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Crude to Consumer: Unraveling the Supply Chain in Oil and Gas-A Comprehensive Comparison

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Abstract

The global oil and gas industry operates as a multifaceted and interconnected network, involving a range of processes, stakeholders, and technologies from crude oil extraction to final consumer delivery. This study provides an in-depth examination of the oil and gas supply chain systems, with a focus on comparing and analyzing their efficiency, sustainability, and resilience. The research employs a qualitative methodology, utilizing Focused Group Discussions (FGDs) and face-to-face interviews to gather data from key industry participants. Research questions, developed through thematic analysis, guided the data collection process, allowing for a comprehensive exploration of various supply chain aspects. The findings are drawn from case studies and empirical data sourced from major oil-producing nations and companies. This study identifies best practices, challenges, and opportunities within the industry, covering upstream activities (exploration and production), midstream processes (transportation and storage), and downstream operations (refining and distribution). The analysis reveals significant disparities and insights across different regions and segments of the supply chain, addressing factors such as geographical diversification, technological advancements, regulatory frameworks, environmental impacts, and socioeconomic considerations. The results underscore the importance of continuous adaptation and innovation in the oil and gas sector to address evolving challenges and ensure the efficient, sustainable, and reliable delivery of energy resources. This comprehensive examination contributes to a nuanced understanding of the industry's dynamics and highlights the need for ongoing improvements to meet global energy demands effectively.

Keywords: Oil and gas supply chain, Refining, Business-to-government, Business-to-public-private partnership, Supply chain resilience, Empirical data analysis.

1 | Introduction

The global oil and gas industry is a critical pillar of the world's energy infrastructure, encompassing a vast array of activities that span from upstream exploration and production to midstream transportation and downstream refining and distribution [1]. This expansive sector relies heavily on efficient Supply Chain Management (SCM) to ensure the uninterrupted flow of resources, materials, and finished products across its

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intricate operations [2]. However, the complexity of managing these supply chains increases with the scale of operations, which can vary significantly from small local enterprises to sprawling multinational corporations [3].

Despite, considerable amount of attention Effective SCM is especially crucial in the oil and gas industry due to its exposure to volatile market conditions, geopolitical uncertainties, and rapid technological advancements [4]. Smaller, localized entities often face challenges such as securing cost-effective transportation solutions and managing limited resources, which can hinder their operational efficiency [5]. In contrast, large multinational corporations must navigate the complexities of coordinating global supply networks, adapting to diverse regulatory environments, and managing geopolitical risks [6–8]. These differences in scale can lead to distinct inefficiencies, elevated operational costs, and varying environmental impacts [9], underscoring the need for a nuanced understanding of supply chain practices across different scales.

Current literature provides valuable insights into various facets of SCM within the oil and gas sector. Studies such as those by Monostori [10] have explored the scale-specific challenges faced by companies, revealing that while smaller players struggle with logistics costs, larger firms contend with the complexities of global supply chain alignment [10]. Chen et al. [11] have investigated the role of digital technologies, finding that while large corporations leverage advanced technologies like data analytics and Artificial intelligence (AI) to enhance operational efficiency, smaller entities often encounter obstacles in adopting these innovations [11]. Zhang et al. [12] have examined resilience strategies, highlighting the importance of supplier and distribution channel diversification for multinational firms in managing global disruptions [12]. Additionally, Zhang et al. [13] have discussed the integration of sustainable practices, noting that larger firms are more likely to invest in green technologies and carbon reduction initiatives compared to their smaller counterparts [13].

Despite these contributions, there remains a gap in comprehensive studies that compare and contrast SCM practices across different operational scales within the oil and gas industry [14]. This study seeks to fill this gap by offering an in-depth analysis of SCM across various scales—local, regional, national, and international. By identifying and examining the unique challenges faced by companies at each scale and evaluating the strategies they employ, this research aims to uncover critical factors that influence supply chain efficiency, cost-effectiveness, and sustainability. The study will also provide insights into successful practices and recommend potential improvements tailored to different operational scales. Ultimately, the findings will contribute to the development of more targeted and resilient supply chain strategies, enhancing the industry's ability to adapt to an evolving energy landscape and meet future demands effectively.

2 | Literature Review

The global oil and gas industry operates within a complex framework, from localized oilfields to extensive international networks. Effective SCM is crucial for ensuring operational efficiency, cost control, and timely delivery of resources. This literature review examines existing research on SCM across different scales in the industry, highlighting variations, challenges, and best practices.

Research by Koshel et al. [15] reveals distinct differences in SCM practices between local and multinational companies. Local firms typically focus on short-term operational efficiency, while multinationals adopt broader strategies that include risk management and sustainability. These differences are influenced by factors such as market reach, organizational complexity, and resource access [15].

Jia et al. [16] identify key factors shaping supply chain practices, including regulatory environments, market dynamics, resource availability, and geographical spread. Multinational companies often face challenges related to diverse regulatory requirements, while local firms struggle with limited technology and global market access [16].

Menhat et al. [17] explore the challenges faced by companies of varying scales. Common issues include fluctuating demand, geopolitical uncertainties, and transportation complexities. Smaller companies, in particular, face resource constraints and difficulties negotiating favorable terms with suppliers [17].

To address these challenges, Hassani et al. [18] highlight strategies and best practices. Larger companies use technology-driven solutions such as real-time monitoring and predictive analytics to optimize supply chains. In contrast, smaller companies often adopt lean and agile practices to improve market responsiveness [18]. Sustainability is another critical area of focus. Ahmadov et al. [19] find that larger firms are more likely to invest in renewable energy, emission reductions, and eco-friendly transportation. Smaller companies face challenges in implementing such practices due to limited resources and a focus on cost reduction [19].

In summary, the literature reveals significant variations in SCM strategies across scales within the oil and gas industry. Regulatory environments, market dynamics, and technological capabilities influence these practices. Larger companies leverage advanced technologies and prioritize sustainability, while smaller firms focus on lean practices and face barriers to sustainability. Understanding these variations helps companies tailor their strategies to enhance efficiency and competitiveness in the global energy market.

Based on the research question the following hypothesis has been developed [20].

Research hypotheses

For research question 1.

Hypotheses 1. There is a significant variation in the management of supply chains across different scales within the global oil and gas industry.

Hypotheses 2. The key factors influencing the variations in SCM across different scales in the oil and gas industry include regulatory environment, market dynamics, and available resources.

For research question 2.

Hypotheses 3. Oil and gas companies, encounter distinct supply chain challenges. Larger-scale firms grapple with intricate global logistics, while smaller-scale counterparts contend with resource constraints and economies of scale issues.

Hypotheses 4. Larger-scale oil and gas companies commonly prioritize environmental sustainability through practices like carbon footprint reduction and green supply chain initiatives. In contrast, smaller-scale firms may encounter hurdles in adopting these practices due to resource limitations.

3|Research Methodology

This study, titled "crude to consumer: unraveling the supply chain in oil and gas-a comprehensive comparison," utilizes a detailed and methodical approach to analyze and compare supply chains within the oil and gas industry. The methodology integrates both descriptive and analytical techniques to offer a comprehensive understanding of supply chain practices and their variations.

3.1|Research Design

The study adopts a descriptive and analytical design to provide a thorough exploration of oil and gas supply chains. This design focuses on describing key components of the supply chain and analyzing differences and similarities across various sectors. By employing this approach, the study aims to elucidate how different supply chains operate and the factors influencing their efficiency and effectiveness.

3.2|Sampling Strategy

A purposive sampling strategy will be employed to select two representative organizations within the oil and gas sector, designated as company X and company Y. This selection ensures a diverse representation of

industry practices and allows for a nuanced comparison of supply chain integration and management across different operational scales [21].

3.3 | Data Collection Methods

Given the qualitative nature of the research, the study will primarily utilize semi-structured interviews to gather in-depth insights. The focus will be on collecting rich, contextual data rather than numerical analysis [22]. The qualitative phase will involve:

I. Interviews with key stakeholders: semi-structured interviews will be conducted with supply chain managers, production supervisors, and industry experts from the selected organizations. These interviews will explore the implementation of lean principles, challenges faced, and lessons learned.

II. Participant selection: purposive sampling will be used to select participants who are directly involved in SCM and lean initiatives. Interviews will be conducted either face-to-face or via video conferencing to ensure comprehensive data collection.

3.4 | Analytical Tools

The analysis will be conducted using qualitative methods to interpret the data collected from interviews. The semi-structured interview format will facilitate open-ended discussions, allowing for a deep exploration of participants' experiences and perspectives. This approach will provide valuable insights into the complexities and contextual factors of SCM in the oil and gas industry.

3.5 | Expected Outcomes

The study anticipates several key findings:

I. Variability in supply chains: significant differences in supply chain structures and processes are expected, influenced by geography, market maturity, and regulatory frameworks.

II. Geographic disparities: variations in supply chain efficiency across regions may be observed, reflecting differences in infrastructure, political stability, and market demand.

III. Environmental and regulatory impacts: differences in environmental impacts and regulatory requirements between crude oil and natural gas supply chains are likely to be identified.

IV. Market dynamics: the influence of market dynamics, such as price fluctuations and consumer preferences, on supply chains will be examined, including the impact of renewable energy trends.

V. Logistical challenges: specific logistical issues, such as transportation bottlenecks and infrastructure constraints, are expected to be revealed.

VI. Safety and sustainability: differences in safety measures and sustainability initiatives may be uncovered, with varying focuses on environmental impact and worker safety.

VII. Cost structures: variations in cost structures related to production, transportation, and distribution will be analyzed, affecting pricing and profitability.

VIII. Policy implications: the study may offer insights into policy implications, potentially guiding interventions or incentives for improving supply chain efficiency, safety, and sustainability.

By providing a comprehensive analysis of supply chain practices and challenges in the oil and gas industry, this study aims to enhance understanding and offer actionable insights for industry stakeholders and policymakers.

4 | Data Collection and Analysis

4.1 | Research Data Collection

The data collection was done in Focused Group Discussion (FGD) format [23]. There were 6 number of people and they were asked few questions based on the theme. For FGD there is a need of facilitator and a note taker. The facilitator conducts the meeting session and note taker takes note. For this particular research, the researcher plays the role of facilitator as well as note taker role.

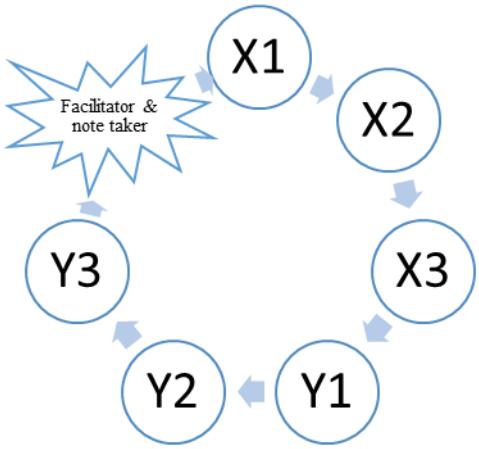


Fig. 1. Data collection process.

The data collection approach utilized direct, in-person interviews with industry experts. Engaging in face-to-face conversations fosters richer and more nuanced responses, as it allows participants to grasp the questions more effectively. This method not only enhances clarity but also encourages a more dynamic exchange of ideas, leading to deeper insights.

Table 1. Background of the respondents.

SL	ID	Designation	Company	Experience (Years)
1	X1	Mechanical shift lead, SCM	Company X	10
2	X2	Electrical specialist, SCM	Company X	9
3	X3	Maintenance specialist	Company X	10
4	Y1	Procurement specialist	Company Y	5
5	Y2	Deputy director, SCM	Company Y	9
6	Y3	Executive, SCM	Company Y	3.5

* Company X (chevron bangladesh) & company Y (oilco Bangladesh).

Few research questions were developed and respondents were requested to answer those questions base on the given themes. Based on those question FGD/ interview was done to collect data from respondents.

Table 2. Research questions and themes.

Research Question	Identified Themes
Q1: in what ways does SCM differ across various scales within the global oil and gas industry?	Overall supply chain process Team functionality Procurement activities
Q2: challenges in managing supply chains for oil and gas companies vary by scale, as do the strategies and best practices adopted to overcome these challenges.	Key challenges Success factors

4.2 | Overall Supply Chain Process for Company X and Company Y

Company X's supply chain is segmented into upstream and downstream components. The upstream segment handles planning and manufacturing, while the downstream segment manages storage and delivery to the end customer. According to A4, the procurement and SCM function at company X works collaboratively both internally and with external partners to effectively manage the supply and demand chain. The objective is to deliver goods and services safely, reliably, and cost-effectively. This function involves strategic processes that ensure close partnership across the enterprise.

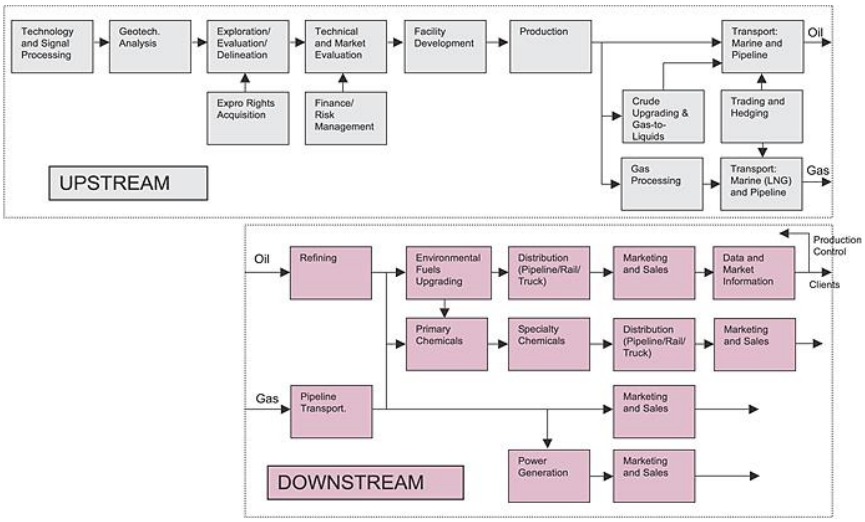


Fig. 2. Overall supply chain process of company X.

According to respondent X1, managing strategic processes involves global, stream, and business unit advisory teams. SCM at company X is responsible for developing supply chains that support the company's progress. SCM oversees third-party spending and ensures the delivery of materials, services, and logistics required to succeed in various environments.



Fig. 3. Strategic processes in supply chain of company X.

Company X support value chain optimization in their process as follows.



Fig. 4. SCM framework of company X.

According to respondent Y1 from company Y, the company has achieved significant success in the Liquefied Petroleum Gas (LPG) industry, securing the second position within just four years. This success is attributed to the company's effective SCM strategies, particularly in transportation networking and distribution. In Bangladesh, where there is a high demand for natural gas that LPG helps to meet, maintaining this position amidst various challenges and competition is demanding. However, the company's well-organized operational team has been key to sustaining this success.

Based on Y1's statement the following supply chain process has been developed as follows.

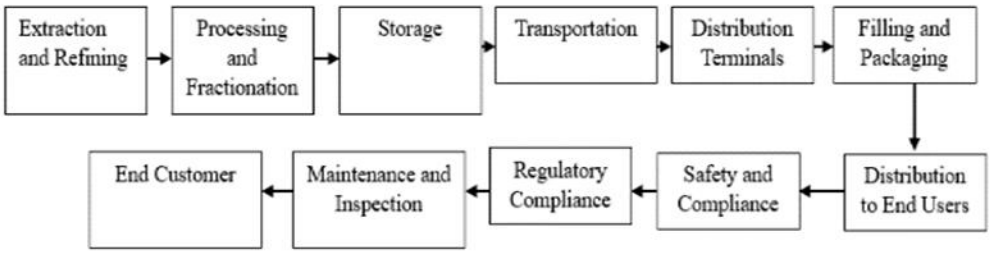


Fig. 5. Overall supply chain process of company.

4.3|Team Functionality

Respondent X2 from company X described their supply chain team as comprising category management, procurement operations, security and services, and logistics and inventory. These departments collaborate across functions to meet the organization's overall goals. In contrast, respondent Y2 from company Y outlined their supply chain team, which includes demand planning, procurement activities, inventory management, and commercial operations. They focus on forecasting based on customer demand, with all departments working together to achieve the company's overall objectives.

Based on the statements from X2 and Y2, a key difference between company X and company Y is their approach to demand fulfillment. Company Y relies on demand forecasting to meet customer needs, while company X depends on the natural production of gas, which affects their ability to forecast and meet demand.

The team functionality has been developed based on the above statement as follows.

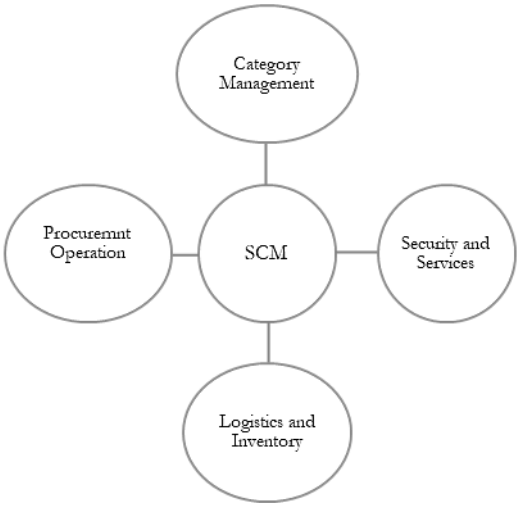


Fig. 6. Team functionality of company X.

Procurement operation: the procurement department handles purchasing, software development (e.g., Ariba), process improvement, e-catalogs, Pcard management, reporting, and repairs.

Category management: this team focuses on supplier qualification, category planning, strategic sourcing, supplier management, and contract management.

Security and services: this team ensures security, manages transportation and personnel logistics, and handles services for expatriates and visitors. They also oversee document control and facility management.

Logistics and inventory: the team is responsible for importation, shore base operations, and inventory and warehouse management.

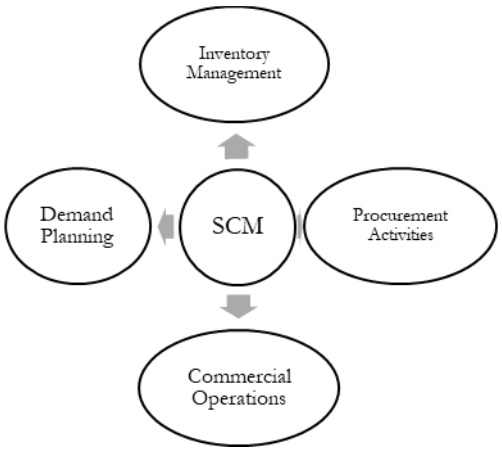


Fig. 7. Team functionality of company Y.

4.4 | Procurement and Sourcing Strategy

Both company X and company Y have distinct procurement and sourcing processes.

Respondent X3 from company X explained 'Our sourcing strategy encompasses everything from category management to operational reporting, focusing specifically on gas production for the government.'

Respondent Y3 from company Y explained 'Upon receiving a requisition, our supply chain team requests competitive quotations to select the best source for purchasing raw materials. The purchase order is then issued with the appropriate delegation of authority.'

Based on the above statements, the procurement and sourcing strategies for company X and company Y are as follows.

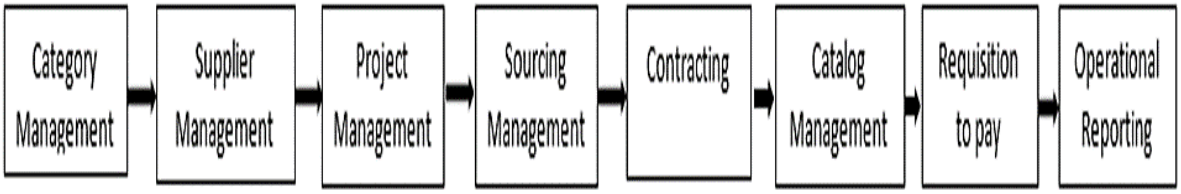


Fig. 8. Sourcing strategy framework of company X.

Company X employs the Project Development and Execution Process (PDEP), a phased approach supported by project contracting and procurement tools. The PDEP consists of five phases: identify and assess opportunities, generate and select alternatives, develop preferred alternative, execute, and operate and evaluate.

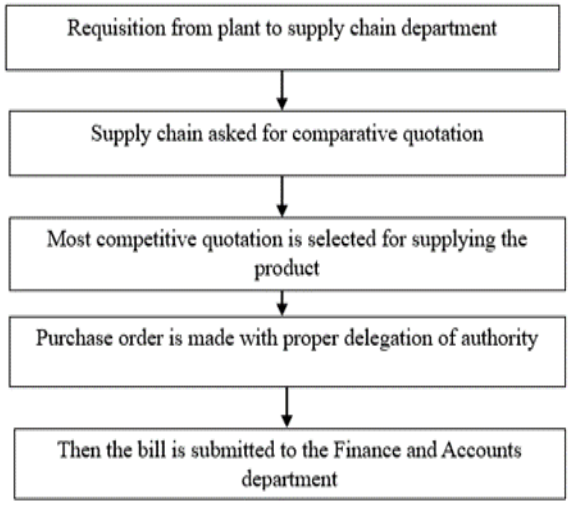


Fig. 9. Procurement and sourcing strategy of company Y.

The objectives of procurement activities are to ensure a consistent supply of quality raw materials, consumables, machinery, and spare parts. This involves creating and sourcing from reliable suppliers to minimize the cost of finished goods and maintain a minimal inventory level.

4.4|Procurement and Sourcing Strategy

For company X:

The respondents X1, X2 and X3 from company X said, they have faced some challenges as well as they have successful factors such as in their business.

Key challenges:

I. Global complexity
II. Energy price volatility
III. Environmental regulations
IV. Safety
V. Inventory management
VI. Supplier and vendor management

Key success factors:

I. Risk management
II. Collaboration
III. Technology adoption
IV. Sustainability
V. Continuous improvement
VI. Customer focus

For company Y:

The respondents Y1, Y2 and Y3 from company Y said, they have faced some challenges as well as they have successful factors such as in their business

Key challenges:

I. Energy price volatility
II. Safety
III. Environmental sustainability

Key successful factor:

I. Continuous improvement
II. Regulatory compliance
III. Continuous improvement

5 | Discussion

Company X and company Y are both active in the energy sector but differ significantly in scale and scope. company X is a major multinational corporation with operations in over 180 countries, encompassing the full energy value chain from exploration to distribution. It holds substantial assets and influences global energy markets and policies. In contrast, company Y, operates primarily in the oil and gas sector with a more regional focus, particularly in Africa and the Middle East. While company Y is expanding internationally, its scale and range of operations are smaller compared to company X extensive global presence.

Table 3. Regulatory and compliance differences.

Area	Company X (Focus)	Company Y (Focus)
Environmental compliance	High	Medium
Safety regulations	High	Medium
Energy regulations	High	High
Taxation	High	Medium
Permitting	High	High

To graphical representations have been analyzed to compare the business operations, product portfolio and Business-to-Government (B2G) and Business-to-Public-Private Partnership (B2P^2) Interactions of a global company with that of a local company, as detailed below.

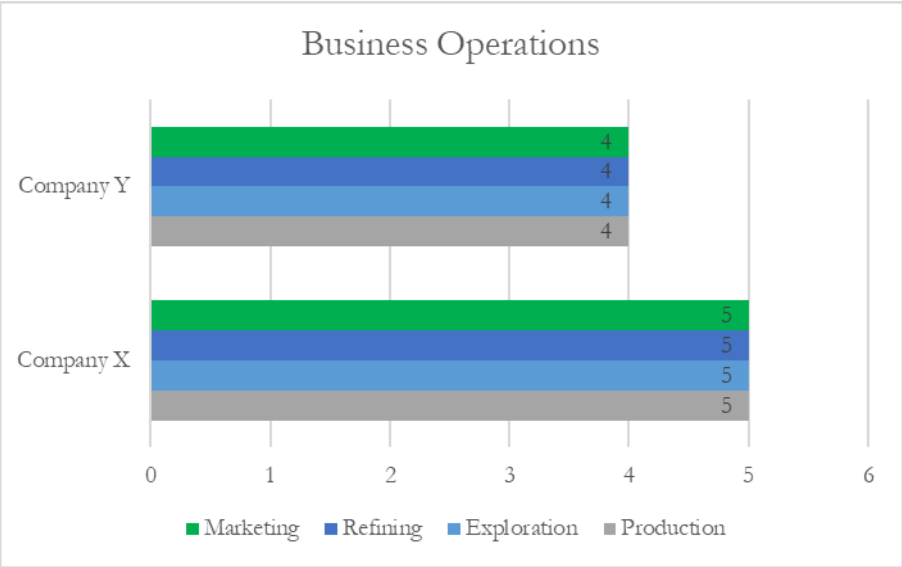


Fig. 10. Differences in business operation.

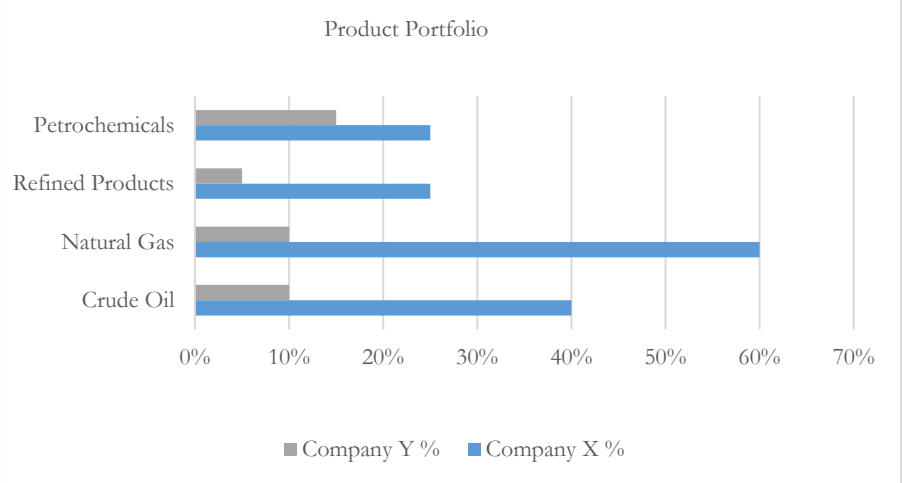


Fig. 11. Differences in product portfolio.

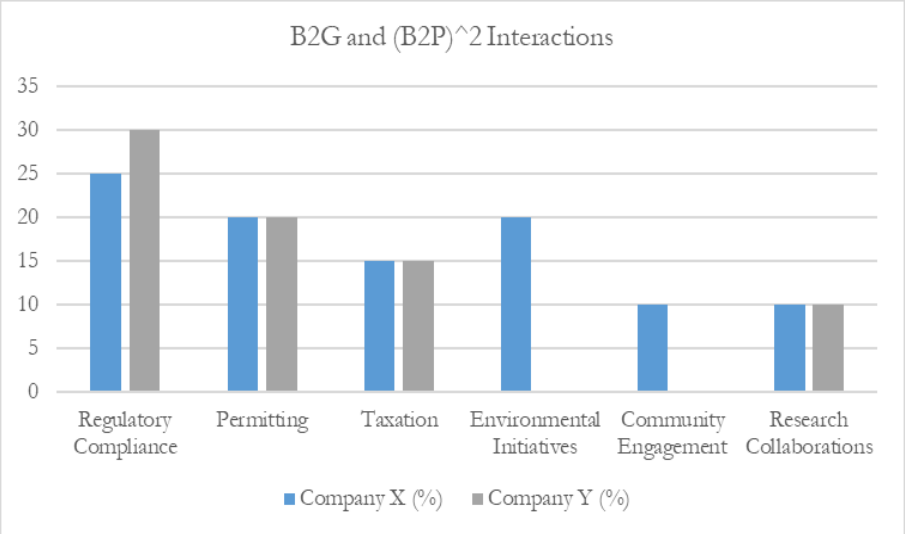


Fig. 12. B2G and (B2P)^2 interactions.

In summary, company X operates on a much larger global scale with a diverse range of energy activities across multiple continents. In contrast, company Y, though expanding, remains focused on a more regional market with a narrower operational scope.

6 | Recommendation

The data indicates that company X effectively utilizes a diverse range of supply chain tools, significantly enhancing its market positioning on a global scale. In contrast, company Y, while on an expansion trajectory, currently operates within a narrower regional market.

To boost its performance and competitiveness, company Y should consider broadening its supply chain toolkit to incorporate advanced methodologies and technologies. Additionally, investing in comprehensive market analysis will enable company Y to better assess customer demand and preferences. This proactive approach will help company Y align its offerings with market needs, ultimately improving customer satisfaction and loyalty.

Fostering a culture of continuous improvement within the organization will also be crucial. By encouraging innovation and incorporating feedback loops into their processes, company Y can drive greater efficiency and adaptability in its operations.

By implementing these strategies, company Y can position itself more effectively within its market, ensuring it not only meets but anticipates customer needs, thereby strengthening its competitive edge.

Demand planning balances supply and demand, enhancing communication across departments. Key goals are to minimize variances and accurately forecast demand using tools like statistical forecasting and demand analysis. Both companies should adopt the proposed demand planning process to lower inventory holding costs.

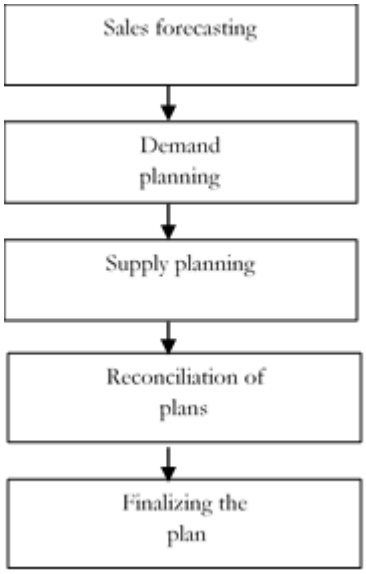


Fig. 13. Process for demand planning.

6|Conclusion

Company X and company Y operate in the energy sector but differ significantly in scale and focus. Company X, a global energy giant, manages a diverse portfolio including exploration, production, refining, and marketing across numerous continents. This extensive reach results in a complex global supply chain. In contrast, company Y operates on a more regional scale, focusing on specific areas such as central Europe, the Middle East, and Africa. Its supply chain is consequently more specialized.

Company X's broad product range—covering crude oil, natural gas, refined products, and petrochemicals—demands a multifaceted supply chain. Company Y, with its focus on petroleum products and petrochemicals, operates a more streamlined supply chain. The global operations and diverse activities of company X contribute to its complex supply chain, whereas Company Y's regional focus leads to a simpler structure.

Both companies face unique regulatory challenges depending on their operational regions, affecting their supply chain strategies. Company X invests heavily in advanced technologies and digital solutions, while company Y's technological investments are tailored to its specific regional needs. Their supplier and partner relationships also reflect their operational scopes.

In terms of interactions, company X engages extensively with government agencies for compliance, permitting, and taxation, and partners with environmental groups, local communities, and research institutions to drive sustainability and innovation. Company Y's government interactions focus on regulatory compliance and licensing within its operational regions.

Overall, both companies navigate the energy sector's complexities through their tailored B2G and B2P^2 strategies, contributing to their respective successes.

Acknowledgement

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We would also like to extend our appreciation to the supply chain teams at both organizations. Your insights and collaboration have greatly enriched our research and contributed to the depth of our findings

Ethical Statement

This study does not include any research involving human or animal subjects conducted by the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest related to this research, ensuring that the integrity of the findings remains intact.

Data Availability Statement

The data that support this research are available upon reasonable request to the corresponding author.

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