

## Article

# Sustainable Supply Chain Practices in the Oil and Gas Industry: A Case Study

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**Abstract:** Sustainability reporting within the oil and gas (O&G) industry started back in the 1990s and has improved longitudinally since then. However, when reporting their sustainability-related practices and initiatives, O&G companies seldomly mention the term green supply chain management (GSCM). The study aims to investigate the development of GSCM practices in the O&G sector and to categorize how they are integrated with the sustainability practices reported by the industry. A multi-phase research approach was adopted consisting of a comprehensive literature review, followed by a single case study employed in an international oil and gas company. Primary data were collected by conducting 12 semi-structured interviews with senior members of an O&G company. Thematic analysis was employed to analyze the primary data from the interviews and to synthesize this work with the secondary data in order to answer the research question. The research identifies that the adoption of green purchasing practices is still in its infancy, whereas green production practices are more advanced compared to the current academic literature on the O&G industry. Additionally, new insights are obtained on how O&G companies are diversifying their business models and investing in the renewable energy business. The results of this work will enable O&G businesses to understand the latest developments in GSCM practices and how they are impacting the O&G sector. Practitioners will also be able to benchmark their current GSCM practices with the research findings and develop and formulate strategies to maximize the implementation of GSCM practices.

**Keywords:** oil and gas; green supply chains; sustainable production

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## 1. Introduction

The oil and gas (O&G) industry is a major contributor to the world economy [1] and is rapidly expanding to meet the ever-increasing demand for energy [2,3]. The industry has largely met the global energy requirements of the last few decades [4] but this in turn has impacted the environment and the ecosystem severely [2–9]. Increasingly so, attention is now turning to the O&G industry to become ‘greener’ in nature and to show its green credentials [2]. However, in an industry that has traditionally not had to deal with green initiatives until relatively recently, O&G companies are now facing challenges in developing green management practices. These challenges come from a combination of governmental and consumer pressures and include the continuing tension between the need to increase O&G production to meet increasing future demand whilst needing to reduce the industry’s environmental footprint, the need to align with and meet various climate change policy and protocol requirements, redesign of the industry’s supply chain system such that GSCM practices are driven down the supply chain effectively, a highly complex and integrated end-to-end production system, and costly investment in new technologies and systems required to meet legislation and government targets. This means that the industry is struggling to meet its goals [4,5,7].

The concept of sustainability has received increasing interest over recent times [10] with one of the major contributions to the topic being the publishing of the Brundtland

Report in 1987 [10,11]. Since then, the O&G industry is facing growing pressure from stakeholders to become sustainable and reduce its environmental footprint [3,5]. Global and regional agreements like the Kyoto Protocol, Paris Accord, and United Nations Sustainable Development Goals (SDGs) have been implemented to drive organizations towards sustainability [9,12]. Therefore, regulatory bodies and societal pressures have played and continue to play a role in moving the industry towards sustainable development. As a result, the O&G industry has started to respond to the need to develop more pro-active sustainable practices in order to stay ahead of legislation [9]. Amongst the changes observed is the voluntary sharing of information publicly, which is seen as a way to improve stakeholder relationships and corporate brand value [5,13,14]. Researchers have deduced that sustainability reporting in the O&G industry has improved longitudinally from 2 companies in 1998 to 40 companies by 2010 among both national and multinational companies [5–7,13,15].

However, there is still substantial area for improvement in sustainability reporting of operational practices as they have been found to be focused more on social performance rather than on environmental performance [2,5,13]. While the application of sustainable supply chain management (SSCM) practices are improving, academics have pointed out the lack of maturity in the implementation of green supply chain management (GSCM) practices in the O&G industry [1,16]. In general, SSCM practices focus on the overall supply chain performance of a business. Whilst they see environmental sustainability as a focus, SSCM has a wider remit than just environmental sustainability and also includes social and economic sustainability dimensions. In many cases, it can be argued that economic sustainability has taken the greater focus within O&G industries over the years [17]. However, in order to meet the future climate and environmental reduction targets specified by governments, the O&G industry needs to focus more specifically on green supply chain management (GSCM). Implementing GSCM practices have been consistently found to directly improve the environmental performance of a firm [18]; as a result, GSCM practices have started gaining popularity within industry [19–21]. The adoption of GSCM practices offers a promising approach for organizations to be more environmentally friendly and become more sustainable [22]. Therefore, the focus of this study is to determine the state of play regarding the application of GSCM practices in the O&G industry. The following research questions are being asked in this study: *How mature are GSCM practices in the O&G industry? and How effectively are GSCM practices integrated within the O&G sector as a whole?*

## 2. Literature Review

A literature review of academic journal articles was carried out in order to identify the scope and depth of previous research on the topic. The academic streams selected for literature review were the following: GSCM practices employed by non-O&G industries and GSCM and sustainability practices reported by the O&G industry. The academic literature was reviewed to address the research question: how are sustainability practices integrated with GSCM of the O&G industry? Two main literature streams were identified, i.e., GSCM practices reported in all industries and sustainability practices reported in the O&G industry. The literature from these two streams were explored to gain knowledge of previous research and to develop a conceptual understanding and framework for this study.

### 2.1. Literature Review Design

A comprehensive literature review was conducted in order to identify key GSCM practices developed within industry in general and then, more specifically, within the O&G industry [23]. A systematic search was carried out using online databases EBSCO, Emerald Insight, and SCOPUS. Key search words were identified from analysis of previous academic publications in the area of study and from prior knowledge of the sector by the researchers [24,25]. Key search terms were (“Sustainable Supply Chain Management” OR “green supply chain” OR “green supply chain management”) AND (“Oil and gas” OR “oil” OR “gas” OR “petroleum” AND “sustainable supply chain” OR “green supply chain” OR “sustainability”).

This practice is in line with the literature review methodology deployed by previous researchers [24]. English language and peer-reviewed journals published in the last 6 years were selected as limiters. A total of 130 articles were downloaded, and their titles, abstract, summary, and findings were reviewed to see if they were relevant to the research topic and that they addressed the research question. In total, 63 articles were shortlisted based on relevancy during this screening process. Additionally, nine articles were manually added that did not appear in the search results but were found to be relevant. The screening of articles and subsequent addition is a practice used by previous scholars on the topic [25].

The first literature stream, i.e., GSCM, has been deliberated within academic circles since 2000 [26] but has seen an increasing number of publications being written on the topic in the last 10 years [20,26,27]. Moreover, an increase has also been observed among companies in incorporating GSCM in their supply chains as a result of increasing environmental awareness and perceived benefits of GSCM practices [21,28]. Common themes observed within the GSCM literature include:

1. The identification and categorization of GSCM practices and strategies [19,20];
2. The impact of GSCM practices on company performance [29];
3. Antecedents, drivers, and barriers in adopting GSCM practices [28];
4. Factors required for successful adoption of GSCM practices [30,31].

The literature review focused on the first theme found in the GSCM literature stream, i.e., the identification and categorization of GSCM practices, to address the research question. The second literature stream reviewed was GSCM and general sustainability practices reported in the O&G industry. Common sub-themes that emerged from this literature review included the following: (1) the identification and benchmarking of sustainability practices in the O&G industry [13]; (2) SSCM practices in the O&G industry [1,5]; and (3) drivers, barriers, and factors affecting sustainability practices in the O&G sector [14]. The first two sub-themes were investigated further in this literature review as they were deemed necessary in identifying and understanding the current level of GSCM practices in the O&G sector.

## 2.2. Green Supply Chain Management Practices

GSCM practices in an organization vary upon the nature, size, and the industry sector to which the firm belongs to [32]. The adoption of GSCM practices also varies between organizations [31] and among countries [33]. The previous literature categorizes GSCM practices either from an organizational perspective, i.e., (1) internal and external GSCM practices [20,34,35] and (2) upstream, internal and downstream practices [29], or from (3) strategic type and importance [19,29].

Table 1 identifies the major GSCM internal practices identified from the literature. These thematic areas include (G1) Internal Environmental Management, (G2) Green Design or Eco-Design, (G3) Green Purchasing or Green Sourcing or Green Procurement, and (G4) Green Production or Green Manufacturing. External GSCM practices observed in the literature include (G5) Green Warehousing and Green Packaging, (G6) Green Logistics including reverse logistics, (G7) Collaboration with Supply Chain Partners, and (G8) Investment Recovery. It is important to highlight that the GSCM practices in all three models do not differ and are similar to each other. The first model of internal and external GSCM practices has been used for developing a conceptual understanding of the academic literature and a baseline for this research.

**Table 1.** Major GSCM Practices Identified in the Literature.

GSCM Practices	Academic Sources
<b>Internal GSCM practices</b>	
G1. Internal Environmental Management (IEM)	[20,22,23,34,35]
G2. Green Design (GD)	[19,21–23,30,32–35]
G3. Green Purchasing (GP)	[11,19–23,30,32,34,35]
G4. Green Production (GPD)	[11,19,20,30]
<b>External GSCM practices</b>	
G5. Green Warehousing and Green Packaging	[11,20,21,30,35]
G6. Green Logistics (GL)	[11,19,20,32,33]
G7. Collaboration with Supply Chain	[19,20,22,23,33–35]
G8. Investment Recovery (IR)	[19,22,23,30,33–35]

### 2.3. Sustainability Practices in the Oil and Gas Industry

The O&G industry has seen an improvement in its environmental reporting in the recent past with most companies now reporting and developing sustainability practices in line with International Petroleum Industry Environmental Conservation Association (IPIECA), the International Oil and Gas Producers Association (OGP), and the American Petroleum Institute (API), which have developed industry specific guidelines [2,5,13]. Companies are similarly now publishing their sustainability performance and practices in line with different international standards [2,7]. This is because O&G management and the larger industry now see sustainability as mandatory in order to operate and to sustain their businesses [7]. Scholars however have noted that there is still a lack of GSCM and supply chain metrics included in the sustainability practices of O&G industries [5,16]. Some of the reasons for this exclusion are that O&G companies usually adopt industry-specific guidelines [5], and any environmental-related disclosures are not regulated and are done on voluntary basis [6].

A study of GSCM practices of O&G companies observed that five out of 30 companies express their interest to purchase environmentally friendly products [5]. More than half of these companies also screen their suppliers to see if they can meet the firm's environmental management systems [5]. This assessment and screening is usually done through evaluating supplier's code of conducts, values, environmental standards and certifications, sustainability scorecards, and contract and quality compliance [1,5,36]. Environmental management certification is usually used as a screening criterion by O&G companies, as it provides evidence of a firm's commitment to adhere to environmental requirements and improving environmental performance [6]. Inclusion of sustainability criteria for selecting suppliers is also a recent trend observed among O&G companies [36].

Key sustainability metrics reported in the O&G industry include greenhouse gas emissions (GHG), oil spills, production and recovery of solid waste, liquid waste and deforestation [5,7,14]. O&G companies are also adopting carbon capture and storage technologies (CCS) which aim to capture and reuse the carbon emissions from its operations rather than releasing these to the atmosphere [12]. Firms are also using eco-innovation capabilities and energy efficient technologies to produce less waste [5] and reduce the use of energy, which helps to reduce GHG emissions and the overall carbon footprint and improve air quality in the production process [5,9,37]. Companies are developing innovative technologies that are designed to reduce the environmental footprint [9]. Other firms have implemented pipeline monitoring and maintenance and wastewater recycling and reduced water in their processes [5]. Organizations are also implementing "Green IT" solutions to support the implementation of sustainability in their business processes [4]. The reduction of oil spills, gases, and other forms of pollution can be classified as falling under GPD processes as O&G production processes are optimized to reduce pollution and

waste derived from O&G operations [1]. However, academics highlight that improvement is still needed in managing environmental spills, emissions, process safety, and process management [2,4,5]. Scholars have also highlighted that O&G companies should also incorporate green packaging in their products where applicable [1,3].

O&G companies are today realizing the importance of GL as a means to achieve sustainability [1]. Based on a GSCM survey [5], around 50% of O&G companies have also mentioned that they have strategies in place for managing logistics in a more environmentally friendly way. Around 13% of O&G companies surveyed for GSCM practices confirmed that they plan vehicle routes and have journey management plans in place [5]. Some companies have transportation management systems in place to optimize energy consumption and reduce emissions [16]. Other measures taken include managing product life and worn-out equipment [16]. Research has highlighted the need for O&G companies to adopt fuel efficient vehicles in their business models to become more sustainable [1,16].

The majority of the O&G companies realize the importance of engaging and collaborating with stakeholders to achieve improvements in their sustainability practices [1,5]. O&G companies are also now collaborating with local communities, customers, and NGOs to meet their expectations [1,7]. This is being done through increased share of information, providing frequent updates and establishing a shared vision [1]. Table 2 shows the general sustainability practices mapped against the GSCM practices of the O&G industry from the literature review conducted.

**Table 2.** A Summary of the Sustainability Practices and Their Integration with GSCM Practices in the O&G Industry Based on the Literature Review.

Internal GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Academic Sources
G1. Internal Environmental Management (IEM)	1. Defining and communicating the organization's environmental policy.	X	[2,5]
	2. Commitment and support of management to adopt environmentally practices.	X	[4,5,8]
	3. Adopting environmental management systems (such as ISO 14001 certification).	X	[2,37]
	4. Complying with legal regulations and adopting environmental audit programs.		
	5. Cross-functional collaboration to improve the environment.		
	6. Raising awareness through training and education of employees.	X	[2,9]
G2. Green Design (GD)	1. Designing products to reduce material or energy consumption.	X	[9]
	2. Designing products so that they can be reused, recovered, or recycled.		
	3. Designing products to reduce usage of hazardous materials.		
	4. Designing products for environmental improvements (packaging, etc.).		
	5. Conducting life cycle analysis of products.		

Table 2. Cont.

Internal GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Academic Sources
G3. Green Purchasing (GP)	1. Purchasing with a preference for environmentally friendly raw materials, products, packaging, etc.	X	[5]
	2. Purchasing from suppliers who have environmental management systems in place (via pre-screening, prequalification, evaluation, etc.).	X	[1,5,6,36]
	3. Conducting environmental audits of first- and second-tier suppliers.		
	4. Collaboration, training, and encouragement of suppliers to adopt environmental management systems.		
G4. Green Production (GPD)	1. Optimizing production process to reduce consumption/efficient utilization of natural resources (water, energy, etc.).	X	[2]
	2. Production process to reduce waste and pollution (solid waste, liquid waste, air and noise pollution, etc.).	X	[4,5,9,37]
	3. Optimizing and making the production process lean by reducing, reusing, recycling, and remanufacturing materials.		
	4. Incorporating environmentally friendly technologies in the production/manufacturing process.	X	[4,5,9,12]
External GSCM practices			
G5. Green Warehousing and Green Packaging	1. Reduction and optimization of inventory levels.		
	2. Selling surplus inventory.		
	3. Selling scrap and redundant inventory.		
	4. Eco-packaging that can be recovered, returned, reused and recycled (environmentally friendly packaging).	Recommended but no evidence seen.	[1,3]
G6. Green Logistics (GL)	1. Reducing fuel consumption.	X	[2]
	2. Use of alternate energy sources in transportation.	X	[2,5]
	3. Ordering and moving goods in complete batches.		
	4. Using environmentally friendly vehicles and transportation.	X	[1,2,16]
	5. Planning vehicle routes.	X	[5,16]
	6. Reverse logistics: transportation of reverse supply chain (recovery, return, recycling, reuse of scarce resources and products).	X	[5,16]



Table 2. Cont.

Internal GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Academic Sources
G7. Collaboration with Supply Chain (Suppliers, customers etc.)	1. Joint definition and achievement of environmental objectives and goals.	X	[1,5]
	2. Joint development of eco-friendly solutions and technologies.	X	[1,16]
	3. Joint environmental design.		
	4. Developing recyclable products and packaging materials.		
	5. Collaboration to use less energy.		
	6. Collaboration to clean production process and employ product take backs or reverse logistics.		
	7. Collaboration to reduce waste and pollution.		
	8. Joint education and training programs with supply chain partners.		
G8. Investment Recovery (IR)	1. Selling excess inventory or raw materials.		
	2. Selling excess capital machinery and equipment.		
	3. Selling used, junk, or scrap materials.		
	4. Collection and development of recycling systems of used, defective materials and end of life products.	X	[16]

The literature review and Table 2 highlight that the O&G industry is rapidly responding to the need to employ more GSCM practices within the industry. Through a systematic review of the literature, eight major GSCM practices were highlighted consisting of four internal and four external GSCM practices. In mapping the information gained from the literature, it shows that the O&G industry is applying many of the general SSCM practices employed in other industry sectors within the internal GSCM sphere. However, areas such as Collaboration with Supply and Demand Chain Companies (G7) are still relatively underdeveloped. Likewise, action on Investment Recovery Practices (G8) is only very partially addressed. The thematic area around Green Design (G2) is also heavily underdeveloped with the focus primarily on designing systems for energy or waste reduction. This in itself is worthy, but a more comprehensive addressing of each of the major GD practices is not current being considered from the literature analyzed. Generally speaking, the literature survey suggests that the O&G industry is making significant efforts in addressing internal GSCM practices but still has some way in addressing external GSCM practices.

### 3. Research Design

The literature review provided a firm foundation for the research work through identifying the key GSCM practices being undertaken in the O&G industry. The second stage of the study was to undertake a comprehensive review of GSCM practices in a O&G company. The aim for conducting this case study was to establish whether the GSCM practices highlighted in the literature review are being applied in the case company and also to identify whether the company employed different GSCM practices that could be reported and allow for the enhancement of the research base of GSCM practices employed in the O&G industry.

The selected case company "X" is an international integrated oil and gas company and has a global presence with its headquarters based in Europe. "X" as an integrated O&G company and has business activities covering exploration and production operations, gas

distribution, refining, petrochemical business, retail outlets, filling stations, and mobility solutions. This means that “X” has end-to-end ownership and control over the oil and gas business and therefore not only has a large environmental footprint but also takes measures to contain this footprint. Company “X” has operations in over 30 countries, employs more than 25,000 people, and has over 80 years’ experience in the O&G business. Company “X” is therefore considered to be relevant for this research as it is a good representation of the O&G industry and has publicly committed to sustainable procurement and supply chain practices, therefore addressing the objective of the research question and being of interest.

Primary research in “X” was carried out via conducting interviews with 12 senior managers from within the company. These managers were selected specifically due to their experience and knowledge of the complete supply chain systems as well as their knowledge of the environmental practices employed within the business. Further secondary data were collected from the company’s internal and publicly available documentation, which is also supported from previous scholarly research on the GSCM topic [20]. The combination of primary and secondary data collection and analysis (including the secondary literature review of data) complemented and supported the research as it allowed for a robust triangulated approach to the work [38,39].

#### *Primary Research Stage Design*

Purposive sampling [40] was initially adopted, meaning that all the interview participants were identified and selected with the knowledge, experience, seniority, and ability to respond to the research question [41–43]. The participants are senior managers from the procurement and supply chain function with key decision-making responsibilities and leadership roles. Their roles cover the end-to-end procurement and supply chain process, which is pertinent to the topic of GSCM [44,45].

The use of semi-structured interviews supported by company documents as secondary data is also observed in qualitative research guidelines [46–49]. The head of the procurement division (CPO) was initially approached with a request to conduct semi-structured interviews in order to obtain consent and secure buy-in [38,50]. Based on the suggestion from the CPO a 15-minute briefing meeting was conducted prior to the interviews with the majority of the participants clarifying the purpose of the interview and to assure that all information shall remain anonymous and confidential [38]. The secondary data phase involved the collation of the latest published company documents and an internal document outlining the company’s SSCM and GSCM process framework. These documents were used as inputs for the preparation of the interviews and were also useful for tracing the values and statements made by the leadership team of the organization [38]. Interviews were then conducted with each of the 12 participants. Participants were asked to review the process documentation provided and to identify their area of responsibility in the process. From here, participants were asked to identify the GSCM practices that they had employed and to whom they were responsible for. Further discussion between interviewer and participant enabled each of the GSCM practices to be further explored and analyzed. The interviewer logged the practices identified and added them to the database of GSCM practices created as part of the primary/secondary data research study. Not only were the key GSCM practices identified but discussion ensued around issues of communication, barriers to implementation, and the general issues surrounding the management and implementation of such practices. Each interview ran of approximately one hour each. Following data collection, thematic analysis was subsequently employed to analyze the collected data [51]. A six-phase guideline to TA [48,51] was adopted. The first phase involved entering all the transcripts of each interview in a single MS Word file and categorizing them based on the participant codes. Participant codes were linked with the data being rearranged in terms of answers to ensure traceability [48].

The second phase in the TA process consisted of reading and analyzing the data through an iterative approach in order to ensure familiarity and acquaintance [48,51]. As a result, 98 initial codes were generated in the third phase from the data set until data



saturation was attained and no further topics were left in the data set. The codes were subsequently categorized in a tabular format to ensure that they are originating from the data set [39]. The fourth phase involved searching for appropriate themes related to the research question and using the conceptual understanding gained from the previous literature as a starting point [39,43,48]. This analysis was done multiple times until the researchers agreed that the emerging themes covered the content of the codes [48,51]. As a result, 42 emerging themes were identified that were reviewed, rearranged, and refined into 16 order themes and subsequently categorized into 7 higher order themes in the fifth phase using axial coding [52,53]. The higher order themes were also aligned with the conceptual understanding of the previous literature [39], ensuring that they addressed the research question and were cross-checked from the research data [50].

#### 4. Research Findings and Analysis

Figure 1 shows the results of the thematic analysis with the resulting first order and second order themes identified. The effective clustering of the thematic areas link neatly to seven of the eight major GSCM practices shown from the literature review. Interestingly, the primary data analysis showed that it was not possible to identify any initiatives or practices being developed relating to Green Design (G2). This connects strongly with the work showing in the literature review and validates to some extent that GD is not seen as a major priority within the industry at the moment. Likewise, some but no significant work is being undertaken in thematic areas, such as Investment Recovery (G8), Collaboration with Suppliers (G7), and Green Logistics (G6) at the moment. Further details are shown in the phase two of the primary research stage.

The second phase of the primary data analysis aimed at analyzing the rich contextual and narrative information that emerged from the interview stage. Once the mapping of the key GSCM practices had been undertaken, the researchers reviewed the narrative information in order to identify the management practices that underpin the work being done in developing the GSCM practices in the company.

The first issue to note was that Company “X” had recently established a “Responsible Procurement (RP)” framework back in December 2021. This framework reiterates the firm’s commitment towards sustainability, in line with its corporate strategy and compliance to regulations. Moreover, it also outlines how “X” intends to reduce its environmental footprint, its areas of focus, and expectations from its supply base. This was one of the most common initiatives as it was identified by eight of the 12 participants and additionally stated in the company’s 2021 annual report. Participants acknowledged that the initiative had only been recently introduced at the time of interview, and a number of participants stated that they were still getting used to it adjusting their operational activities to align their departments with the requirements of the framework. One third of the participants (four of 12) also emphasized the need for the company to equip the procurement community with the necessary knowledge and tools to successfully implement the actions identified in the “Responsible Procurement” framework. These participants highlighted that internal workshops and roundtable discussions on sustainability had been arranged at different forums within the company to raise awareness. Moreover, detailed internal training material has also been developed in collaboration with external partners focusing on sustainability and SSCM practices. Two of the participants (Participants 8 and 11) also highlighted that the importance of sustainability was regularly communicated through townhalls, and updates and projects linked with GSCM practices were also shared in those meetings.

The second theme that emerged was the preference of company “X” to purchase environmentally friendly materials and source from suppliers who have sustainable practices in place. The majority of the participants (eight of 12) stated that “X” had also introduced a mandatory sustainability related questionnaire in its pre-qualification process that is managed via its e-procurement platform. The objective of introducing the questionnaire in the pre-qualification process was to learn more about the supplier’s sustainable practices and evaluate the maturity of the supply base and to subsequently set SSCM and GSCM

targets. This information was also found to be present in the secondary research documents, i.e., the RP framework as well as the organization’s 2021 annual report.

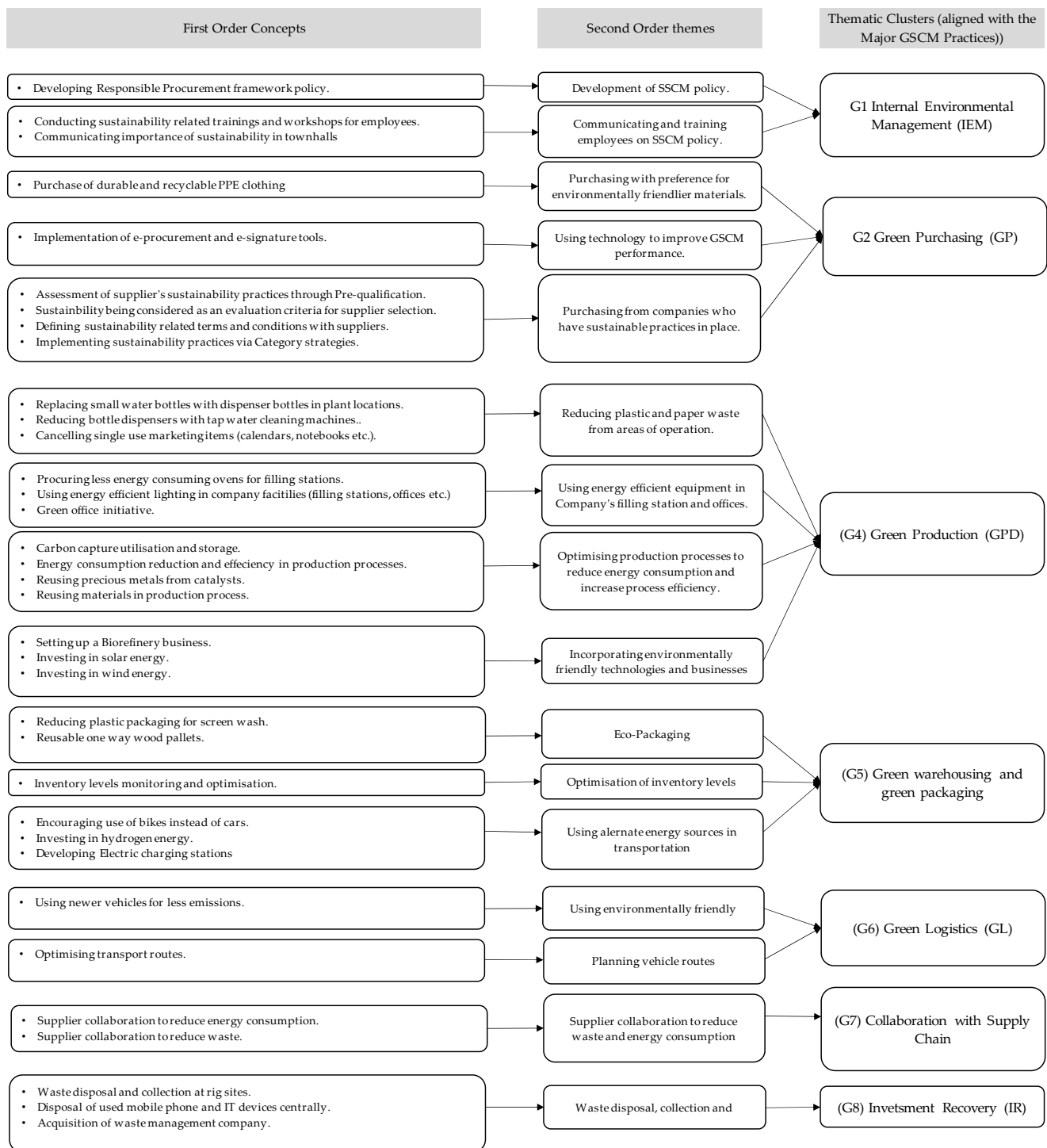


Figure 1. Results of Interview Phase.

A further practice identified is the inclusion of third-party sustainability-related clauses in contracts. For example, “X” includes the RP framework in all its contracts as an annexure that all suppliers need to agree and sign-off if they intend to do business with “X”. Including sustainable aspects (practices, policies and actions) in contracts was identified by five of the 12 participants, and support of the same was also available in the annual report. While the ‘sustainability requirements’ were covered in the pre-qualification and contracting

process, they were not prevalent in the supplier evaluation selection process as only two participants mentioned the incorporation of sustainability in evaluation models.

Participants 1 and 10 said that fuel consumption is made part of the evaluation process, via the total cost of ownership (TCO) model, although Participant 10 acknowledged that such practice is not typically found in evaluation and supplier selection processes. Sustainability aspects are also driven through the company's category strategies which are prepared by the category management team as confirmed by 4 participants. The company also aims to have 100% category strategies reviewed from a sustainability perspective. Another aspect of GP identified from the research is the application of e-procurement and e-signature systems present in the organization's procurement process. Both systems eliminate the usage of paper, reduce CO<sub>2</sub> emissions, and improve GSCM performance. The procurement team is also looking into the implementation of IT solutions that could help in assessment of CO<sub>2</sub> emissions impact of the firm's supply chain as mentioned by Participant 10. Participant 6 also provided an example where the procurement team makes purchases with a preference for environmentally friendlier materials.

Being an integrated O&G company, "X" has significant potential to increase the efficiency of its operations, reduce its energy consumption, and improve its GSCM performance via GPD across all its activities simultaneously. One of the major initiatives taken by "X" is to capture CO<sub>2</sub> emissions using carbon capture, utilization, and storage technology (CCUS) in the upstream operations. Four of the participants identified this initiative and the positive impact it is having by reducing the carbon footprint of the company, and this initiative was also mentioned in secondary sources, such as its annual report.

Participants 1, 2, and 7 also highlighted capital expenditure investments that the company has made over the past 2 decades in modernizing its downstream and refinery operations. These new technologies not only increase process efficiency but also help in monitoring and reducing harmful emissions. Participant 4 provided an example where the company reuses precious metals from the catalyst in its downstream operations, subsequently benefiting the environment. Participant 2 also revealed that the downstream production business is optimized in such a way that materials that are no longer used in the refining process can be used in the petrochemical business or can be sold to other industrial sectors. Participant 10 informed that the company is planning to relocate its headquarters, and the new under-construction building is an environmentally friendly structure that will use minimum artificial lighting and shall be powered by solar technology. Apart from this new building "X" is also using solar panels in its warehouses and plant operations. In addition to optimizing its production processes and using energy efficient equipment, "X" is proactively trying to reduce its plastic waste and is also investing in renewable energies and technologies to move towards a circular economy. Around half of the participants informed that the company has expanded its solar energy capabilities and is now producing 100% renewable energy generated from solar panels. This was also highlighted in the annual report.

The fifth major theme emerging from the research is GL. Participants 6 and 12 confirmed that "X" uses optimal transport routes in its logistics operations, which helps in decreasing logistics cost and CO<sub>2</sub> emissions. Participant 6 also shared information on the car sharing and e-mobility system, which is a success story for the company where consumers can share electric cars for conveyance, representing a neutral mobility solution. "X" is also now offering electric vehicle charging points at its filling stations as confirmed by Participants 6 and 10, and it intends to install 500 electric vehicle charges by 2025 as stated in its annual report. Participant 2 also mentioned that "X" also plans to offer hydrogen fuel cell-related mobility options as it has also started its green hydrogen manufacturing facility, and this information is also supplement in the annual report. Apart from providing alternate energy sources for transportation "X" also encourages the use of bikes as a conveyance mode from the office and has set up bike facilities and rental bike options to facilitate its employees as specified by Participant 6. Participants 1 and 3 also pointed out that "X" has also replaced diesel forklifts with electric forklifts in its warehouse and indoor operations

to reduce the environmental impact from heavy lifting equipment operations. Where replacement is not possible, “X” is also using newer trucks that produce less emissions compared to older models as specified by Participant 12.

The research findings provided very little evidence on collaboration of “X” with its suppliers. Participant 12 identified that the change of lighting systems in all buildings and administration sites to LED technology was proposed by one of its suppliers, whereas Participant 11 shared the initiative taken by one of the rig suppliers in reducing food waste at drilling rig sites by incentivizing shifts that produced less food waste. Four participants however highlighted the waste collection, disposal, management, and remediation services that “X” employs through one its waste management and remediation suppliers. Participants 6 and 10 also shared a recent update where “X” acquired a waste management company through which it will manage and recycle plastic waste. Another small-level initiative shared by Participant 4 was a disposal program through which used mobile phones and IT devices could be handed over centrally for efficient handling and disposal.

## 5. Discussion

IEM is essential in improving an organization’s economic and environmental performance [54] and subsequently is commonly adopted by companies [19]. IEM usually involves the commitment of the leadership team [18,34,35], which is subsequently communicated and developed into the strategy [20]. The commitment to address environmental issues through mission, values, and policies [2,5,7] and through leadership commitment and support [4] was observed previously in O&G companies. “X” is no different in that the organization regularly reiterates its commitment towards sustainability through its public reports. Moreover, the company has developed a SSCM framework titled Responsible Procurement (RP) through which it has outlined its vision and aspirations towards its supply chain. This commitment in the form of a policy was one of the common themes obtained from all of the research participants. Research findings confirmed the presence of roundtable discussions and training in “X” to raise awareness with regards to sustainability. Furthermore, extensive training material has also been prepared for the procurement and supply chain community. Management commitment and training sessions are found to be the biggest factors to adopt GSCM practices for O&G companies [3], and these are validated through the research findings. The adoption of environmental management systems [19,34] and compliance to regulations and environmental programs [22] are the third most common sub-practice found in IEM, and evidence of this has also been found for O&G companies previously [2,37].

The research findings provided partial evidence on compliance to regulations and environmental systems as this was not frequently identified by the participants. However, it was mentioned in detail in the annual report. This could be possible due to less knowledge among the procurement community considering that this topic is more associated with the Health, Safety and Environmental (HSE) department of “X”. This is identified as an area of and for improvement, and reinforcement is needed on this practice. Another sub-practice found in the previous literature is cross-functional collaboration [19,22,34], and there was little to no evidence seen of such cross-functional collaboration within O&G companies in both previous and current research. This is identified as another area of improvement as sustainability targets for the organization can be met through cross-functional collaboration among departments. The presence of IEM was partially supported in “X” through its leadership’s commitment, formulation of policies to address sustainability, and imparting trainings to its staff. Research however identified that there is no conscious cross-functional collaboration, and compliance to regulations and environmental management systems was not identified by the research participants primarily as it is not perceived as a procurement- or supply chain-specific topic.

In terms of green design (GD), no clear and direct evidence of GD was highlighted by the participants. Likewise, no evidence emerged from the literature review that O&G companies extensively redesign their products at the product development stage to provide

environmental benefits. This is a conscious cultural approach that “X” and other O&G companies need to adopt so that they can obtain further environmental benefits from their offerings. It is important to note that GD has an overlap with green production (GPD) in terms of reusing, recovering or reducing material usage in the production.

In terms of green purchasing (GP), evidence suggests that there was only a partial consideration in purchasing environmentally friendlier materials by the company. Again, this further validates the information from the literature review in that the practice is not observed to be widespread within the company or industry as a whole. Pre-screening suppliers on the basis of environmental systems and certifications and including sustainability aspects in the tendering stage are one of the common GP techniques prevalent in previous research and also practiced in the company [19,20]. However, this is not universally adopted amongst the 12 participants in the respective departments. Organizations outside the O&G industry are found to be pro-active in their GP practices. They not only conduct environmental audits of their first- and second-tier suppliers; they are also encouraging, collaboration, and training of their suppliers to become more environmentally sustainable [19–21]. This practice is not prevalent in the O&G industry as a whole and also has not been observed in “X” either. O&G firms are more focused towards contract and quality compliance [1,5,36], and this is also evident in “X” where it has made its policy part of contract annexures. This reflects a more conservative approach in GP practices generally within the O&G industry and specifically in “X”. Practices are limited to compliance of suppliers either through pre-screening assessments or through clauses in the contract with little evidence of evaluating suppliers on sustainability in tenders. A possible reason could also be the lack of knowledge among practitioners and difficulty in the preparation of tendering documents and evaluation criteria [55,56].

In terms of green production (GPD), one of the common techniques used in GPD is the focus on minimizing solid, liquid, and noise and air pollution [19–21]. O&G companies are reducing air emissions through carbon capture, utilization, and storage technology [12], and the same practice has also been validated in “X”. O&G companies also measure and report their spills, solid waste, and greenhouse gas emissions [5,7,14]. While “X” is also reporting its oil spills and other waste metrics in its annual report, current research did not find any initiative taken to reduce such waste.

This could possibly be due to a lack of technical knowledge among the procurement community given that it is a business-led initiative. However, participants did mention capital expenditure investments made by “X”, including green technology in order to increase the process efficiency and monitor and reduce air emissions. Such technologies are also documented in previous research [5,9,37]. However, an initiative found in other O&G industries is to consciously reduce water in their production processes and also recycle wastewater where possible [5]. Such efforts to reduce and reuse water are not observed within “X” even though it is reporting its water consumption in the annual report. Scholars have identified that O&G companies need to improve their GPD processes related to environmental spills, emissions, process safety, and process management [2,4,5], and the same holds true for “X”. Another GPD practice is the recycling of raw materials or not using hazardous materials [19,20]. The research findings show that “X” is pro-active compared to its peers as it is reusing raw materials and precious metals multiple times throughout its operations and also selling used raw materials to other industrial units. This practice is not prevalent in the previously reviewed research.

An additional practice found in “X” is its focus on reducing its energy consumption through investments in energy efficient ovens and lighting in its retail operations and also reducing plastic waste through initiatives taken to reduce plastic water bottles as much as possible. “X” has also removed paper waste from its operations by introducing paperless technology and reducing paper marketing material. While these initiatives are small and not directly related to the production process, they do show that “X” is pro-actively identifying areas of opportunity to reduce its energy consumption and paper and plastic waste, and this phenomenon is not documented in the previous literature. The

introduction of such practices not only decreases the cost of operations but also brings quantifiable environmental performance. One of the most popular GPD practices involves moving toward alternate renewable energies [57].

In terms of green warehousing (GW), previous research has identified this to be one of the least adopted practices in industry as a whole [21]. This is true in O&G companies as well as no evidence was seen from the reviewed literature. One of the twelve participants mentioned optimization of inventory levels as an initiative by “X” to save space, reduce waste, and improve environmental performance. However, this was not highlighted by other participants. This could be primarily due to this practice not being widespread in the organization or the fact that an initiative is not considered to be a GSCM or sustainable practice. Another important topic linked with GW in the previous literature is green packaging, which involves the use of environmentally friendly materials to package products [21,29]. The practice is extensively found in over half of the S&P 500 firms [58], is commonly adopted [59], and is also driven by increasing environmental awareness of the consumers to prefer green packaging [60]. The practice has been found to be employed not only because of environmental reasons but also because it reduces inventory handling-related costs [61]. Academics have highlighted that employing green packaging is an area of improvement for O&G firms, and they should employ such practices where possible [1,3]. Green packaging is found to be a common practice in “X”, and multiple examples were given by the majority of the participants on different initiatives taken in this area, such as reusable wooden pallets, foil packaging, and reductions in the plastics used in its offered products. This is another area where the research differs from previous literature on practices adopted by O&G companies. Research identifies that the green packaging initiatives at “X” share more in common with non-O&G companies, and participants are employing it as it provides both environmental and economic benefits.

In terms of green logistics (GL), some of the practices employed in GL involve the use of environmentally friendly vehicles and technologies and alternate energy sources with the objective to reduce fuel consumption and emissions [29,59] [21]. Previous studies have also identified that O&G companies need to adopt more fuel-efficient vehicles in their business to become more environmentally friendly [1,16]. This research confirms that “X” has already adopted most of the practices either observed or recommended in the previous literature. One of the observed practices includes providing electric vehicles through a car sharing system as a neutral mobility solution. “X” is also encouraging less use of vehicles as a conveyance mode through the encouragement of bike friendly solutions. Using optimal transport techniques, such as planning vehicle routes and moving goods in complete batches [29], is another prevalent practice in previous research. Reverse logistics (RL) is one of the most important GSCM practices employed by companies and includes the transportation process for recovery, return, recycling, and reuse of scarce resources and products [19,59,60]. Overall, “X” was found to employ relatively advanced GL/RL practices similar to its peers both inside and outside the O&G industry, with a major highlight being the adoption of green fuel solutions, such as electric charging stations and hydrogen fuel.

In terms of collaboration with supply chain partners, this research identifies that collaboration practices with supply chain partners is still in its early stages at “X”, and there are very few and discrete examples of such collaborations occurring. However, in waste collection and disposal, “X” has not only recently acquired a waste management company but also collaborates with its partners on safe collection, disposal, and remediation of its generated waste. The lack of collaboration overall could be primarily attributed to the fact that “X” has just recently implemented its RP framework and supplier assessment processes and is not yet fully aware of the capabilities of its supplier base. This is definitely identified as one of the areas of opportunity for “X” as it is lagging amongst its peers in such collaboration.

Finally, in terms of investment recovery (IR), “X” provides very little evidence on such practices. This is in line with the literature review material on the O&G sector. However, “X”



has developed IR practices that include the reuse and selling of raw materials or catalysts in downstream production process and programs implemented for safe disposal of mobile phones and other IT used equipment.

Overall, in terms of integration of these various GSCM practices in “X”, evidence of integration is observed in most of the dimensions. However, many of the practices are employed on a piecemeal basis with some departments employing certain practices and others not. This creates a patchwork of activity with little widespread use of coherency of practices employed. Table 3 illustrates the nature of the deployment of such practices across “X” and suggests that a more universal adoption of GSCM practices is employed in the form of an overall company strategy that is linked to the frameworks already in existence.

**Table 3.** Evidence of Integration of GSCM Practices and Sustainability Practices in Company X.

GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Evidence of GSCM Practices Found in Company “X”
G1. Internal Environmental Management (IEM)	1. Defining and communicating organization’s environmental policy.	X	X
	2. Commitment and support of management to adopt environmentally practices.	X	X
	3. Adopting environmental management systems (such as ISO 14001 certification).	X	<i>Partial evidence</i>
	4. Complying with legal regulations and adopting environmental audit programs.		
	5. Cross-functional collaboration to improve the environment.		
	6. Raising awareness through training and education of employees.	X	X
G2. Green Design (GD)	1. Designing products to reduce material or energy consumption.	X	
	2. Designing products so that they can be reused, recovered or recycled.		
	3. Designing products to reduce usage of hazardous materials.		
	4. Designing products for environmental improvements (packaging etc.).		<i>Partial evidence</i>
	5. Conducting life cycle analysis of products.		
G3. Green Purchasing (GP)	1. Purchasing with a preference for environmentally friendly raw materials, products, packaging, etc.	X	<i>Partial evidence</i>
	2. Purchasing from suppliers who have environmental management systems in place (via pre-screening, prequalification, evaluation, etc.).	X	<i>Partial evidence</i>
	3. Conducting environmental audits of first- and second-tier suppliers.		
	4. Collaboration, training, and encouragement of suppliers to adopt environmental management systems.		

Table 3. Cont.

GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Evidence of GSCM Practices Found in Company "X"
G4. Green Production (GPD)	1. Optimizing production process to reduce consumption/efficient utilization of natural resources (water, energy, etc.).	X	X
	2. Production process to reduce waste and pollution (solid waste, liquid waste, air and noise pollution, etc.).	X	Partial evidence
	3. Optimizing and making production process lean through reduced, reuse, recycling, and remanufacturing of materials.		X
	4. Incorporating environmentally friendly technologies in the production/manufacturing process.	X	X
G5. Green Warehousing and Green Packaging	1. Reduction and optimization of inventory levels.		Partial evidence
	2. Selling surplus inventory.		
	3. Selling scrap and redundant inventory.		
	4. Eco-packaging that can be recovered, returned, reused, and recycled (environmentally friendly packaging).	Recommended but no evidence seen.	X
G6. Green Logistics (GL)	1. Reducing fuel consumption.	X	X
	2. Use of alternate energy sources in transportation.	X	X
	3. Ordering and moving goods in complete batches.		
	4. Using environmentally friendly vehicles and transportation.	X	X
	5. Planning vehicle routes.	X	X
	6. Reverse logistics: transportation of reverse supply chain (recovery, return, recycling, and reuse of scarce resources and products).	X	Partial evidence
G7. Collaboration with Supply Chain (suppliers, customers, etc.)	1. Joint definition and achievement of environmental objectives and goals.	X	
	2. Joint development of eco-friendly solutions and technologies.	X	
	3. Joint environmental design.		
	4. Developing recyclable products and packaging materials.		Partial evidence
	5. Collaboration to use less energy.		X
	6. Collaboration to clean production process and employ product take backs or reverse logistics.		
	7. Collaboration to reduce waste and pollution.		X
	8. Joint education and training programs with supply chain partners.		

Table 3. Cont.

GSCM Practices	Sub-Practices	Practices Employed by the O&G Industry	Evidence of GSCM Practices Found in Company "X"
G8. Investment Recovery (IR)	1. Selling excess inventory or raw materials.		
	2. Selling excess capital machinery and equipment.		
	3. Selling used, junk, or scrap materials.		
	4. Collection and development of recycling systems of used, defective materials and end of life products.	X	<i>Partial evidence</i>

The findings contribute to management practice by providing a detailed list of GSCM sub-practices that are currently present in the O&G sector along with areas of opportunities. The findings can also help managers and practitioners to benchmark their practices and develop policies, procedures, and systems in their organizations to reach the desired level of maturity in GSCM practices and subsequently make their supply chains more environmentally sustainable. Key theoretical contributions in GPD practices include business model diversification by O&G companies and investments in renewable energy business<sup>1</sup>, which is a direction for future research.

This paper set out to answer two key research questions relating to the implementation and integration of GSCM practices in the O&G industry. How mature are GSCM practices in the O&G industry? How effectively are GSCM practices integrated within the O&G sector as a whole? In general, the research highlighted eight key GSCM practices identified from a comprehensive literature review and a two-stage primary data gathering and analysis process within a case company called company "X". In terms of how mature are GSCM practices in the O&G sector, the research highlighted that whilst the O&G industry (and in particular, Company "X") had employed a range of GSCM practices, many of those practices were in their infancy, and the industry was still trying to understand and employ the practices to best effect. Company "X" applied practices similar to the rest of the industry with the exception that "X" had developed more activity around supply chain collaboration than what the literature had identified as sector norms. Second, for the research question that asks how effectively are GSCM practices integrated within the O&G sector as a whole, evidence suggests that full integration is not currently apparent. There are pockets of best practice being deployed. However, as with the case of "X", GSCM practices are not employed in every part of the business with certain departments some and other departments employing different practices. It is encouraging to see the adoption of GSCM practices in "X", and it very much will now rely on institutional leadership to drive forward the adoption of more widespread use of these GSCM practices throughout the business whilst working on introducing more practices into the system going forward.

## 6. Conclusions and Recommendations

The findings have both theoretical and practical implications. The research validates the findings of the previous literature in terms of presence and maturity of IEM, GD, GL, GW, collaboration with supply chain partners, and IR practices adopted by O&G companies. However, the research identifies that "X" is still conservative in adopting GP practices compared to its peers in the O&G industry and is more advanced in GPD technologies compared to previous research.

The research also highlighted that "X" is diversifying its business model and investing in the renewable energy business, and this was not reported in the previous academic literature for the O&G industry. This is an original contribution to the theoretical literature on the presence of sustainability practices within the O&G industry and is potentially a direction for future research. Moreover, the research also summarizes a list of GSCM

sub-practices, and such details are not frequently listed in previous scholarly work. This could help both academics and practitioners alike. Given that the nature of GSCM practice deployment within “X” and the wider O&G sector as a whole is ‘patchy’, this research provides useful information to leaders and managers within the industry in providing support for their future strategy formulation and development plans. It should allow for the identification of new GSCM practices that managers are then able to adopt and to compare their businesses against current practice within the industry.

In general, “X” was found to be on par with its O&G peers and have partial IEM practices when compared to other industries. However, cross-functional collaboration within “X” related to IEM was not observed, and there was little evidence highlighting the implementation and compliance of environmental management systems. While “X” was found lacking in GD practices similar to other O&G companies, a new finding not reported previously was the conscious designing of packaging material by “X” in its downstream operations, which can also be adopted by other O&G firms. This demonstrates that the adoption of GD practices is relevant for the O&G industry, especially in its downstream and retail operations. Regarding GP, “X” was found to be conservative in its approach. While there was an interest to purchase environmentally friendlier materials, the practice was not found to be widespread among the organizations. Similarly, supplier pre-screening and assessment questionnaires were developed and used to obtain information about the supply market rather than to actually “screen out” suppliers from the company’s supply chain. Using sustainability as an evaluation criterion in tenders is also not prevalent. In addition, no evidence of “X” collaborating with and training its supply partners was observed, although evidence of this is seen recently among its O&G peers. The lack of maturity in GP practices has been highlighted previously and is confirmed through this research.

The research identifies a new phenomenon not reported previously, namely that “X” is also diversifying its business and investing in renewable energy technologies to become a carbon neutral company. This is the third recommendation that all companies working in the O&G industry need to explore, i.e., to diversify their operations to more renewable and sustainable energy solutions.

In terms of GW techniques, “X” has adopted green packaging practices, and these practices are mature compared to what has been reported previously for O&G firms. One of the practices least adopted by “X” and other O&G companies is the collaboration of these companies with its supply chain partners. This is a major area of improvement especially given that this is one of the main practices adopted by firms to truly become green throughout its value chain.

This research however has limitations like any other research. The findings are based on a single company case study and may not be representative of or may not be applicable to the whole industry. Moreover, the observed practices, while extensive, may not cover all the GSCM practices adopted by “X”. It is possible that there are some local or country specific practices that were not accounted for or confirmed by this research. Therefore, future research should consider practices of multiple companies so that the findings can be cross-validated and generalized more to the whole industry.

Also, considering that GSCM is a contemporary topic, participants may not be fully aware of the practices adopted by their firm or be able to link existing practices within their organization to the concepts of GSCM or sustainability. Future research should also conduct interviews of participants who are working in health, safety and environment, circular economies, and other related departments, other than the procurement and supply chain function. This shall be beneficial as it shall not only give a holistic view of an organization’s GSCM practices but is also able to identify areas of cross-functional collaboration that are found to be lacking in the O&G industry. Additionally, longitudinal data should be acquired to assess the evolution of GSCM practices within the O&G sector.

Despite these limitations, the findings contribute to implementation of GSCM practices. It also offers a new opportunity for research, especially in the transition of the O&G sector

from its traditional business model toward investment in renewable energy to achieve its goals of becoming an environmentally friendly and sustainable industry.

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