated with successful international technology transfer. These factors were subsequently supplemented and refined through specialized interviews with experts in oil-industry technology and science and technology policymaking. The interviews focused on factors that could facilitate or hinder effective technology transfer from multinational corporations to host-country organizations and industries. Based on the combined evidence from the literature and expert interviews, a comprehensive set of critical success factors was developed. These factors covered characteristics of the technology provider, capabilities of the technology recipient, conditions governing cooperation between the two parties, and characteristics of the technology itself. In the second major stage of data collection, information concerning the technology-acquisition policies and practices of Brazil, Saudi Arabia, and Nigeria was gathered and examined. Particular attention was given to national technological strategies, domestic-content policies, research and development activities, institutional structures, human-resource development, financial support mechanisms, regulatory arrangements, university–industry collaboration, cooperation with international firms, and measures intended to strengthen domestic absorptive capacity. After the strategies used in each country had been identified, they were compared with the previously established critical success factors. Expert judgment was used to determine whether each policy or strategic instrument could make a positive contribution to the realization or coverage of a particular critical success factor. Thus, the study relied on multiple qualitative data sources and used expert assessment as a means of linking country-level strategies to the conditions required for successful technology transfer.

The collected qualitative data were analyzed primarily through thematic analysis and comparative matrix analysis. Thematic analysis was first applied to the findings derived from the literature review and expert interviews in order to organize the critical success factors into conceptually coherent categories. As a result of this process, the factors

were classified into four overarching domains: factors related to the technology holder or provider, factors related to the technology recipient, factors related to the cooperative environment between the participating organizations, and factors related to the nature and characteristics of the technology being transferred. The same thematic approach was then used to extract and classify the principal technology-acquisition and technology-development strategies implemented in Brazil, Saudi Arabia, and Nigeria. Following identification of the strategies, a cross-country comparative analysis was undertaken to establish which measures were adopted in each national context and to determine the similarities and differences among the three cases. In the final analytical stage, the identified strategies were mapped against the critical success factors through a strategy–factor matrix. The analytical logic of this matrix was based on whether a particular strategy or policy instrument could positively influence, facilitate, or partially cover each critical success factor. Accordingly, the matrix was not intended to indicate that a given strategy completely guaranteed the achievement of a success factor; rather, it represented the potential positive contribution of each strategy to the conditions necessary for effective technology transfer. The resulting comparison enabled the researchers to identify recurring policy patterns across the selected countries and to infer which institutional, regulatory, technological, financial, and human-capital mechanisms could be relevant to strengthening technology transfer in Iran's oil industry. The final interpretation was therefore based on the convergence of thematic findings, expert assessments, and comparative evidence from the three country cases.

3. Findings and Results

The findings were organized in four successive analytical stages corresponding to the logic of the study. First, the critical success factors affecting technology transfer through multinational corporations were identified and classified according to the principal actors and conditions involved in the transfer process. Second, the comparative examination of Brazil, Saudi Arabia, and Nigeria yielded a set of technology-transfer and technology-development strategies implemented within the oil sector of these countries. Third, the distribution of these strategies across the three national cases was examined to identify common and country-specific approaches. Finally, the extracted strategies were matched with the critical success factors to determine the extent to which each policy or strategic instrument could positively contribute to the requirements of successful technology acquisition. This procedure resulted in 46 critical success factors grouped into four major domains and 31 technology-transfer strategies. The comparative findings demonstrated that technology acquisition in the oil industry is a multidimensional process extending beyond contractual arrangements with foreign firms and encompassing recipient capabilities, provider characteristics, institutional and regulatory conditions, research and development capacity, human-resource development, interorganizational relationships, financial mechanisms, localization policies, and the characteristics of the technology itself.

Table 1

Critical Success Factors for Technology Transfer

Domain	Code	Critical Success Factor	Source No(s).
Technology-provider-related factors	KSF01	Motivation and willingness to transfer knowledge	18, 19
Technology-provider-related factors	KSF02	Skills and experience in interorganizational knowledge transfer	18, 20
Technology-provider-related factors	KSF03	Level of knowledge and experience relative to the knowledge recipient	20
Technology-provider-related factors	KSF04	Awareness of local laws and regulations	21
Technology-provider-related factors	KSF05	Commitment, support, training, and assistance throughout the transfer process	22
Technology-provider-related factors	KSF06	Strength and size of the technology source	29
Technology-provider-related factors	KSF07	Skills of the personnel and team involved in the project	30
Technology-provider-related factors	KSF08	Presence of the technology owner/provider in the host destination	29

Technology-provider-related factors	KSF09	Technical capability of the source in the subject of transfer	31
Technology-recipient-related factors	KSF10	Human-resource training	21
Technology-recipient-related factors	KSF11	Allocation of adequate and appropriate resources to knowledge transfer	18, 20
Technology-recipient-related factors	KSF12	Commitment and willingness to receive knowledge	27, 30, 38
Technology-recipient-related factors	KSF13	Conducting appropriate feasibility and needs-assessment studies	63, 65
Technology-recipient-related factors	KSF14	Efforts to acquire knowledge and information through informal mechanisms	25
Technology-recipient-related factors	KSF15	Documentation of acquired knowledge	25
Technology-recipient-related factors	KSF16	Technology absorptive, exposure/dissemination, and adoption capacity	26, 30, 35, 36
Technology-recipient-related factors	KSF17	Project-management skills of the manager and technology-transfer team	26, 28
Technology-recipient-related factors	KSF18	Previous technology-transfer experience	37
Technology-recipient-related factors	KSF19	Presence of an organizational learning culture	28
Technology-recipient-related factors	KSF20	Clear objectives and scope of work for knowledge transfer	28
Technology-recipient-related factors	KSF21	Rewards and incentives for individuals involved in knowledge transfer	32, 33
Technology-recipient-related factors	KSF22	Availability of skilled and specialized human resources	34, 35
Technology-recipient-related factors	KSF23	Commitment and support of senior management	29
Technology-recipient-related factors	KSF24	Technology-transfer timetable and scheduling	63, 67
Interorganizational cooperation-context factors	KSF25	Ability of the two organizations to establish effective communication	29, 37
Interorganizational cooperation-context factors	KSF26	Cultural similarities between the technology source and recipient	29, 38, 61, 63
Interorganizational cooperation-context factors	KSF27	Characteristics of technology-transfer contracts	3
Interorganizational cooperation-context factors	KSF28	Previous history of cooperation between the two companies	40
Interorganizational cooperation-context factors	KSF29	Mutual trust	38, 41, 42
Interorganizational cooperation-context factors	KSF30	Formal and informal communication for knowledge exchange and creation of new ideas	43
Interorganizational cooperation-context factors	KSF31	Presence of strong suppliers in the local firm's supply network	29, 38, 44, 61
Interorganizational cooperation-context factors	KSF32	Strength of interorganizational relationships	23
Interorganizational cooperation-context factors	KSF33	Supportive government policies, including commitment to a technological approach, a long-term perspective, and provision of facilities and support	29, 38, 45
Interorganizational cooperation-context factors	KSF34	Provision of tax and tariff incentives	46, 47
Interorganizational cooperation-context factors	KSF35	Appropriate communication infrastructure, including information technology	29, 47, 61
Interorganizational cooperation-context factors	KSF36	Facilitation of legal and regulatory issues, including intellectual property and corporate rights	44, 62, 63
Interorganizational cooperation-context factors	KSF37	Research and development capacity, including universities, research institutes, and knowledge-based companies	29, 61, 64
Interorganizational cooperation-context factors	KSF38	Access to natural resources and inexpensive raw materials	44
Interorganizational cooperation-context factors	KSF39	Presence of facilitating organizations	48
Interorganizational cooperation-context factors	KSF40	Appropriate financing infrastructure	63

Interorganizational cooperation-context factors	KSF41	Proper understanding of technology within the country	65, 66
Technology-related factors	KSF42	Degree of tacitness of knowledge	39, 41
Technology-related factors	KSF43	Age/life cycle of the technology	27, 49
Technology-related factors	KSF44	Cost of technology acquisition and absorption	49
Technology-related factors	KSF45	Complexity of knowledge	39, 41
Technology-related factors	KSF46	Familiar and proven technology	39, 41

As shown in Table 1, the thematic analysis generated 46 critical success factors distributed across four major domains. Nine factors were associated with the technology provider, indicating that successful technology transfer depends partly on the foreign or multinational firm's willingness, experience, technical competence, commitment, personnel capabilities, familiarity with the local regulatory environment, and physical or organizational presence in the recipient country. Fifteen factors were related to the technology recipient, making recipient-side capabilities a particularly extensive dimension of the framework. These factors emphasized human-resource training, allocation of adequate resources, willingness to learn, feasibility and needs assessment, knowledge documentation, absorptive and adoption capacity, project-management competence, previous experience, organizational learning, explicit transfer objectives, incentive mechanisms, skilled personnel, senior-management commitment, and appropriate scheduling. Seventeen factors concerned the cooperation context, demonstrating that technology transfer cannot be understood exclusively as an exchange between a provider and a recipient but is embedded within a wider institutional, relational, regulatory, financial, and innovation environment. Particularly important elements in this domain included effective interorganizational communication, cultural compatibility, contract characteristics, prior cooperation, mutual trust, supplier networks, supportive government policies, incentives, legal arrangements, research and development capacity, facilitating organizations, financing, and an appropriate national understanding of technology. Finally, five factors concerned the inherent nature of the transferred technology, including knowledge tacitness, technology life cycle, acquisition cost, knowledge complexity, and whether the technology was familiar and proven. Collectively, these findings indicated that successful transfer requires simultaneous attention to provider capability, recipient readiness, cooperation infrastructure, and technological characteristics rather than reliance on any single contractual or organizational mechanism.

Table 2

Extracted Strategies for Technology Transfer and Development in Brazil, Saudi Arabia, and Nigeria

Strategy Code	Extracted Strategy
S01	Formulation of a specific strategy for technology transfer and development in the oil industry
S02	Emphasis on the use of domestic goods, services, and products
S03	Assessment of the financial, technical, and legal qualifications of foreign companies
S04	Provision of appropriate incentives for capable international companies to participate in the oil sector and cooperate with domestic companies
S05	Establishment of a unit to facilitate innovation, technology transfer and development, interaction, and cooperation in the oil industry
S06	Designing contracts with foreign companies in accordance with a technology-transfer strategy
S07	Participation of domestic companies in research and development activities
S08	Establishment of an oil technology development fund
S09	Establishment of multinational oil and gas companies within the country
S10	Support for universities and research institutions active in the oil sector
S11	Establishment of a national petroleum research center
S12	Establishment of a governmental institution to strengthen relationships between major oil and gas actors and small and medium-sized enterprises
S13	Conducting international tenders in the oil industry
S14	Emphasis on targeted training of domestic personnel with the participation of foreign companies
S15	Facilitation of the localization and transfer of new technologies for application in the oil industry
S16	Utilization of the capabilities and capacities of domestic companies
S17	Facilitation of international companies' participation in investment in research and education

S18	Establishment of reputable and leading scientific centers within universities and research institutions
S19	Development and enforcement of intellectual-property rights and regulations
S20	Emphasis on maximizing the use of domestic human resources
S21	Initiation, promotion, and enhancement of technology-development projects with the participation of capable foreign companies
S22	Replacement of foreign personnel with local personnel after local employees acquire the required skills
S23	Strengthening research and development infrastructure in the oil sector
S24	Attraction of distinguished foreign researchers
S25	Recruitment of domestic human resources for oil-industry research and development activities
S26	Coordination and cooperation among research institutions and exchange of experience and expertise
S27	Maximization of cooperation and creation of synergy between domestic and foreign companies
S28	Coordination and cooperation between the industrial and research sectors
S29	Specification of the exact share of domestically manufactured equipment in contracts
S30	Study and identification of technological gaps and research needs in the relevant field
S31	Separation of executive responsibilities from policymaking, legislative, and regulatory responsibilities

Table 2 presents the 31 strategies extracted from the comparative examination of the three selected oil-producing countries. The strategies reveal that the countries' approaches to technology acquisition were substantially broader than the direct purchase or contractual transfer of technology. At the strategic and governance level, the findings included formulation of an explicit technology-transfer strategy, separation of executive and regulatory responsibilities, specification of domestic-content requirements, examination of technological gaps, and alignment of foreign-company contracts with technology-transfer objectives. At the institutional level, the strategies included establishment of specialized facilitating units, national research centers, technology-development funds, government bodies linking major firms with small and medium-sized enterprises, and leading scientific centers. A further group of strategies concentrated on domestic capability building through targeted personnel training, localization of technology, use of domestic firms and human resources, replacement of foreign personnel with trained local staff, strengthening of research and development infrastructure, and involvement of domestic companies in research activities. Other measures sought to strengthen connectivity within the innovation system through university support, international research investment, coordination among research institutions, industry–research cooperation, and collaboration between domestic and foreign firms. The strategy set also included market- and regulation-oriented mechanisms, such as international tendering, screening the qualifications of foreign firms, intellectual-property regulation, investment incentives, and explicit domestic-equipment requirements. Therefore, the comparative evidence indicates that the technology-transfer policies identified in the three countries operated through an interconnected combination of strategic planning, institutional development, localization, human-capital formation, research capacity, financial support, regulation, and domestic–international collaboration.

Table 3

Distribution of Technology-Transfer Strategies across the Selected Countries

Strategy Code	Brazil	Saudi Arabia	Nigeria
S01	✓	✓	✓
S02	✓	✓	✓
S03	—	—	✓
S04	✓	—	—
S05	—	✓	✓
S06	—	✓	—
S07	✓	—	—
S08	✓	—	—
S09	—	—	✓
S10	✓	✓	—
S11	✓	✓	—
S12	✓	✓	—
S13	—	—	✓

S14	✓	—	—
S15	—	—	✓
S16	—	✓	—
S17	✓	—	—
S18	—	✓	—
S19	—	✓	—
S20	—	✓	—
S21	✓	✓	—
S22	✓	✓	—
S23	—	—	✓
S24	✓	✓	✓
S25	—	✓	—
S26	—	✓	—
S27	—	✓	✓
S28	✓	✓	—
S29	—	✓	—
S30	✓	—	—
S31	✓	—	—

The cross-country comparison in Table 3 shows substantial variation in the composition of technology-transfer policy packages. Saudi Arabia had the largest number of identified strategies, with 19 of the 31 strategies represented in its policy configuration, followed by Brazil with 16 strategies and Nigeria with 10. Three strategies were common to all three countries: formulation of a specific strategy for technology transfer and development in the oil industry (S01), emphasis on the use of domestic goods, services, and products (S02), and attraction of distinguished foreign researchers (S24). These commonalities indicate that explicit technological direction, domestic capability utilization, and access to high-level international expertise constituted recurring components across otherwise different national models. Brazil and Saudi Arabia shared several additional strategies, including support for universities and research institutions (S10), establishment of national petroleum research centers (S11), institutional mechanisms for linking major oil and gas actors with smaller firms (S12), joint technology-development projects involving capable foreign companies (S21), replacement of foreign personnel by trained local personnel (S22), and coordination between industry and research (S28). Saudi Arabia and Nigeria shared the establishment of a specialized technology-transfer and innovation facilitating unit (S05) and emphasis on maximizing collaboration between domestic and foreign companies (S27). Brazil also displayed a distinct combination of mechanisms involving incentives for international firms (S04), participation of domestic companies in research and development (S07), a technology-development fund (S08), targeted training involving foreign companies (S14), international investment in research and education (S17), technological-gap assessment (S30), and separation of operational functions from policymaking and regulatory functions (S31). The Saudi Arabian configuration was especially extensive in institutional, regulatory, localization, research, and human-resource measures, including technology-oriented contract design (S06), use of domestic company capabilities (S16), scientific-center development (S18), intellectual-property arrangements (S19), domestic workforce utilization (S20), recruitment for research and development (S25), coordination among research institutions (S26), and specification of domestic equipment shares in contracts (S29). Nigeria's identified configuration, although comprising fewer strategies, included several distinctive measures, particularly qualification assessment of foreign firms (S03), establishment of multinational oil and gas companies within the country (S09), international tenders (S13), facilitation of technology localization (S15), and reinforcement of oil-sector research and development infrastructure (S23). Accordingly, the results demonstrate that the three countries pursued technology acquisition through different policy combinations while retaining several common principles related to strategic direction, domestic participation, international expertise, and institutional capacity building.

Table 4

Correspondence between Critical Success Factors and Technology-Transfer Strategies

Critical Success Factor	Strategies Positively Associated with the Factor	Number of Associated Strategies
KSF01	S13, S19, S23, S24, S26, S27	6
KSF02	S03, S13	2
KSF03	S03, S06, S13	3
KSF04	S27	1
KSF05	S27	1
KSF06	S03, S06, S13	3
KSF07	S07	1
KSF08	S13, S21, S27	3
KSF09	S03, S13	2
KSF10	S10, S11, S14, S15, S18, S20, S22, S23, S25, S27, S28	11
KSF11	S01, S02, S08	3
KSF12	S27	1
KSF13	S02, S07, S15, S29	4
KSF14	S15, S24	2
KSF15	S27, S28	2
KSF16	S05, S07, S10, S15, S16, S18, S20, S22, S24, S25, S26, S27, S28	13
KSF17	S07, S09, S13, S27	4
KSF18	S03, S06, S27	3
KSF19	S13, S24, S27	3
KSF20	S01, S03, S07, S11, S27	5
KSF21	S20, S27	2
KSF22	S03, S09, S10, S11, S18, S20, S22, S23, S24, S25, S26, S27, S28	13
KSF23	S01, S12	2
KSF24	No corresponding strategy was marked in the source matrix	0
KSF25	S05, S06, S07, S11, S13, S17, S24	7
KSF26	S06, S24, S27	3
KSF27	S06, S29	2
KSF28	S06, S27	2
KSF29	S05, S13, S17, S27	4
KSF30	S05, S13, S17, S24, S26, S27	6
KSF31	S09, S12, S16, S20, S25, S26, S27, S28	8
KSF32	S05, S13, S17, S24, S27	5
KSF33	S01, S02, S04, S08, S10, S11, S12, S15, S16, S17, S18, S20, S22, S25, S28, S31	16
KSF34	S02, S04, S08	3
KSF35	S04, S17	2
KSF36	S01, S02, S04, S08, S17, S19	6
KSF37	S07, S10, S11, S15, S18, S20, S23, S24, S25, S26, S27, S28	12
KSF38	S04, S27	2
KSF39	S05, S15	2
KSF40	S01, S03, S08, S09	4
KSF41	S02, S07, S10, S11, S13, S18, S23, S24, S26, S27, S28	11
KSF42	No corresponding strategy was marked in the source matrix	0
KSF43	S06	1
KSF44	S05, S06, S07, S08, S10, S11, S13, S17, S23, S24, S26, S27, S28	13
KSF45	S07, S26	2
KSF46	S06, S07	2

Table 4 provides the integrative result of the study by showing how the 31 identified strategies corresponded to the 46 critical success factors. The results demonstrate that the strategies differed considerably in their breadth of potential influence. Among all strategies, S27, maximizing cooperation and synergy between domestic and foreign companies, had the broadest correspondence, being linked to 24 critical success factors. This finding places domestic–foreign collaboration at the center of the technology-transfer system because such cooperation potentially influences

provider commitment, recipient motivation, absorptive capacity, learning culture, project-management capability, knowledge documentation, mutual trust, communication, supplier development, research capacity, understanding of technology, and several other transfer conditions. S13, international tendering in the oil industry, was associated with 14 critical success factors, while S24, attraction of distinguished foreign researchers, corresponded to 12 factors. Participation of domestic companies in research and development (S07) was associated with 11 factors, contract design based on a technology-transfer strategy (S06) with 10 factors, and both coordination among research institutions (S26) and industry–research coordination (S28) with nine factors each. These patterns indicate that strategies facilitating interaction, competition, knowledge exchange, research engagement, and institutional coordination tend to influence multiple conditions of successful technology acquisition simultaneously.

From the perspective of the critical success factors themselves, supportive government policies (KSF33) displayed the widest strategic coverage, with 16 strategies contributing to this factor. This result indicates that government support is not represented by a single policy instrument but can be operationalized through strategic planning, domestic-content requirements, incentives, technology-development financing, research institutions, linkages among industry actors, localization mechanisms, domestic-company utilization, international research investment, scientific-center development, domestic workforce development, replacement and training of personnel, research recruitment, industry–research cooperation, and separation of executive and regulatory responsibilities. Technology absorptive, exposure/dissemination, and adoption capacity (KSF16), availability of skilled and specialized human resources (KSF22), and cost of technology acquisition and absorption (KSF44) were each associated with 13 strategies, showing that capability building, human capital, and the economic feasibility of technology acquisition represent highly interconnected dimensions within the policy system. Research and development capacity (KSF37) was linked to 12 strategies, while human-resource training (KSF10) and proper national understanding of technology (KSF41) were each associated with 11 strategies. Strong local supplier networks (KSF31) were linked to eight strategies, effective interorganizational communication (KSF25) to seven strategies, and several provider-, recipient-, and cooperation-related factors were connected to multiple policy instruments. In contrast, no strategy was explicitly marked for the technology-transfer timetable (KSF24) or degree of tacitness of knowledge (KSF42), suggesting that these two factors were recognized in the critical-success-factor framework but were not directly covered by the extracted national strategies in the final correspondence matrix. Several additional factors, including awareness of local laws (KSF04), provider commitment and support throughout the transfer process (KSF05), skills of project personnel (KSF07), recipient commitment and willingness to acquire knowledge (KSF12), and technology life cycle (KSF43), were each associated with only one strategy.

Taken together, the final correspondence analysis demonstrates that effective technology acquisition is produced not through an isolated policy but through a portfolio of mutually reinforcing strategies. Strategies related to domestic–foreign cooperation, international tendering, research collaboration, human-capital development, institutional coordination, localization, and technology-oriented contracting had particularly broad relevance across the identified critical success factors. At the same time, the concentration of numerous strategies around government support, absorptive capacity, skilled human resources, research and development capacity, and technology-acquisition costs shows that the successful use of multinational corporations as a channel of technology transfer requires an enabling domestic technological system. The comparative results therefore indicate that merely creating contractual access to foreign technologies is insufficient. Sustainable technological spillovers require policies that simultaneously strengthen internal absorptive capacity, develop skilled personnel, integrate research and industry, support domestic firms and suppliers, create suitable legal and financial infrastructure, coordinate institutional actors, and structure relations with foreign technology holders in a way that converts international participation into domestic learning and technological capability.

4. Discussion and Conclusion

The present study compared the technology-acquisition policies adopted in the oil industries of Brazil, Saudi Arabia, and Nigeria through multinational corporations and examined these policies through a critical success factors framework. The findings showed that successful technology transfer is not dependent on a single contract, policy instrument, or institutional actor. Rather, it emerges from the

interaction of multiple conditions related to the technology provider, the technology recipient, the context of interorganizational cooperation, and the characteristics of the technology itself. Forty-six critical success factors were identified across these four domains, while the comparative analysis yielded 31 distinct strategies for technology transfer and development. The results further demonstrated that the three countries differed considerably in the combination of strategies they employed, although certain common approaches were evident, including the formulation of explicit technology-development strategies, emphasis on domestic goods and services, and attraction of foreign expertise. The final strategy–factor correspondence analysis indicated that policies promoting domestic–foreign cooperation, research and development, absorptive capacity, skilled human resources, institutional coordination, and supportive government intervention had the broadest relevance across the critical success factors. Collectively, the results suggest that technology acquisition in the oil industry should be understood as a systemic process of capability building rather than as a narrow transaction involving the purchase or contractual transfer of foreign technology.

One of the most important findings was the prominence of recipient-side capabilities, particularly absorptive capacity, skilled human resources, training, organizational learning, project-management competence, and the ability to document and disseminate acquired knowledge. This finding suggests that the availability of advanced foreign technology is insufficient unless domestic organizations possess the capacity to recognize its value, internalize it, adapt it, and integrate it into existing operational and innovation systems. This interpretation is consistent with broader evidence showing that developing countries gain more from participation in international production networks when they possess the institutional, technical, and human capabilities required for economic upgrading (Dutta, 2024). It also aligns with research emphasizing that participation in the Fourth Industrial Revolution is conditioned by domestic capabilities and that technological access without adequate skills and infrastructure may reproduce rather than reduce technological inequality (Kshetri, 2023). The current findings therefore reinforce the argument that the developmental value of multinational corporations is contingent upon the strength of the recipient system. In this regard, the emphasis placed on human-resource training, specialist personnel, research capacity, and domestic organizational learning in the present study can be interpreted as mechanisms that convert foreign technological presence into endogenous capability.

The importance of absorptive capacity also helps explain why policies that supported universities, research centers, domestic research and development, recruitment of skilled researchers, and cooperation between industry and research institutions were repeatedly associated with multiple critical success factors. The comparative cases showed that technology transfer becomes deeper when it is embedded in a wider knowledge system rather than confined to a project site or contractual relationship. This finding is compatible with the literature on science diplomacy and international scientific cooperation, which emphasizes the role of cross-border scientific networks in strengthening knowledge exchange and technological capability (Bezak et al., 2023). It is also consistent with the broader argument that complex development challenges require coordinated systems involving governmental, scientific, private-sector, and international actors (Kumar et al., 2023; Marten et al., 2022). In the oil industry, this means that universities and research institutions should not remain peripheral to technological agreements. Instead, their participation can facilitate adaptation, reverse engineering, applied research, codification of imported knowledge, training of specialized personnel, and ultimately the development of indigenous technological competence.

Another major result concerned the role of supportive government policies. KSF33, representing government support and a long-term technological orientation, was connected to more strategies than any other critical success factor. This suggests that the state has a central coordinating role in shaping the conditions under which multinational corporations can contribute to domestic technological upgrading. The finding is consistent with evidence indicating that the developmental outcomes of resource sectors depend heavily on resource governance, political arrangements, and state capacity rather than resource abundance alone (Franz, 2025). It also aligns with research showing that different policy instruments can vary substantially in effectiveness and that policy design matters as much as policy intent (Lee, 2025; Phonsuk et al., 2025). From this perspective, technology-transfer policy should not be limited to formal statements encouraging localization or cooperation. It should establish measurable obligations, institutional responsibilities, financial mechanisms, monitoring arrangements, and incentives that create a credible link between foreign participation and domestic technological development.

The differences identified across Brazil, Saudi Arabia, and Nigeria further support the importance of institutional context. Saudi Arabia employed the broadest set of identified strategies, particularly in relation to institutional development, research, localization, human resources, and regulation. Brazil also demonstrated a relatively extensive policy configuration, including support for domestic firms, research and development participation, financing mechanisms, targeted training, technological-gap assessment, and institutional separation between executive and regulatory functions. Nigeria, although displaying fewer identified strategies, emphasized selected mechanisms such as qualification assessment of foreign companies, international tendering, localization, and strengthening of research and development infrastructure. These variations suggest that technology-transfer strategies are shaped by national institutional structures, policy priorities, industrial capacity, and the maturity of domestic innovation systems. Similar heterogeneity has been reported in studies examining foreign direct investment and its developmental consequences, where outcomes vary across countries depending on economic structure and institutional conditions (Amin et al., 2022; Ochoa-Moreno et al., 2021). Therefore, the findings indicate that there is no universally optimal technology-transfer model; rather, strategies must be configured in accordance with domestic capabilities and developmental priorities.

The comparative findings also showed that local-content policies and the use of domestic goods, services, firms, and labor were recurring components of technology-acquisition strategies. The presence of these measures across the selected countries indicates that governments view domestic participation as a central mechanism for generating technological spillovers. This interpretation is supported by evidence from Nigeria showing that multinational-corporation activity can contribute to domestic-company development when linkages with local firms are sufficiently established (Andrew, 2023). However, the present findings also imply that local-content requirements alone are unlikely to generate meaningful technological upgrading if domestic firms lack technical, financial, or managerial capacity. Therefore, local-content policy should be integrated with supplier development, financing, training, research collaboration, and technological assistance. This point is especially important because global value-chain participation does not automatically move domestic firms toward higher-value activities; upgrading requires deliberate support and capability accumulation (Dutta, 2024).

A particularly significant result was the broad correspondence of S27, maximizing cooperation and synergy between domestic and foreign companies, with numerous critical success factors. This suggests that sustained interorganizational cooperation is one of the most influential mechanisms through which technology transfer may occur. Effective cooperation creates opportunities for learning-by-doing, informal knowledge exchange, joint problem-solving, personnel interaction, trust development, and the transfer of tacit knowledge that cannot easily be codified in contracts or manuals. The importance of such cooperation is conceptually consistent with broader evidence showing that multinational enterprises adapt their organizational and market strategies to local contexts and that sustained interactions with domestic actors can substantially shape outcomes (Huse, 2022). At the same time, research on multinational corporations has demonstrated that corporate objectives do not necessarily coincide with public developmental goals (Hoe et al., 2022; Peer & Kengne, 2021). Consequently, cooperation needs to be structured through policies that encourage knowledge sharing while protecting national interests and ensuring that domestic actors gain genuine technological competencies rather than remaining limited to routine subcontracting or operational roles.

The importance of appropriate regulation and legal infrastructure was another notable finding. Intellectual-property regulation, contractual provisions, legal facilitation, and institutional separation between regulatory and executive functions emerged as relevant components of the technology-transfer environment. These findings are consistent with debates in other technology-intensive sectors showing that intellectual-property regimes may either facilitate or restrict access to strategically important knowledge (Adikari & Wijesinghe, 2021). The COVID-19 experience, for example, demonstrated that the existence of technological knowledge at the global level does not guarantee equitable access when ownership, financing, production capacity, and institutional constraints limit transfer (Baykara et al., 2022; Boro & Stoll, 2022; Kim, 2021). Although the oil sector differs substantially from health technologies, the underlying principle remains relevant: technology ownership and access are institutionally mediated. Thus, petroleum contracts should address not merely delivery of equipment and services but also intellectual-property use, training rights, access to technical documentation, joint research, localization

obligations, and mechanisms enabling domestic organizations to accumulate usable knowledge.

Financial mechanisms also appeared prominently in the findings, particularly through technology-development funds, incentives for international participation, appropriate financing infrastructure, and support for domestic research and development. This result highlights that technological learning requires sustained investment and cannot be expected to emerge without financial commitment. Developing-country firms, research institutions, and suppliers often face resource constraints that limit their ability to participate effectively in technology-intensive projects. Similar financing constraints have been identified in broader development contexts, where limited fiscal capacity, debt pressures, and unequal access to capital can restrict investment in long-term development priorities (Lopez et al., 2022). Innovative financing arrangements may therefore be necessary to support technological upgrading, particularly among domestic small and medium-sized enterprises. Evidence on blended finance and impact investment illustrates the potential value of targeted financing mechanisms for strengthening firms that would otherwise be excluded from investment opportunities (Lybbert et al., 2024). In the oil sector, dedicated technology funds and preferential financing mechanisms could similarly support local suppliers, technology-based firms, research institutions, and collaborative research projects.

The findings also have broader implications for sustainability and long-term resource governance. Technology acquisition in petroleum industries cannot be separated from emerging environmental pressures, changing energy systems, and climate-related expectations. Research has increasingly demonstrated that energy capacity, environmental quality, and development policy are interconnected (Andriamahery et al., 2022; Youssef & Dahmani, 2024). Corporate environmental accountability is also becoming more prominent, particularly as multinational energy companies face greater expectations to respond to climate commitments (Santiago et al., 2021). Therefore, strengthening technological capability in oil-producing developing countries should not be understood only as a means of increasing production. It can also provide the engineering, research, monitoring, and innovation capacity needed to improve environmental performance and respond to future energy transitions.

Finally, the findings reinforce the broader conclusion that foreign corporate participation can generate developmental opportunities but also creates asymmetries of resources, knowledge, and bargaining power. Studies of commercial determinants and transnational corporations consistently show that powerful firms can exert substantial influence over domestic markets and policy environments (Islam et al., 2025; Milsom et al., 2021). Related research on private-sector involvement in policy processes has shown that private actors may influence not only implementation but also financing, agenda setting, and institutional decision-making (Sriram et al., 2024). Accordingly, developing countries need sufficient policy and regulatory capacity to ensure that collaboration with multinational oil companies serves long-term national technological goals. The results of the present study suggest that the most promising approach is neither isolation from multinational corporations nor unrestricted reliance on them, but strategically managed cooperation that combines foreign technological access with domestic capability building, institutional coordination, local participation, research development, legal safeguards, and long-term industrial policy.

This study has several limitations that should be considered when interpreting the findings. First, the comparative analysis was restricted to three countries—Brazil, Saudi Arabia, and Nigeria—and therefore cannot represent the full diversity of institutional, economic, technological, and political conditions found across petroleum-producing developing countries. Second, the identification of critical success factors and the matching of strategies to these factors relied partly on expert judgment, which may involve subjective interpretations despite the expertise of the participants. Third, the study was based primarily on documentary evidence, previous studies, and qualitative assessment rather than direct quantitative measurement of the actual magnitude of technology transferred through each strategy. Accordingly, the correspondence between a strategy and a critical success factor indicates potential contribution rather than causal effectiveness. Fourth, some policies may have changed over time, while the comparative structure necessarily reflects the policies and information available in the examined sources. Finally, the study concentrated on national and institutional mechanisms and did not investigate firm-level differences in technological capability, organizational culture, bargaining power, or learning processes in sufficient depth.

Future studies should expand the comparative framework to include a larger and more diverse group of oil-producing and technology-importing countries and examine how different institutional models affect technology-transfer outcomes over time. Longitudinal research could evaluate

whether specific strategies actually lead to measurable improvements in domestic technological capability, patent activity, local-content sophistication, supplier upgrading, research productivity, workforce expertise, and innovation performance. Future research could also employ quantitative methods to weight and prioritize the identified critical success factors and determine the relative effectiveness of individual strategies. Firm-level studies involving national oil companies, multinational corporations, contractors, suppliers, universities, and research centers would provide a more detailed understanding of knowledge-transfer mechanisms. Researchers should also examine emerging digital, low-carbon, and advanced energy technologies because changes in the global energy system may alter both the sources of technology and the mechanisms required for successful acquisition.

For practical implementation, policymakers in the oil industry should develop a unified national technology-acquisition strategy with clearly defined objectives, responsible institutions, monitoring indicators, and measurable obligations for foreign partners. Technology clauses should be incorporated systematically into major petroleum contracts, but contractual mechanisms should be complemented by investments in domestic research and development, specialized human-resource training, supplier upgrading, university–industry cooperation, and technology financing. Regulatory and executive functions should be clearly separated to improve transparency and accountability. Domestic companies should be progressively integrated into higher-value technical activities rather than being confined to routine services, and joint research projects should be designed to ensure actual knowledge accumulation. Dedicated technology-development funds, targeted incentives, research networks, and mechanisms for documenting and disseminating acquired knowledge should also be strengthened. Most importantly, technology transfer should be evaluated according to the capabilities that remain within the country after foreign partners reduce or terminate their involvement, rather than solely according to the equipment, services, or production outputs delivered during the contract period.

Authors' Contributions

Authors contributed equally to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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