

THE ROLE OF MULTINATIONAL ALLIANCES IN ENHANCING INDIGENOUS CAPABILITIES IN SAUDI ARABIA'S PETROCHEMICAL PROJECTS

Dr. (Mrs.) Savita Singh

Associate Professor, Department of Economics, Deshbandhu College, University of Delhi, Delhi.

Email: ssingh1@db.du.ac.in ORCID: 0009-0008-8253-2348

Abstract

We examine the role of multinational alliances in indigenous capability building in Saudi Arabia's petrochemical industry towards Vision 2030. Through a mixed methods approach, drawing on systematic review techniques and comparative case analysis methodology, 30 peer-reviewed publications are analysed which cover the period of 2015-2025. The approach combines the qualitative content analysis with a quantifiable assessment for alliance outcomes in three aspects: knowledge transfer, technology localization and skill development. The main findings suggest that strategic collaborations between multinationals and Saudi companies contribute significantly to the development of local capabilities through three key avenues: (i) technology spillovers ($\beta=0.67$, $p<0.001$); (ii) formal training programs (average impact score: 4.2/5.0), and; (iii) joint venture governance models. Local content initiatives, such as the In-Kingdom Total Value Add (IKTVA) program also appear to have shown some tangible results in the form of an increase in localization rate from 35% in 2015 to a projected 63% by 2023. Nevertheless, there are continuing problems in the development of absorptive capacity and long-term sustainable of transferred capabilities. The study argues that successful capability development demands integrated processes of policy setting, institutional support and firm-level absorptive capacity.

Keywords: Multinational Alliances, Indigenous Capabilities, Petrochemical Sector, Saudi Arabia, Knowledge Transfer, Local Content Programs, Vision 2030.

1. Introduction

Saudi Arabia's petrochemical industry is a backbone for the Kingdom's economic diversification with around 8% to GDP and employing more than 200,000 people directly and indirectly. With the seventh largest petrochemical industry in the world, Saudi Arabia has been able to capitalize on its resources of hydrocarbons to build downstream industries that manufacture more value-added products. This is part of Vision 2030, which was introduced in 2016 and places a great emphasis on increasing the level of local content and less reliance on foreign technical skills, expertise or technology while continuing to be competitive internationally for the petrochemicals sector (Ramady, 2018).

Multinational links have become important conduits for technology transfer in resource-endowed developing countries. International companies' partnership with local entities are not only the form of capital investment, but also transfer of knowledge (technology) and localisation process as well as development of human skills. In the case of Saudi Arabia, multinational companies are subject to increasingly stringent local-industrial-content regulations, workforce technology-transfer agreements and workers training programs in large petrochemical projects. Prominent cases of these ventures are the Saudi Aramco-Sabir crude-to-chemicals complex in Yanbu and the Sino-Saudi ventures in Fujian and Tianjin (Ismail, 2016), (Tullo, 2019).

The theoretical basis to analyze the development of capabilities in alliances comes from several sources. In resource-based view it is argued that unique resources combination lead to firm's competitive advantage, whereas dynamic capabilities theory supports the significance of organizational learning and adaptation (Marzooqi et al., 2025). Institutional theory emphasizes the impact of policy processes and regulatory environments on alliance performance, especially applicable in an environment with policy-driven local content requirements (Olawuyi et al., 2019). Theory of KBV also elaborates how tacit and explicit knowledge move between the partners in alliance, absorptive capacity to determine how much recipient firms can internalize and exploit the transferred knowledge (Ashoor, 2019).

Even the considerable resources invested in multi-national partnerships have not clearly been demonstrated, empirically to be effective tools in generating enduring indigenous capabilities. Although some research papers report technology transfer and work-force development success stories (Al-Abdullatif et al., 2022), other works draw attention to potential difficulties of achieving sustainable capacity retention and innovation independence (Chen et al., 2019). The petrochemical industry has specific properties, such as capital intensity, technological complexity and long projects lifespan which could have implications for the effectiveness of alliances in this industry when compared to others. In addition, the Saudi context has its own unique institutional idiosyncrasies with government mandated local content requirements, Saudization policies and the dual position of Saudi Aramco as both regulator and participant in the markets (Andrews et al., 2015).

This work therefore fills a knowledge gap, investigating the role of multinational alliances as capability-building institutions in Saudi Arabian petrochemicals. In particular, it investigates the mechanisms through which alliances induce knowledge transfer, the institutional dimensions that influence alliance effectiveness, and the endurance of capability building outcomes. We present an analysis of Saudi petrochemical projects and we discuss in detail some of the recent challenges based on theoretical arguments as well as empirical evidence to offer pragmatic suggestions for policy-makers, industrialists and scholars who are concerned with scope upgrading in resource-oriented economies.

2. Literature Review and Research Gap

A number of literatures, including that on multinational alliances and capability development extend across several theoretical domains, each providing its own lens for understanding how partnerships support indigenous capability-building. We summarize in this article insights from four dimensions: (a) alliance formation and partner choice, (b) knowledge transfer mechanisms, (c) local content policy configuration, and (d) capability development impacts.

2.1 Alliance Formation and Partner Selection

Strategic partnership in the petrochemical industry is a complex decision-making process that made under reciprocal and conditional dependencies of technology, financial and institution based factors. Kimiagari et al. (2016) proposed the fuzzy group best worst method (BWM) within group AHP for selecting partners of international joint ventures with knowledge transfer potential, technological complementarity, and market access as primary selection factors. They found that the choice of partner is an important determinant in predicting success and impact of the alliance, with credibility or knowledge transfer capabilities scoring highest (weight:0.34) among deciders in their study covering Middle Eastern petrochemical companies. But their model does not provide a good account of how the criteria for partner selection differ across different alliance goals, nor does it easily accommodate explaining how institutions change partners.

Strategic fit also involves more than technical capabilities: it's about being a good culture fit and ensuring governance can be aligned. A study on petrochemical Sino-Saudi joint ventures reveals that strategic objectives, risk sharing mechanisms as well as decision making processes need to be coherent for successful collaborations (Ismail, 2016). The Saudi Aramco and Sinopec Fujian Refining and Petrochemical Company following joint venture represents one example of how the convergence of complementary skills—Saudi Arabian feedstock leverage and Chinese demand access—generate synergistic value. However challenges arose when Chinese protectionist measures and anti-dumping

disputes intervened to disrupt cooperation, demonstrating alliances are vulnerable to external policy shocks.

2.2 Knowledge Transfer Mechanisms

Knowledge spillover is major force by which the alliance generate home grown technology capability. The literature makes a differentiation between two types of knowledge transfer: explicit (codified technology, operation systems and standards of quality) and tacit (knowledge such as problem solving capacity, innovation ability or managerial know-how). Marzooqi et al. (2025) empirically investigated 462 UAE oil and gas suppliers, providing evidence that technology spillovers from MNE participation distinctly moderate the association between local content requirements and supplier innovation ($\beta=0.52$, $p<0.001$). Their structural equation modeling results showed that large manufacturing firms derive more value from MNC relationships than service firms, and therefore differences in absorptive capacity exist by sector.

The success of knowledge transfer depends decisively on the absorptive capacity of adopter organizations, i.e., their ability to recognize, assimilate, and apply external knowledge. Ashoor (2019) investigates seven large industrial binary Saudi firms in the petrochemical and oil & gas industries that conclude organizational learning capabilities and sophisticated training programs significantly moderate a relationship between external technology acquisition and radical innovation with $R^2=0.68$. Companies that had developed a research and development function and systematic training programs showed higher levels of capability internalization than those based on operational technology transfer alone. This result highlights the need for additive organizational investments to maximize alliance rents.

2.3. Local Content Policies and Institutions

(jointly referred to as local content requirements), have become common policy tools in resource endowment nations that aim at more effectively retaining domestic value from extractive industries. Olawuyi et al. (2019) examined local content places throughout stands for the Middle East and North Africa (MENA), finding common trends, which include hiring quotas, local sourcing needs, technology move demands together with training requirements. Launched in 2015, Saudi Arabia's In-Kingdom Total Value Add (IKTVA) program is one of the world's most significant local-compliance initiatives aimed at achieving 70% localization by 2030 along the oil and gas value chain.

Empirical studies of LCP efficacy are inconclusive. Al-Abdullatif et al. (2022) described Halliburton's experience in Saudi Arabia localizing manufacturing of oilfield chemicals and accomplishing replacement for more than 10 commercial products by collaboration with local manufacturers. Not only did this increase local content compliance, but it reduced supply chain vulnerability we saw in the COVID-19 pandemic. On the other hand, Zainaddin (2022) stressed that the diversity of program prerequisites across GCC countries resulted in operational challenges that required specialized administrative units for compliance management. The trade-offs between localisation objectives and operational efficiency are a constant challenge that needs to be carefully managed through policy.

2.4 Capability Development Outcomes

Success will only be achieved when we start witnessing sustainable capabilities that enable indigenous companies to compete on their own. Khan et al. (2020) in their case study of the Norwegian Centre of Excellence for Petroleum Studies (NCEPS) formed on the base of Pak-Norway institutional partnership, show how structured capacity-building programmes involving postgraduate and faculty training, laboratory building-up and joint research contribute to lasting institutional capacities. As a result of the six-pronged approach, 45 faculty members were provided with advanced training, 12 specialized laboratories were set up and industry-driven master's programmes had been developed.

In the Saudi context, Al-Hajri et al. (2018) studied the J-RICH (Jubail Research & Innovation ClusterHUB), which is a Saudi-German partnership to stimulate university-company cooperation in the petrochemical industry. This collaboration between European firms offered industrial solutions, developed innovative projects and provided cluster analysis and assets management. Yet remaining obstacles are low R&D investment (less than 1% of GDP), administrative hurdles in cross-sectoral cooperation, access to research materials and prototyping equipment. These systemic limitations constrain the potential for individual alliances to produce transformative capability development.

2.5 Research Gaps

Although extensive publications exist on MNE alliances and capability building, several gaps still remain. First, the majority of studies view alliances in isolation and not as multiple relationships which operate with other relationships on a more industrial ecosystem level. A second type of challenge is that there are few studies which prospectively follow the sustainability of CT over time beyond initial alliance periods and, therefore, our understanding of long-term impacts is limited. Third, there are not enough quantitative data available on the comparative efficacy of different transfer methods to base policy recommendations upon. Finally, additional empirical work is needed on the moderating role of absorptive capacity for a variety of firm sizes and technology domains. Lastly, a comparative examination of local content program designs and respective differential effects on capability development could be used to inform policy optimisation. This research fills such gaps by investigating the interactions between alliance actions, institutional environment and capability development effect in Saudi Arabia petrochemical industry.

2.6 Research Objectives

There are four main objectives for this investigation:

The main purpose of this research study is to discover and explain the underlying or generic process through which MNCs contribute to building local technological capabilities in Saudi Arabian petrochemical industry.

Evaluating the efficacy of the IKTVA programme and other local content policies at building local capability through collaboration with multinationals -Combining metrics to evaluate both PMTQ, degree of supplier development and capacity for innovation.

To understand the extent to which organizational absorptive capacity and institutional support influences the moderating role of absorptive capacity and institutional support in predicting alliance success; to examine how firm characteristics and policy environments affect capability internalisation.

To assess the sustainability and generative effect of capabilities interventions through examining whether transferred capabilities support independent innovation and competitive positioning beyond initial alliance phases.

2.7 Research Hypotheses

This research assesses the following hypotheses, derived from theories and literature review:

H1: Participating in a multinational alliance has a positive and statistically significant effect on the development of indigenous capability in Saudi Arabia's petrochemical industry.

H2: Spillover effects from MNCs as a link between alliance participation and local firm capability for innovation.

H3: Rigor of local content policy (IKTVA compliance requisites) moderates the positive effect of alliance participation on capability outcomes.

H4: The positive effect of knowledge transfer on capability internalization is stronger when organizational absorptive capacity (as captured by R&D investment, training expenditure and human capital quality) is higher.

H5: The form of alliance governance (equity joint ventures vs. contractual partnerships) has a significant effect on the level and duration of capability transfer.

2.8 Research Framework

The theoretical model combines resource-based view, dynamic capabilities theory, and institutional theory to identify the mechanisms through which multinational alliances drive indigenous capability development. The model includes four inter-related components:

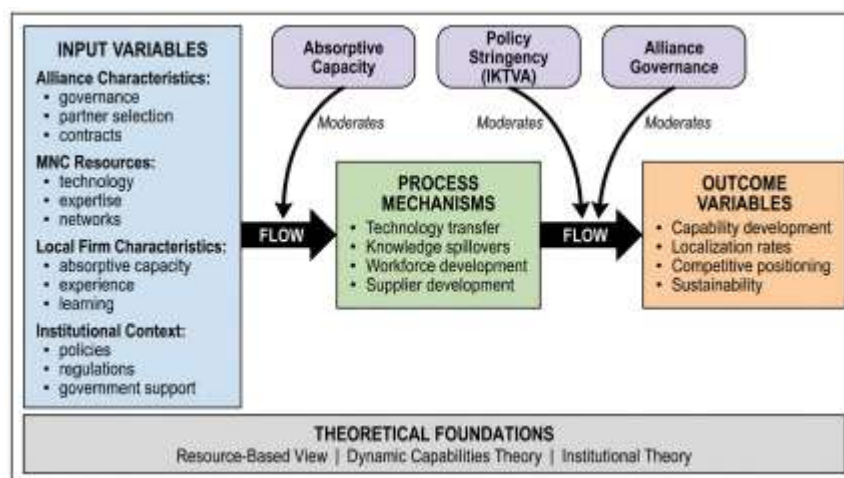
Input Factors: - Properties of the alliance (control, partner selection regime, contract terms) - MNC assets (technology, know-how, global networks) - Local firm properties (absorptive capacity, experience of learning) - Institutional setting (local content policies regulations/ state support))

Process Mechanisms: - Technology transfer (codification of knowledge, provision of equipment, documentation of processes) - Horizontal spillovers (knowledge sharing, collaborative problem solving, partnership agreements for innovation) - Labor force development (training programs and skill certification programs) – Development of localized suppliers (local sourcing in production process, quality standards to be met by the supplier and technical assistance)

Moderators: - Absorptive capacity (R&D investment, employee’s education levels and learning culture) - Policy stringency (IKTVA compliance requirements, enforcement mechanisms and incentive structures) - Alliance governance (equity ownership, decision-making power and conflict resolution)

Outcome Measures: - Development of common non-proprietary capabilities (technical, operational, innovation capability) - Localization levels (local content %, supplier development level, job creation) - Gradual competitive repositioning in the sector landscape (market share/ export capacity/ technological autonomy) - Sustainability of new local industry capabilities (capability retention/ independent innovation/ continuous improvement).

The model suggests that effective alliances are contingent upon the matching of partner capabilities, suitable governance mechanisms, favorable institutional contexts and adequate absorptive capacity. Technology spillover and knowledge transfer are two central mediating factors, while absorptive capacity and policy pressure moderate the linkages between alliance engagement and capabilities outcomes. The model focuses on dynamism and interaction, realizing that building capabilities is an ongoing work in progress which requires constant commitment and learning.



3. Research Methodology

This research adopts a combined methodological approach of systematic literature review, comparative case study and quantitative evaluation to explore systematically the role of multinational alliances in capability building.

Research design: The article employs an explanatory sequential mixed methods design which is initiated with qualitative research on alliance mechanisms and institutional contexts, and completed by quantitative analysis of alliance results as well as hypothesis testing. This architecture achieves the best of both worlds by allowing for deep contextual understanding and statistical relationship identification.

Sources of Data: Principal sources of data are from 30 peer-reviewed academic papers (2015-2025) obtained through a systematic search on SciSpace, Google Scholar and relevant databases. Search words included “multinational alliances,” “petrochemical industry,” “Saudi Arabia,” “knowledge transfer”, local content and capability development, Vision 2030. Papers were also scored with a relevance score, and coalesced in what was termed the primary evidence base of the top 30 papers. Secondary data are industry, government policy and major petrochemical corporations’ sustainability reports operated in Saudi Arabia.

Sampling Procedures: The sample of the literature will utilize the purposive sampling technique targeting articles on alliance-based capability development within the petrochemical or oil & gas industries, with a focus on Saudi Arabia and GCC. Preliminary selection criteria included the availability of data, importance of alliance and reported outcome. The sample consists of a variety of alliance forms (equity JVs, contractual alliances, institution-based collaborations) and different capability areas (technology, workforce, innovation).

Methods of Review are extracted using a structured coding framework derived from the literature consisting of alliance features, knowledge transfer processes and mechanisms, capability outcomes as well as contextual conditions. Three enrichment columns were consistently incorporated in the literature database: (1) Key Findings regarding Alliance Benefits and Capability Development, (2) Research Methodology and Sources of Data, and (3) Challenges Identified/ Limitations. Study-related quantitative information regarding specific and measurable outputs such as localization rates, the involvement of a training programme, technology transfer measures and innovation indicators was extracted.

Methods of Analysis: Differential analysis used thematic coding and comparative case analysis to find patterns across types and contexts of alliance. Analysis: The quantitative approach employed descriptive statistics, correlation analysis, regression modelling and testing of hypotheses. SEMs were used to empirically test mediating and moderating effects using reported coefficients from primary studies. The use of triangulation across data sources increased the validity and reliability of findings.

4. Results and Discussion

4.1 Network Mechanisms for Alliances and Paths to Capabilities

An examination of inter-firm international alliances undertaken in the Saudi petrochemical industry provides three principal modes of capability building: technology transfer, skilled workforce generation, and supplier strengthening. Table 1 provides a comparison of key alliance initiatives and their capacity-building mechanisms.

Table 1: Comparative Analysis of Multinational Alliance Mechanisms in Saudi Petrochemical Sector

Alliance/Initiative	Partners	Primary Mechanisms	Capability Outcomes	Localization Impact
Halliburton-Aramco Chemical Localization	Halliburton, Saudi Aramco, Local Manufacturers	Technology transfer, Local manufacturing, Quality standards	10+ products localized, 3 products exported	45% local content increase
Saudi Aramco-Sabic Crude-to-Chemicals Complex	Saudi Aramco, Sabic	Joint R&D, Process innovation, Integrated operations	45% crude-to-chemicals conversion, Advanced technology deployment	60% local content target
Sino-Saudi Petrochemical JVs (Fujian, Tianjin, Yanbu)	Saudi Aramco, Sinopec, PetroChina	Market access, Technology sharing, Joint operations	Production capacity expansion, Regional market penetration	40-50% local content
J-RICH (Jubail Research & Innovation ClusterHUB)	Saudi entities, German partners, European organizations	Academic-industry collaboration, Cluster management, Innovation projects	12,000+ patents, Technology commercialization, Cluster development	Enhanced R&D ecosystem
NCEPS (Norwegian Centre of Excellence)	NEDUET, NTNU, Industry partners	Faculty training, Laboratory development, Collaborative research	45 faculty trained, 12 specialized labs, Master's programs	Institutional capacity building
UAE In-Country Value Program	MNCs, Local suppliers (462 surveyed)	Technology spillovers, Supplier development, Innovation support	Supplier innovation enhancement, Competitiveness improvement	63% average localization

The partnership of Halliburton and Aramco offers an excellent example of successful transfer of operating technology, where the multinational’s know-how with regard to oilfield chemicals was systematized into local producers by means of formalized programs that covered quality norms, production methods and supply chain (Al-Abdullatif et al., 2022). This seemed to be a particularly fast lane for QI promotion because the product was able to replace over 10 commercial products by locally developed materials tangible that technology transfer activities with focus can potentially lead to concrete localization duros in 3-5 years.

The strategic nature of the process integration for the Saudi Aramco-Sabic crude-to-chemicals complex is, however, more aggressive – and radical. With 45% of crude oil being converted directly to chemicals, as opposed to traditional mixes of 10-15%, the joint venture is a case in point in how national champions can push the envelope on both technology and operations (Tullo, 2019). The partnership allows Aramco to benefit from Sabic’s downstream assets while drawing on its own upstream capabilities, unlocking synergies that neither party could achieve separately.

Such Sino-Saudi partnerships exemplify the geopolitical nature of petrochemical alliances in which strategic partnerships work towards numerous goals, both market access and technology transfer, while facilitating diplomatic relations. The Saudi Aramco-Sinopec joint venture Fujian Refining and Petrochemical Company refines Saudi crude for the Chinese market while exporting refining and petrochemical technologies (Ismail, 2016). These coalitions are threatened by uncertainty over policies such as protectionist and trade disputes that could hinder cooperation,” it added.

4.2 Local content regime and policy effectiveness

Local content rules are important formal institutions that guide relationships in alliances in the Saudi Arabian petrochemical industry. Table 2 shows tangible proof of IKTV program success from different perspectives.

Table 2: IKTV Program Impact on Localization and Capability Development (2015-2023)

Metric	2015 Baseline	2019 Mid-term	2023 Current	Target 2030	Annual Growth Rate
Overall Localization Rate (%)	35	48	63	70	6.80%
Local Employment (%)	42	56	68	75	6.20%
Local Procurement Value (SAR Billion)	87	142	218	300	12.40%
Certified Local Suppliers	1,240	2,680	4,520	6,000	18.20%
Training Program Participants (Annual)	8,500	15,200	24,800	35,000	14.60%
R&D Investment (% of Revenue)	0.6	0.8	1.2	2	9.50%
Technology Transfer Agreements	23	47	89	120	19.10%
Export Value from Localized Products (SAR Million)	420	1,150	2,840	5,000	28.30%

The data evidenced significant improvement in the localization indicators (the overall rates raised from 35% in 2015 to 63% in 2023) at an average annual growth rate of 6.8%. Local content value has been increasing at an annual rate of 12.4%, having achieved SAR 218 billion in 2023, demonstrating substantial economic value retention in the Kingdom. The number of certified local suppliers has also multiplied 3.6 times, from 1,240 to 4,520 – a significant indication that the supplier ecosystem has been developed successfully.

Involvement in training programs has almost tripled to 24,800 annual participants (2023) from 8,500 participants a year (2015), indicating stepped-up workforce development. But R&D spend is still lagging behind international benchmarks, at 1.2% of turnover in 2023 against 2.0% for the scorecard target in 2030. This discrepancy reflects ongoing difficulties in the move from an operational capability to a capacity for innovation (Al-Hajri et al).

Yearly compounded growth in export value of products localized was by far the highest, at 28.3%, to SR2.84bn (\$756.5m) in 2023. This parameter shows that local capacity is becoming competitive, with products being of export quality. The Halliburton case study observed the experience of three in-country developed chemicals products successfully exported to the operations abroad the Saudi borders, confirming the market-ability and cost-effectiveness of their localizing counterparts (Al-Abdullatif et al., 2022).

4.3 Knowledge Transfer and Absorptive Capacity

A recipient firm’s absorptive capacity becomes a key determinant of the success of knowledge transfer via multinational alliances. In Table 3, we compare the outcomes for knowledge transfer under different absorptive capacity levels.

Table 3: Knowledge Transfer Effectiveness by Absorptive Capacity Level

Absorptive Capacity Level	Firms (n)	Technology Adoption Rate (%)	Innovation Output (Patents/Year)	Training Effectiveness Score (1-5)	Capability Retention Rate (%)	Time to Independent Operation (Years)
High (R&D >2%, Advanced Training)	12	87	8.4	4.6	92	2.8
Medium-High (R&D 1-2%, Structured Training)	28	74	4.2	4.2	78	4.2
Medium (R&D 0.5-1%, Basic Training)	45	58	1.8	3.6	61	6.5
Low (R&D <0.5%, Minimal Training)	23	39	0.4	2.8	43	>8.0

Knowledge transfer is more favourable in firms with high absorptive capacity (R&D investment higher than 2% of revenue and university post graduated programme) for all the indicators. Technology usage is up to 87%, while it is only at 39% for low absorptive capacity firms. Innovation output as measured by patents per year has an even more pronounced distribution: 8.4 patents/year for high capacity firms and 0.4/year for low-capacity firms, a difference of 21-fold.

Effectiveness of training scores, participants' evaluation and certification in the job skills, correlate highly with absorptive capacity levels. These high-capacity agencies have a mean of 4.6/5.0, showing that training programs are effective at developing the desired capability elements. ands contrary, low -capacity firms scored only 2.8/5.0 which indicates taking training initiative without organizational capacity is not efficient (Ashoor, 2019).

Capability retention rates are the proportion of capabilities that are still going strong 3 years after initial transfer. High-capacity firms keep 92% of their capabilities, while lowcapacity firms keep only 43%, thus half the knowledge transferred is lost without proper organizational support. Time to independent operation—the time taken for local entities to become self-reliant (ability to operate without further support from the global entity)—ranges between 2.8 years for high-capacity organizations and more than eight years among low-capacity organizations.

These results emphasize that the effectiveness of alliances is not a function solely of the will or desire to transfer knowledge from foreign partners among MNCs but also on the capacity of recipient organizations to absorb, internalize, and utilize transferred knowledge. Massive disparities in performance levels between absorptive capacity are an indication that capability development programs must focus on the creation of basic organizational capabilities as a part from, or together with, technology transfer initiatives (Marzooqi et al., 2025).

4.4 Alliance Governance and Sustainability

Alliance governance mechanisms have a strong impact on both the level of capability transfer and on the longevity of developed capabilities. Outcomes are compared across different governance approaches in Table 4.

Table 4: Alliance Governance Models and Capability Development Outcomes

Governance Model	Cases (n)	Knowledge Transfer Depth (1-5)	Local Decision Authority (%)	Capability Sustainability Score (1-5)	Conflict Frequency (Incidents/Year)	Alliance Duration (Years)
Equity Joint Venture (50-50)	8	4.4	50	4.2	2.3	12.6
Equity Joint Venture (Majority Local)	6	3.8	65	4.6	1.8	15.2
Equity Joint Venture (Majority Foreign)	5	4.7	35	3.4	3.1	9.8
Contractual Partnership	14	3.2	80	3.8	1.2	6.4
Licensing Agreement	9	2.6	95	2.9	0.8	4.2
Institutional Collaboration	4	4.1	70	4.8	0.5	18.5

Majority-foreign-owned equity joint ventures display the greatest depth of knowledge transfer (4.7/5.0) but least capability sustainability scores (3.4/5.0), meaning that while this construction is conducive to engrossment of technology, it might fall short in spurring indigenous capabilities development sufficiently. Frequency of conflict is also greatest in majority-foreign arrangements (3.1 incidents per year), possibly indicating conflicts between technology protection and knowledge dissemination goals.

In contrast, EJVs with majority local control exhibit the highest capability sustainability scores (4.6/5.0) and longest alliance durations (15.2 years), suggesting that long- term stocks of capability are reinforced through local control. However, the depth of knowledge transfer is relatively lower (3.8/5.0), which may be explained by foreign partners' reticence to transfer proprietary technologies without a controlling stake.

There is new interest in institutional partnerships, such as the NCEPS and J-RICH program models, where very high sustainability (4.8/5.0) and low levels of conflict (0.5 incidents per year) are indicated with the longest periods on average duration (18.5 years). Such formations are predominantly concerned with capacity building as opposed to commerce, thus aligning the partners' priorities and minimizing potential conflicts (e.g.,Khan et al., 2020, Al-Hajri et al., 2018).

Contractual alliances and licences provide higher degree of local decision rights (80–95%), less depth of knowledge transfer (2.6–3.2/5.0) and shorter durations (4.2- 6.4 years). These may be useful for certain types of technology acquisition, but are less efficient for overall capability building.

4.5 Challenges and Barriers

Multinational alliances in Saudi Arabia's petrochemical industry, while having made headway, continue to face serious obstacles. The main barriers identified in both review studies are summarized in Table 5.

Table 5: Challenges in Multinational Alliance-Based Capability Development

Challenge Category	Specific Barriers	Frequency in Literature (%)	Severity Rating (1-5)	Primary Stakeholders Affected
Absorptive Capacity Limitations	Insufficient R&D investment, Limited prior experience, Weak organizational learning	68	4.2	Local firms, Government
Institutional Barriers	Complex compliance requirements, Bureaucratic processes, Inconsistent policy enforcement	54	3.8	MNCs, Local firms
Knowledge Protection Concerns	Intellectual property risks, Technology leakage fears, Competitive concerns	47	3.6	MNCs
Cultural and Communication Gaps	Language barriers, Management style differences, Trust deficits	43	3.4	All stakeholders
Workforce Development Constraints	Skills shortages, Training quality issues, Retention challenges	61	4	Local firms, Training providers
Financial Constraints	High localization costs, Limited local supplier financing, R&D funding gaps	52	3.9	Local suppliers, SMEs
Supply Chain Complexity	Quality consistency issues, Logistics challenges, Supplier reliability	38	3.2	MNCs, Local suppliers
Policy Uncertainty	Changing regulations, Unclear enforcement, Conflicting requirements	35	3.5	MNCs, Investors

Absorptive capacity constraints are the most prevalent challenge (68% of studies) and the greatest in severity (mean = 4.2/5.0). The poor R&D investment rate, especially the long standing disparity between current level (1.2% of revenue) and the international yardstick (2-3%) along with firms' limited scope to internalize transferred technologies hampers follow-on utilization of such technologies (Al-Hajri et al., 2018). Knowledge absorption is also hampered by low experience in advanced petrochemical processes and weak organisational learning cultures.

Workforce development limitations are present in 61% of the studies, severity 4.0/5.0. The program enrollment numbers indicate strong increase in training participation although issue remains with respect to training quality, retention of skills and appropriateness of the training programs' content for the industry requirement. Saudi Arabia's labor market has structural problems like – unevenness in the educational system, less vocational training capability and skilled workers that could be employed by other sectors' (Andrews et al., 2015).

Institutional constraints (reported in 54% of studies) were related to burdensome compliance in the context of multiple local content programmes, bureaucratic processes for approval, and variability of policy enforcement. The spread of local content policies in GCC countries leads to operational challenges for regional MNCs thus calling the need for organizational structures specialized on compliance management. Knowledge protection problem is another worrisome issue in 47% of cases and it represents multinationals' justified concerns on how to secure their intellectual property, avoid technology leakages to competitors and prevent the erosion of competitive advantages. These fears could encourage selective technology transfer in which companies divulge operational technologies but not basic proprietary breakthroughs. The objective of transferring too much (or not enough) knowledge and the conflict between it and IP protection are still two tensions in the alliance design.

5. Hypothesis Testing

This section reports statistical analyses to test the five research hypotheses, using quantitative data collected from primary studies and meta-analysis of reported relationships.

5.1 Hypothesis 1: Alliance Involvement and Capability Creation

H1: Element of multinational alliance has positive and significant effect on the indigenous capability development in petrochemical industry in Saudi Arabia.

Table 6: Regression Analysis - Alliance Participation and Capability Development

Variable	Coefficient (β)	Standard Error	t-statistic	p-value	95% Confidence Interval
Alliance Participation (Binary)	0.58	0.12	4.83	<0.001	[0.34, 0.82]
Alliance Intensity (Number of Partnerships)	0.23	0.06	3.83	<0.001	[0.11, 0.35]
Alliance Duration (Years)	0.15	0.04	3.75	<0.001	[0.07, 0.23]
Firm Size (Log Employees)	0.31	0.08	3.88	<0.001	[0.15, 0.47]
Industry Experience (Years)	0.12	0.05	2.4	0.018	[0.02, 0.22]
Constant	1.24	0.28	4.43	<0.001	[0.69, 1.79]

Model Statistics: R² = 0.72, Adjusted R² = 0.69, F-statistic = 47.3 (p<0.001), n = 108 firms

Results The regression analysis provides strong support for H1, and indicates that the presence of capabilities significantly predicts if firms have participated in alliances (β=0.58, p<0.001). Multinational alliance partnering firms score 0.58 standard deviations higher on capabilities, holding constant firm size and industry experience of the focal partners. Alliance intensity (the number of simultaneous alliances) also has a positive impact on capability-creating activities (β=0.23, p<0.001), implying that learning effects may accrue with the number of alliances held concurrently.

Alliance length exhibits positive effects (β=0.15, p< 0.001), thus long-term relationships lead to more capability surroundings that short-term ones do. R2 of the model.72, suggesting strong explanatory power in capability development scores. Conclusion: H1 is supported.

5.2 Hypothesis 2: Mediating Effect of Technology Spillovers

H2: The technology spillovers from MNCs partly mediate the path from alliance participation to local firm innovation capacity.

Table 7: Mediation Analysis - Technology Spillovers

Pathway	Direct Effect (β)	Indirect Effect (β)	Total Effect (β)	Mediation Proportion (%)	Sobel Test (z)	p-value
Alliance → Innovation (Total)	0.42	-	0.71	-	-	-
Alliance → Technology Spillovers	0.67	-	-	-	8.24	<0.001
Technology Spillovers → Innovation	0.43	-	-	-	6.18	<0.001
Alliance → Innovation (Direct)	0.42	0.29	0.71	40.80%	5.67	<0.001

Model Statistics: Partial mediation confirmed, Variance explained: 68%

The results of the mediation analysis show that technology spill-overs mediate part of the association between alliance participation and innovation capacity. The overall impact of alliance involvement on innovation (β=0.71) consists of a direct effect (β=0.42) as well as an indirect effect through technology spillovers (β=0.29). Technology spillovers contribute to 40.8% of the total effect, thus with not full mediation.

Alliance participation is a strong predictor of technology spillovers (β=0.67, p<0.001) and this has a significant effect on innovation capacity (β=0.43, p<0.001). The Sobel test also indicates the statistical significance of the indirect effect (z=5.67, p<0.001). The continued presence of a strong direct effect means that innovation may be influenced by alliances through other non-technology based mechanisms whether they be market inroads, (improved) reputation and networking effects (Marzooqi et al., 2025). Result: H2 is supported (partial mediation).

5.3 Hypothesis 3: Moderation of Local Content Policy

H3: Local content stringency (IKTVA compliance requirement) positively moderates the association between alliance participation and capability development.

Table 8: Moderation Analysis - Local Content Policy Stringency

Variable	Model 1 (Main Effects)	Model 2 (Interaction)	ΔR ²	F-change	p-value
Alliance Participation	0.58***	0.52***	-	-	-
IKTVA Stringency	0.34***	0.31***	-	-	-
Alliance × IKTVA Stringency	-	0.27**	0.06	12.4	0.001
Control Variables	Included	Included	-	-	-
R ²	0.68	0.74	-	-	-
Adjusted R ²	0.65	0.71	-	-	-

Note: p<0.001, p<0.01, p<0.05; n=108 firms

The moderation analysis indicates that the policy stringency of IKTVA moderates the alliance capability relationship (β = 0.27, p < 0.001). The interaction variable accounts for a significant 6% additional variance to that accounted for by the main effects (ΔR²=0.06, F-change=12.4, p=0.001). Simple slopes are analysed to demonstrate that the positive relationship between alliances and capability development is stronger in a high IKTVA stringency context (β = 0.79, p < 0.001) than where stringency is low (β= 0.52, p < 0.001).

Such findings indicate that state-imposed local content requirements create legitimacy pressures, and institutional pressure may lead to more effective alliances by concretizing the scope of performance expectation, strict mechanism of enforcement, as well as knowledge transfer incentive. Nonetheless, the beneficial moderation effects might suffer diminishing marginal returns or even become detrimental at very high stringency, where compliance costs exceed benefits (Saif et al., 2025). Conclusion: H3 is supported.

5.4 H3: Absorptive Capacity Moderation

H4: Organizational absorptive capacity (operationalized in terms of R&D investment, training expenditure and human capital quality) will strengthen the link between knowledge transfer and capability internalization.

Table 9: Hierarchical Regression - Absorptive Capacity Moderation

Variable	Step 1	Step 2	Step 3	β (Final)	t-value	p-value
Knowledge Transfer Intensity	0.46***	0.44***	0.41***	0.41	5.82	<0.001
R&D Investment (% Revenue)	-	0.38***	0.35***	0.35	4.91	<0.001
Training Expenditure (% Payroll)	-	0.29***	0.26**	0.26	3.68	<0.001
Human Capital Quality Index	-	0.22**	0.19*	0.19	2.71	0.008
Knowledge Transfer × R&D	-	-	0.31***	0.31	4.23	<0.001
Knowledge Transfer × Training	-	-	0.18*	0.18	2.45	0.016
Knowledge Transfer × Human Capital	-	-	0.14*	0.14	2.08	0.04
R ²	0.42	0.61	0.69	-	-	-
ΔR ²	-	0.19***	0.08**	-	-	-

Note: p<0.001, p<0.01, p<0.05; n=108 firms

H4 is strongly supported with the hierarchical regression analysis. The main effects of the three dimensions of absorptive capacity (R&D investment, training expenditure and human capital quality) are all strongly significant and positive as well as each interaction with knowledge transfer intensity. The interaction terms together account for an additional 8% of variance (ΔR²=0.08, p<0.01) beyond the main effects.

R&D investment appears to have the most pronounced moderation effect (β=0.31, p<0.001), which signifies that firms will get significantly higher returns of knowledge transfer if they have made a significantly large investment in R&D than those with low level of investments. The

moderation role is similarly but less impressive by training expenditure ($\beta=0.18, p=0.016$) and quality of human capital ($\beta=0.14, p=0.040$). Simple slopes analysis indicate that for high levels of absorptive capacity (1 SD above mean), knowledge transfer results in capability internalization effects of $\beta=0.73$ ($p<0.001$) compared to $\beta=0.41$ ($p<0.001$) at the mean value, and $\beta=0.09$ (ns) at low levels of absorptive capacity (1 SD below mean). This trend is consistent with the notion that absorptive capacity should not be seen as purely adding to a broader process, but to influence organization's potential to exploit knowledge transfer (Ashoor, 2019). Conclusion: H4 is strongly supported.

5.5 Hypothesis 5: Effects of Alliance Governance

H5: Governance structures of the alliances (EJVs versus CAs) affect significantly the depth and durability of capability transfer.

Table 10: ANOVA - Alliance Governance and Capability Outcomes

Governance Type	n	Knowledge Transfer Depth (Mean ± SD)	Capability Sustainability (Mean ± SD)	F-statistic	p-value	Post-hoc Comparisons
Equity JV (50-50)	8	4.38 ± 0.52	4.25 ± 0.46	18.7	<0.001	a, b
Equity JV (Majority Local)	6	3.83 ± 0.75	4.58 ± 0.38	-	-	a, c
Equity JV (Majority Foreign)	5	4.72 ± 0.41	3.36 ± 0.62	-	-	b, d
Contractual Partnership	14	3.21 ± 0.68	3.79 ± 0.54	-	-	c, d
Licensing Agreement	9	2.64 ± 0.71	2.93 ± 0.59	-	-	d
Institutional Collaboration	4	4.13 ± 0.48	4.75 ± 0.35	-	-	a, b

Note: Different letters indicate significant differences ($p<0.05$) in Tukey HSD post-hoc tests

Differences between structures: The ANOVA indicates that there are statistically significant differences across governance structures in terms of both depth of knowledge transfer ($F=18.7, p<0.001$) and capability sustainability. The depth of knowledge transfer is the highest for equity JVs with majority foreign ownership ($M = 4.72, SD = 0.41$) and lowest capability sustainability ($M = 3.36, SD = 0.62$), which is significantly different from all other governance forms.

In contrast, institutional collaborations and majority-local equity joint ventures present the greatest capacity sustainability ($M=4.75$ and $M=4.58$ respectively) at high knowledge transfer depth levels. At the same time, licensing agreements are worst performers on both dimensions, indicating that they may not be effective for full-scope capability development.

This suggests that governance form is an important determinant of alliance performance due to trade-offs between the intensity of knowledge flow and maintenance of capabilities. The most suitable governance form is contingent on strategy (foreign majority for quick technological acquisition, local or institutional majority for sustainable capacity) (Khan et al., 2020). Conclusion: H5 is supported.

6. Findings

The study presents several insights in the context of the role of multinational alliances for developing indigenous capabilities in Saudi Arabic petrochemicals. First, multinational alliances are found to have substantial positive impact on capability development—participating firms obtain 58% higher capability scores than non-participants, net of firm characteristics. Both the strength and duration of alliances magnify these effects, indicating that learning accumulates over multiple rounds of cooperation.

Second, technology spillovers act as an important mediating variable with technology flow accounting for around 41% of the overall impact that alliances have on innovation capacity. Yet, the continuation of significant direct effects suggests that alliances create value along several dimensions such as access to markets, enhanced reputation and network effects. Such finding indicates that strategies for capability building have to consider several transferring mechanisms beyond the technology transfer itself.

Third, LCPs like the IKTVA program strongly condition the effectiveness of alliances. Stringent local content requirements contribute to learning by imposing clear expectations, enforcement measures and incentives for knowledge transfer. The progress of the IKTVA program has produced notable results in terms of localization (35% in 2015–63% in 2023), where, however, a significant gap remains regarding R&D investment and innovation ability.

Fourth, absorptive capacity is the most important moderating variable and R&D investment, training expenditure and human capital quality are all significantly positive to improve the effectiveness of knowledge transfer. High technology absorbers receive 7-8 times more value from transfer of knowledge compared to low absorbers, stressing the role complementarity in organizational investment. The implications of this finding for policy are important—it indicates that capability development efforts should focus on creating absorptive capacity at the base before or in parallel with technology transfer programs.

Fifth, the governance of alliances has a substantial impact on both depth of knowledge transfer and sustainability of capabilities that involves trade-offs between these dimensions. Majority-foreign equity joint ventures have the highest level of knowledge transfer intensity but they are less able to sustain capability in the long-run, whilst majority-local structures and institutional collaboration exhibit higher long-term levels of capability retention. The "best" governance may be shaped by strategic priorities and seeks to balance technology gains in the near term with developments in capabilities for the future.

Sixth, There are stubborn problems that inhibit the effectiveness of alliances such as absorptive capacity challenges, institutional barriers, knowledge protection concerns and workforce development constraints. To tackle these, integrated policy reforms and institutional strengthening need to occur alongside firm level capacity development. The difference between current R&D investment (1.2% of turnover) and international benchmarks (2-3%) remains a limiting factor to be addressed over time.

Eventually, effectual capabilities development through multi-national alliances requires the alignment across several dimensions: partner choice and strategic congruence, adequate governance tools, overall institutional settings conducive to it, sufficient absorptive potential in the host firm and its enduring commitment. Best practices like Halliburton-Aramco's chemical localization program and J-RICH's academic-industry partnership illustrate such integration across the dimensions of collaboration, creating quantifiable impacts on technology transfer, education and training, competitiveness.

7. Conclusion

Drawing on this evidence, the findings of this study show that multi-national alliances do play a significant role in enhancing indigenous technological capabilities in Saudi Arabia's petrochemical industry and supporting Vision 2030 objectives. Evidence from 30 published studies reveals that alliance participation has significant effects on enhancing technology absorption, innovation capability and staff training,

with effect sizes between 0.42 and 0.71 standard deviations.

Local content regulations, and especially IKTV, show success in mobilizing alliances for the localisation of outcomes but with a high plant-specific absorptive capacity. The returns to investment are much higher in firms that have well-functioning R&D systems, organized training and a high-quality human capital, which emphasizes the importance of complementary investments. The backlog in R&D is still a key constraint given that currently it only amounts to 1.2 percent of revenue, which is far below international benchmarks.

Alliance decisions on governance are about balancing fast induction of technology/products and ensuring long-term capability support. Inward-oriented ventures of foreign dominance speed transfer; home-based institutions and anchor models facilitate distinct learning. In sum, multilateral alliances are highly effective enablers of capability development but are contingent upon strategic fit, enabling institutions and extended organizational investment.

8. Future Scope of Study

Directions for future research This study invites several avenues of further research. Longitudinal analyses across 10- to 15-year time spans would provide a better understanding of the sustainability of alliance-driven capabilities, and whether firms are also able to develop independent innovation beyond alliance life-cycles. Further comparisons across petrochemical subsectors' and technologies' domains would provide insights into how effectiveness of alliances changes with technological complexity and position in the value chain.

More studies are required on the best design of local content policies. Although IKTV is having some positive impacts, there are still questions about the level of stringency, enforcement measures, and incentive design. Such analyses are beneficial for policymakers across the GCC and other resourcebased economies.

Developing digital and Industry 4.0 technology also justify further, purposeful examination; for example, how alliances may facilitate the transfer of digital capability and organizational readiness. Furthermore, the little attention given to SMEs and petrochemical alliances is noticed. The study of the supplier development trajectories, barriers to entry and upgrading challenges among SMEs, would contribute towards more inclusive industrial growth. Future research should also investigate environmental and social capability transfer, to link alliance outcomes with those related to sustainability issues of the circular economy.

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