REVIEW ARTICLE

An integrative framework for sustainable supply chain management practices in the oil and gas industry

Nurul K. Wan Ahmad a,c,*, Marisa P. de Brito b, Jafar Rezaei a and Lóránt A. Tavasszy a

aTransport & Logistics Section, Delft University of Technology, Delft, The Netherlands; bAfL-NHTV, Breda University of Applied Science, Breda, The Netherlands; cFaculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia, Johor, Malaysia

(Received 20 April 2015; final version received 11 April 2016)

This paper proposes a framework for understanding the contextual factors of sustainable supply chain management (SSCM) practices in the O&G industry. It is based on a literature review of studies related to SSCM of O&G topics. The review reveals that there is a lack of SSCM research specific to the industry. Present studies focus on individual stages of its supply chain and do not consider all dimensions of sustainable development, namely economic, environmental and social factors. In addition, existing frameworks lack important contextual aspects of the industry’s business and organizational environment. To address these gaps, our research develops an overarching framework operationalizing the internal and external contextual factors of the O&G industry environment that can influence the outcome of its SSCM practices. The proposed framework is useful as a tool in the formulation and implementation of SSCM strategy that enables alignment of a company’s internal capabilities with its external environment.

Keywords: sustainable supply chain management; oil and gas; contextual factors; conceptual framework

1. Introduction

The role of the oil and gas (O&G) industry within a sustainable society has been called into question due to the environmental impacts of its activities and products. Events like the oil spills in the Gulf of Mexico and negative attention to the development of unconventional O&G sources, such as shale gas and oil sand, have increased the call for the development of its replacement. Even though the percentage of O&G in the future energy mix is predicted to be lower, it will remain as the most important sources of energy for decades to come. If we could somehow solve sustainability issues plaguing the industry, we could eventually eliminate some of the root causes of sustainability problems that the world is facing today.

Sustainable supply chain management (SSCM) practices can contribute in helping the O&G industry address this issue as it integrates the triple-bottom line (TBL) dimensions of sustainability, i.e. economic, environmental and social, in the management of key business processes of an organization and its supply chain. The O&G supply chain involves complex networks of companies doing highly specialized activities in some of the world’s most difficult and fragile environments. It develops and transports flammable...
and toxic products which are highly risky to health, safety and the environment. In
addition, the companies must be responsive to their business environment as operations
are dispersed globally, transcending various geographical, political, technological and
cultural boundaries.

This complexity has led to research into supply chain modelling aimed at, among
others, the improvement of logistic systems, and production and operation planning. As
yet, little attention has been devoted to the sustainability aspects of the supply chain
(Lakhal, H’Mida, and Islam 2007). An overview of the complexity of the O&G supply
chain is needed to identify the factors that could drive or hinder the achievement of a
sustainable O&G supply chain. One direction that the research in SSCM of O&G can
follow is to study the supply chain context. This is because the best way SSCM can be
implemented is by understanding the contextual factors that influence an industry and the
companies operating within it (Halldórrsson, Kotzab, and Skjøtt-Larsen 2009), as
sustainability strategy may impact every industry differently (Ekins and Vanner 2007).

As such, the aim of this paper is to present a conceptual framework on the key
contextual factors of SSCM of O&G and their interrelationship. It will shed light on the
external business-related and internal organizational-related factors that can play a role in
the SSCM implementation, and eventually the developmental causes of SSCM strategy in
the O&G industry. The framework is developed based on a literature review around the
key topic areas of SSCM and sustainability practices within the O&G industry, where we
identify the relevant factors through the literature, classify them, describe their
interactions, and map their interrelationships in a framework.

The structure of the paper is as follows. Section 2 defines SSCM, followed by a
description of the methodology used to develop the conceptual framework in Section 3.
Section 4 discusses the conceptual framework. It is followed by a discussion on the
implications of the changes in the contextual factors to SSCM of O&G in Section 5.
Section 6 concludes with a summary of the main findings and recommendations for
further research.

2. Sustainable supply chain management defined

Global concerns regarding climate change, unsustainable use of natural resources and
economic slowdown are forcing businesses to reconsider the way they operate. Many of
them are incorporating the sustainability agenda, involving control of the TBL, i.e.
economic, environmental and social performance, in their operations (Dhiman 2008).
TBL was introduced by Elkington who stresses that social and economic dimensions of
sustainability must be addressed in a more integrated way to enable real environmental
progress (Elkington 2004). According to Carter and Rogers (2008), the micro-economic
perspectives of sustainability have been applied more often in research than the macro-
economic perspectives. This could be due to the difficulty in identifying the effective way
of addressing sustainability when various, often conflicting, issues need to be considered
simultaneously.

Carter and Rogers (2008, 368) define SSCM as “the strategic, transparent integration
and achievement of an organization’s social, environmental, and economic goals in the
systemic coordination of key organizational business processes for improving the long-
term economic performance of the individual company and its supply chains.” According
to Seuring and Muller (2008b, 1700), SSCM is “the management of material, information
and capital flows, as well as cooperation among companies along the supply chain while
taking goals from all three dimensions of sustainable development, i.e. economic,
environmental and social, into account which are derived from customer and stakeholder requirements.” Pagell and Wu (2009), on the other hand, simply define it as the managerial decisions and behaviours designed to ensure that a supply chain performs well in the TBL dimensions to create a truly sustainable supply chain.

These definitions imply that managerial decisions and behaviours should be aimed at ensuring that both individual companies and their supply chain as a whole perform well economically, environmentally and socially, through a strategic integration of key business processes in the management of resources and the delivery of products and services. To achieve sustainable practices, companies should move beyond their immediate concern, which is to gain profit, and take appropriate steps to protect the environment and stakeholders’ interests. The companies must employ new strategies to achieve joint optimization of these sustainability aspects, including through waste optimization, carbon footprint reduction, green purchasing and green product design which, in essence, are part of supply chain management (SCM) (Markley and Davis 2007).

A sustainable O&G supply chain is crucial not only because O&G sources are finite, but more importantly, the demand for energy will continue to increase. By 2035, approximately 81% of the energy supply will be from fossil fuel sources (i.e. including coal) (BP 2015). The environmental and social implications of irresponsible and unsustainable exploitation of these resources can be devastating. The implementation of SSCM practices should help minimize, if not eliminate, the negative impacts, while allowing the industry to sustain itself economically and ensure energy security. This requires close cooperation between all supply chain members and the integration of key activities throughout the industry’s supply chain. The industry must work together with its stakeholders, such as governments, local communities, suppliers, customers and employees to solve its sustainability issues so we could benefit from a more sustainable O&G development.

3. Methodology

According to Meredith (1993, 8), a framework “may identify relevant variables, classify them, describe their interactions, and allow a mapping of items (such as the existing literature or research studies) on to the framework.” This paper proposes a framework that can be used to describe the key contextual factors of SSCM and explain their relationships in the context of the O&G supply chain. We adapted the methodology used by Seuring and Müller (2008b) in our literature search, as shown in Figure 1, to develop the framework.

Literature review on studies related to SSCM of O&G was conducted to identify the state of current research in the area. The studies were identified through a structured keyword search (i.e. “supply chain”, “sustainable”, “green”, “oil and gas”, and “petroleum”) in four electronic databases, namely: Emerald, Elsevier, Springer and Wiley. Additionally, Google Scholar was also used. The journal articles found through the databases were examined for their relevancy to this research: (1) all studies where O&G industry is the main focus, or is part of the researched area, were selected; and (2) studies on sustainable development of O&G where their relationship to SCM was not clear were excluded, e.g. studies on corporate governance practices among O&G companies.

The literature search was conducted for papers which were published until 2012. Studies on SCM within the O&G context began around the early 1990s (Neiro and Pinto 2004), and integration of sustainability within the SCM field has only gained prominence
during recent years. This is confirmed by the literature search, where the earliest study found was conducted by Min and Galle (2001). However, the study includes other manufacturing industries besides oil/gas extraction and the petroleum refining industry. The earliest studies specific to the O&G industry were published in 2007.

Overall, we found ten papers related to sustainable or green SCM of O&G, as summarized in Table 1. Due to the lack of literature, we included all the papers found. For that same reason, we also referred to industry reports, such as the sustainability reports of O&G companies, industry guidelines, and books related to O&G development to increase our understanding of the activities in the O&G supply chain and the sustainability issues involved. Additionally, we also referred to the SSCM literature from other industry areas to identify the factors that could be used to describe the context or the environment in which the O&G industry operates and the management of its supply chain.

The framework was refined through discussions with colleagues and academic experts in areas ranging from transport and logistics, SCM, energy systems, as well as through conference presentations. Discussions were also conducted with nine operations, supply chain or sustainable development managers and practitioners from three integrated O&G companies and an O&G consultant who used to work for a major O&G company. These discussions helped us to ensure that relevant factors are included in the framework and the relationships between those factors are mapped correctly. Revisions of the framework

Table 1. List of literature related to SSCM of O&G.

| Focus area                        | Author                                                                 | Total |
|-----------------------------------|------------------------------------------------------------------------|-------|
| Sustainable/green SCM of O&G      | Lakhal, H’Mida, and Islam (2007), Midttun et al. (2007), Lakhal, Khan, and Islam (2009), and Deng and Liu (2011) | 4     |
| O&G is part of researched area    | Min and Galle (2001), Zhu, Sarkis, and Lai (2007b), Matos and Hall (2007), Hartman, Rubin, and Dhanda (2007), Zhu, Sarkis, and Lai (2008b), and Zutshi, Creed, and Sohal (2009) | 6     |
were done until all researchers involved in this study agreed with the final framework. Throughout this process, we seek to ensure that the framework developed is able to reflect the reality of SSCM practices in the O&G industry adequately, by examining relevant literature and reports to support the categorization and the relationship proposed.

4. Conceptual framework
This section presents the conceptual framework for this research. The discussion focuses on the positioning of the framework within the broader context of SSCM and O&G sustainability research. First, we will describe the O&G supply chain and review the literature found relating to SSCM of O&G. This is followed by a discussion on the conceptual framework.

4.1. Sustainable supply chain management of oil and gas
The O&G industry consists of various players with different positions in terms of access to resources, technology, consumer markets, capital availability and expertise (Edwards, Ishaq, and Johnsen 2010). They can be categorized into operators (oil companies), main contractors, sub-contractors and suppliers (Anderson 2003). Although the industry is often perceived as a single industry, it actually comprises companies from diverse backgrounds that represent various industrial cultures and areas of expertise (Dauda and Yusuf 2009). Its supply chain can also be influenced by many internal (business-related) and external (political/economic) forces (Anderson 2003).

Generally, the supply chain of O&G is as illustrated in Figure 2 (Kilponen 2010). In functional terms, the supply chain includes three different sections. The upstream section, widely known as exploration and production (E&P), is involved in finding and producing crude oil and natural gas. The downstream section produces and markets various refined petroleum and petrochemical products for public and corporate consumers. Occasionally,
a midstream section is distinguished, involving storage and distribution of hydrocarbon products. We consider the midstream and downstream sections together in this study.

In the upstream section, the decisions made during the E&P stage may include design and planning of oil field infrastructure (Neiro and Pinto 2004). Many factors must be taken into consideration in this stage, such as the deployment of new or newly adapted E&P technologies, environmental laws and regulations which often vary between countries, and local socioeconomic issues (Elcock 2007). The E&P facilities are decommissioned at the end of their commercial life, which can be about 20–40 years. The decommissioning process involves building and equipment removal, site restoration, implementation of site re-vegetation measures and continued monitoring after closure (UNEP 1997).

The downstream business of O&G involves decisions such as crude procurement, supply planning, logistics scheduling, storage scheduling and crude scheduling (Julka, Karimi, and Srinivasan 2002; Neiro and Pinto 2004). Production planning generally focuses on the individual product’s production level and refinery operating condition, while transportation focuses on scheduling and inventory management (Neiro and Pinto 2004). In refinery operations, the decision-making process may be divided among various departments with conflicting objectives, which may negatively affect performance (Julka, Karimi, and Srinivasan 2002).

Table 2 summarizes the characteristics of the downstream supply chain. The downstream supply chain of O&G is both simpler and more complex than other industries. For instance, the product mix of O&G is more stable and static compared to, for example, car parts. However, they are highly flammable and considerable risks are involved during transportation activities due to the large distance between supply sources and consumer markets. Therefore, modifications are needed to supply chain solutions that are widely used in other industries for it to work for the O&G downstream activities (IBM 2005).

Currently, very little research on the sustainability of the O&G supply chain is reported in the scientific literature. Table 3 summarizes the studies related to sustainable or green SCM in the O&G industry found through literature search. None of these studies particularly examines different stages of the O&G supply chain and incorporates all the TBL dimensions of sustainable development. Most studies focus on economic and/or environmental issues that are specific to a certain stage of the supply chain. Only one study incorporates the three dimensions of sustainability. In terms of the supply chain stages, the sustainability of E&P has been studied most. Studies that include O&G as one of the researched areas generally focus on no particular stage, which can be attributed to the broad nature of the industries studied.

One of the first studies specific to the O&G supply chain was conducted by Lakhal, H’Mida, and Islam (2007), who note that there were no green supply chain management (GSCM) studies in the petroleum industry prior to their research. They introduced the “olympic” green supply chain (OGSC) concept that aims to ensure that all resources used during refining operations result in five zeros of waste or emissions. This includes zero: (1) emissions, e.g. air, soil, and water, (2) waste of resources, (3) waste in administration activities, (4) use of toxics, and (5) waste in product life cycle (Lakhal, H’Mida, and Islam 2007). Their later study demonstrated the applicability of the concept in identifying the economic, environmental and social imbalances in the decommissioning process and inefficient resource utilization in the O&G production life cycle (Lakhal, Khan, and Islam 2009).
A study on the offshore petroleum industry was conducted by Midttun et al. (2007). They focus on identifying the challenges in integrating corporate social responsibility (CSR) with other strategic foci, i.e. health, safety and environment (HSE), into the supply/contractor chain. The study found that there is considerable discrepancy in the integration between suppliers/contractors and petroleum companies. The suppliers/contractors tend to focus on the technology dimension more, compared to the petroleum companies (Midttun et al. 2007). The CSR and HSE are also strategically undercommunicated within the industry (Midttun et al. 2007).

Deng and Liu (2011) propose a model of GSCM for the oil industry in China. They found that there is a lack of understanding of the GSCM concept among Chinese oil companies. This finding is consistent with the study conducted by Zhu, Sarkis, and Lai.
(2007b) among Chinese manufacturers that also include chemical/petroleum companies in their research areas. Deng and Liu (2011) found that there are no strong initiatives by the companies to green their supply chain due to the lack of policy to support the initiatives. The process and technology are also inadequate, especially for energy conservation and emissions reduction (Deng and Liu 2011).

It is apparent that there is a lack of research on SSCM specific to the O&G industry, which is surprising since the sustainability of the industry is crucial in the achievement of a sustainable future. Several researchers include the O&G industry as part of the research areas in their studies. These studies focus on green purchasing/SCM (Min and Galle 2001; Zhu, Sarkis, and Lai 2007b, 2008b), life cycle analysis (LCA) (Matos and Hall 2007) and corporate social responsibility (Hartman, Rubin, and Dhanda 2007; Zutshi, Creed, and Sohal 2009). Among the studies, only Zhu, Sarkis, and Lai (2007b), Zhu, Sarkis and Lai (2008b) and Matos and Hall (2007) distinguish their findings according to the industries studied.

Our review of the existing literature related to sustainability of the O&G supply chain indicates that these studies are highly fragmented. Specifically, there is a lack of studies that consider the: (1) alignment of different supply chain functions and strategies towards sustainable practices, (2) different segments of the O&G supply chain, and (3) the joint improvement of economic, environment and social performance of supply chains. It is, therefore, apparent that there is no systemic SSCM research specific to the O&G industry. This is surprising, considering its importance in the achievement of a sustainable future; both due to our increased dependency on O&G and the impact of the development and use of the resources on the environment and public health and safety.

This lack of research necessitates studies specific to the O&G industry context to enable better understanding of the sustainability issues which have long plagued the industry. It will enable us to identify the possible solutions to the issues that could help the industry to operate more sustainably throughout its supply chain. The review also shows that there is no “SSCM” research specific to the O&G industry. For that reason, we propose a conceptual framework for the study of SSCM of O&G in the next section.

| Author                  | Year | TBL dimension | Supply chain stage (SCS) | No focus on any SCS |
|-------------------------|------|---------------|-------------------------|---------------------|
| Min and Galle           | 2001 |   |   | x | x |
| Zhu, Sarkis, and Lai    | 2007b|   |   |   |   |
| Hartman, Rubin, and Dhanda | 2007 |   |   |   |   |
| Lakhal, H’Mida, and Islam | 2007 |   |   | x | x |
| Midttun et al.          | 2007 |   |   | x |   |
| Matos and Hall          | 2007 |   |   |   | x |
| Zhu, Sarkis, and Lai    | 2008b|   |   |   | x |
| Zutshi, Creed, and Sohal | 2009 |   |   |   | x |
| Lakhal, Khan, and Islam | 2009 |   | x |   |
| Deng and Liu.           | 2011 |   |   | x |   |

1ECO: economic, ENV: environment; SOC: social, E&P: exploration & production, R&P: refining & processing, LOG: logistics, T&R: trading & retail

1Papers specific to the O&G supply chain.
4.2. Conceptual framework for sustainable supply chain management of oil and gas

Every company operates in a particular context that influences its strategies; companies, to a certain extent, are also able to influence this environment (Gillespie 2011). According to Neubauer and Solomon (1977), the determinants of corporate strategy may include (1) internal factors consisting of company capabilities and limitations, and (2) external factors including threats and opportunities in the environment and society’s expectations. These factors would force a company to examine its strategic position within the environment to strengthen its competitiveness.

The suggestion made by Halldórsson, Kotzab, and Skjøtt-Larsen (2009) for more studies on understanding the contextual factors of SSCM is especially relevant to the O&G industry. This is due to the global and strategic nature of its activities and products that could heavily influence the achievement of a sustainable future. Therefore, we propose a framework that aims to shed light on the key contextual factors of SSCM of O&G. The hypothesized relationships between the factors are depicted in Figure 3. The factors are categorized into external factors within the O&G industry’s business environment, and internal factors that consist of organizational and supply chain function-related factors.

We think that the framework proposed is different from the existing SSCM framework in three aspects. First, the framework is a multidimensional conceptualization of internal and external factors that could determine companies’ adoption of a sustainable supply chain strategy. While various studies have been conducted to examine the external drivers of SSCM, they are relatively limited to understanding the impact of the economic condition, stakeholder pressure, competition and the regulatory environment on supply chain sustainability. Studies that investigate multiple macro-environment factors simultaneously, as proposed in our framework, are rare. Furthermore, the framework incorporates four main supply chain functional areas that are involved in the acquisition of new or used materials/resources, their conversion into products or services, and distribution of the products or services to satisfy customer requirements. As far as we know, there is no such study yet in the context of O&G supply chain sustainable practices, or even in the broader SSCM field that includes these multidimensional perspectives.

Second, the O&G industry is one of the industries that face intense sustainability pressure from its external environment. For instance, there are no other industries that can be influenced by the dynamics in global political environment more than O&G due to the strategic importance of these energy sources to world’s economy and in giving reserve holders political leverage in international negotiations. In addition, when we talk

![Figure 3. Conceptual framework of SSCM in the O&G industry.](image-url)
about regulations or efforts to limit the carbon footprint in industrial activities (or in transportation and energy generation), we are essentially talking about O&G. For example, manufacturing processes involve materials acquisition, production, transport and distribution. These activities are powered by O&G, so we can say that the origin of most sustainability issues that the world is facing today comes from the O&G industry. If we put this problem in the context of demand and supply, all other industrial and institutional actors are demanding that the industry provide O&G supply that causes minimal harm to the environment, and health and safety so they could also reduce their negative impacts.

The inherent carbon-intensive nature of O&G development and products, however, is an inescapable stumbling block to the O&G industry’s sustainability efforts. The question therefore becomes, can the industry ever be sustainable? The immediate answer that comes to everyone’s mind is probably in the negative. Or, some might think that it can achieve an acceptable level of sustainability if conducted on a smaller scale, complemented by a transition to low carbon energy systems that include a more prominent role for alternative and renewable energy. That is, in essence, one of the resolutions achieved by the recently concluded United Nation Climate Change Conference or COP21 in Paris. Although energy transition can affect all industries, the O&G industry is at the core of the transition. The industry is estimated to lose approximately $33 trillion of revenue within the next 20 years as a result of the climate and carbon emissions deals reached at COP21 (CA2015).

The O&G industry occupies a unique position in sustaining the world’s economy and our lives, but it is also the cause of the sustainability problems we face today. Through our conceptual framework, we want to understand how companies in the industry respond to the sustainability pressure exerted by the dynamics within their external environment, using internal resources and capabilities to implement sustainable supply chain practices. While all industries operate within a similar environment, we think that the O&G industry experiences greater pressure from the actors and institutions in the environment because of its central role in the achievement of a sustainable future.

The final aspect that differentiates our SSCM framework from the existing studies is the inclusion of supply chain sustainability goals as a distinct factor that can influence supply chain strategies. Sustainability goals are rarely included explicitly in SSCM studies as a factor that can influence or be influenced by companies’ external and internal environment. It is, however, often discussed in relation to its integration in corporate and functional strategies (Wolf 2011; Harms, Hansen, and Schaltegger 2013), supply chain performance measurement (Wittstruck and Teuteberg 2012; Darnall, Jolley, and Handfield 2008) and in resources and capabilities development (Paulraj 2011). Very few studies incorporate sustainability goals as an explicit factor in the SSCM framework, notably Hervani, Helms, and Sarkis (2005) and Pagell and Wu (2009) studies. Besides the lack of attention on sustainability goals, the extant SSCM literature offers little empirical evidence on how external factors can affect the goals.

Based on the above arguments, we think that we have developed an overarching SSCM framework that aims to capture the dynamics of the O&G industry’s business and organizational environments that can affect its adoption of sustainable supply chain strategies. We also try to contribute to the discussion that SSCM strategy is an outcome of companies’ responses to these dynamic environments. We discuss these environments further in the following sections.
4.2.1. External business environment

The O&G industry environment is characterized by a complex interplay of diverse environmental, socio-economic, political and regulatory settings (Wagner and Armstrong 2010). In order to identify the forces that could influence the sustainability of the O&G supply chain, we adapt the PESTEL model, i.e. political, economic, social, technology, environmental and legal, to the context of the O&G industry’s business environment. The model allows us to assess the environment in which a company operates and to identify how it could potentially affect the company’s activities (Yüksel 2012). Based on the PESTEL model and the O&G business environment literature, we distinguished the external factors into six categories, namely political stability, economic stability, stakeholder pressure, competition, energy transition and regulations.

We consider that the environmental and social factor is intrinsic to the discussion of the external factors, thus they are not addressed as separate factors. The technological factor, meanwhile, is addressed through competition in the energy industry due to increased control of O&G reserves among few producers that led to the development of unconventional O&G sources, and the advances in alternative energy development, thus increases the competition in the energy market. In addition, we include stakeholder pressure because it is one of the most often cited external pressures for sustainable practices in the supply chain (Seuring and Müller 2008b). The final factor considered is the pressure resulting from the need to transition to low carbon energy systems to address climate change and energy security, which could affect the strategy that the companies in the O&G industry employ to enhance its position during the transition (Fouquet 2010; Escobar and Vredenburg 2011). The discussion on each of the factors selected is as follows.

Political stability. The O&G industry operations are globally dispersed, transcending various political barriers. Due to its strategic importance, the industry is at the centre of the international geopolitical and economic landscape (Manzano 2005). Unstable political conditions in producing countries, for example, can result in oil price increase, which is detrimental to economic growth. Most of the countries depend on O&G revenues for economic development, and to some extent gain political power through ownership. Conflicts of interest in the management of a company may arise due to the needs to safeguard national and, often, political interests of the government (Wolf 2009).

Political instability has also been found to cause severe economic, environmental and social implications in producing countries. An example is Iraq’s invasion of Kuwait in 1990 that caused ecological disaster and the loss of Kuwait’s oil industry (Al-Damkhi, Abdul-Wahab, and Al-Khulaifi 2009). It has also resulted in huge economic losses due to the damage caused to its petrochemical and other industrial facilities, transport infrastructures and communication networks (Al-Damkhi, Abdul-Wahab, and Al-Khulaifi 2009). This could create an uncertain business environment as the supply chain can be exposed to disruption risks (Kleindorfer and Saad 2005), which in turn, would make it harder for sustainable supply chain strategies to be implemented.

Economic stability. The relationship between energy demand and economic growth became apparent when global consumption of energy decreased in 2009 because of global recession. In 2008, oil prices peaked at $147, but slower economic growth and reduced consumption caused the price to fall to almost $40 by the end of that year (BP 2015; Lior 2010). Halldórsson, Kotzab, and Skjott-Larsen (2009) question whether companies can afford to maintain their commitment to sustainability initiatives during the trying time of the global financial and economic crisis.
Economic instability can create financial risks, especially in terms of liquidity and solvency, and risks related to contractual obligations and commercial commitments with suppliers and customers (Repsol 2011). In addition, market risks related to the volatility of global O&G prices, exchange rates and interest rates could reduce the profitability of operations (Repsol 2011; Petrobras 2011). It could impact company ability to implement planned capital investment programmes that could lead to investment cuts, for example, in field development (Lukoil 2011). The companies are also expected to contribute to the socio-economic development of their host communities. Economic instability, therefore, is a great challenge to the O&G industry in achieving its economic goals, and at the same time fulfilling its obligations to the stakeholders.

**Stakeholder pressure.** The external micro-environment of business consists of stakeholders such as suppliers, employees, competitors, and distributors in which the relationships between these stakeholders can affect the costs, quality and overall success of a business (Gillespie 2011). Response to stakeholder pressure is one of the most frequently mentioned factors in SSCM literature as the drivers of SSCM implementation (Seuring and Müller 2008b). The quality of the relationship with stakeholders could determine company ability to respond in a flexible way to changes in macroeconomic and market conditions, and to manage social and environmental risks (Gazprom-Neft 2010).

One of the challenges that companies have to address in building enduring and mutually beneficial relationships with stakeholders is the ability to understand stakeholders’ expectations. However, the process of reaching that understanding and responding to the expectations is often difficult and confusing (Total 2011). Factors such as inconsistent or contradictory expectations among stakeholders, and issues which are in direct conflict with business practices could add to this problem. Some of the issues that are often brought up by stakeholders with regard to the O&G industry activities include climate change, safety and environmental management, human rights and transparency.

**Competition.** Global factors such as market competition will affect all businesses (Kumar and Putnam 2008). Generally, the O&G companies can be divided into two groups – national O&G companies (NOCs) and international O&G companies (IOCs). Many believe that the future competition will be between these groups, especially in terms of access to energy sources (Edwards, Ishaq, and Johnsen 2010; Kjærstad and Johnsson 2009; Wolf 2009). Increasing shares of global O&G resources are controlled by NOCs, where IOCs on the other hand, are facing deteriorating fiscal terms and increasing difficulty in accessing the reserves (Kjærstad and Johnsson 2009). Cooperation between NOCs will be the norm and companies that control O&G reserves will have more power in selecting their alliance (Edwards, Ishaq, and Johnsen 2010). Since the O&G reserves are increasingly being controlled by a smaller number of players, supply disruptions could occur in the absence of supportive policies, investment, and technology and infrastructure (Farrell and Brandt 2006).

The O&G industry is also facing increasing competition from alternative energy. The current advances in alternative energy development are quite slow and cost intensive since the technology used is fairly new (Lior 2010; Verbruggen *et al.* 2010). Although the energy is gaining momentum, there may be little to no pressure for the O&G industry to take the necessary actions to secure its competitiveness in the market due to these factors. However, there might be greater focus among companies in the industry to improve supply chain sustainability, thus their ‘green competitiveness’, such as through carbon emission reduction and energy efficiency measures to offset the negative attention of the O&G exploitation and secure their legitimacy as responsible corporate citizens.
Energy transition. Concerns over the environmental impacts of the O&G and energy security have resulted in increased pressure for the transition to a low carbon energy system that favours the development of renewable energy, such as wind, solar and biofuel. The emergence of this alternative energy is expected to have an impact on O&G companies in the future (Edwards, Ishaq, and Johnsen 2010). While it is too early and complex to identify the strategies that O&G companies will develop to respond to the energy transition, it is expected that they will become more competitive and harder to replace, and their responses “will probably be on a scale unprecedented in the history of energy transitions” (Fouquet 2010, 6594).

Currently, an oil transition is also happening in the O&G industry. Increasing demand and competition in accessing conventional O&G reserves has caused the industry to explore unconventional sources that are located in difficult and harder to reach environments. These sources differ mainly in terms of the nature in which deposits can be found and production technology used. Farrell and Brandt (2006) stress that the main challenge in the oil transition is to manage the risks of environmental damage, economic risks to consumers and investors, as well as the strategic risks associated with access to oil reserves and supply disruption. Due to its high development costs, the risks associated with unconventional O&G is higher, especially when oil prices are low (Farrell and Brandt 2006).

Regulations. Among the pressures for sustainability in supply chains are legal demands or regulations (Seuring and Müller 2008b; Giunipero, Hooker, and Denslow 2012). Most companies in the O&G industry operate in several countries, with different regulatory frameworks and requirements, which may cause considerable regulatory and compliance-related risks. The risks can be due to changes to laws, regulations and compliance mechanisms related to legal, fiscal, safety and environmental matters and corporate governance reporting aspects (Repsol 2011). Since the O&G industry’s activities and products are often associated with climate change and environmental problems, there could be stricter domestic and international regulations related to its products, activities and trade (Petrobras 2011; Salter and Ford 2000). This can also cause changes to technical and trade requirements in the supply chain, increase operating costs and reduce companies’ overall competitiveness (Petrobras 2011).

Zhu, Sarkis, and Lai (2007b) found that the “traditional polluters” such as the chemical/petroleum companies in China have a comparatively higher level of GSCM implementation compared to other industries due to the government regulatory pressures. Lack of regulations or institutional pressure could cause severe impacts on the environment and society. An example is the Deepwater Horizon case that is caused partly by insufficient regulations in offshore O&G drilling (Lin-Hi and Blumberg 2011). The safety, legal and environmental standards were quite low in the United States compared to, for example, Brazil and Norway (Lin-Hi and Blumberg 2011). Although regulatory pressures require the O&G industry to spend considerable resources to comply with the requirements, on the other hand, it helps the industry avoid losses and prevent undesirable incidents that are usually more costly to be rectified.

The discussions on the O&G supply chain and its business environment show that the industry faces considerable challenges that could affect its ability to operate sustainably. The strategy used to integrate sustainability in the SCM of the O&G must be able to align company internal capabilities with the external operating context.
4.2.2. Internal organizational environment

The lack of research on SSCM of O&G necessitates the use of broader SSCM literature to help us identify the internal factors that could facilitate (or hamper) the implementation of SSCM strategy. The definitions of SSCM suggest that managerial decisions and behaviours must be directed towards ensuring the economic, environmental and social goals of an individual company and its supply chain, which can be achieved through systemic integration of key processes and cooperation among supply chain members. Therefore, an inventory was made of internal factors that are used by researchers to measure the SSCM practices that appear frequently in the literature.

Through the analysis, a pattern emerges in which the factors can be grouped into two categories: (1) organizational-related factors and (2) supply chain function-related factors. These are summarized in Table 4 and Table 5, respectively. We will first discuss these aspects in terms of broader SSCM practices. In Section 5, the discussion will focus on the implications of the changes in the internal and external factors in the context of the O&G supply chain.

We define these factors as context-related because they are able to explain the environment in which SSCM strategy and decisions are made in a company. The conceptual framework proposed in this research categorized the organization-related factors into supply chain sustainability goals, commitment to sustainability and management preparedness (i.e. includes risk management, cross functional integration and performance management).

| Factor                      | Item                                                                 | Authors                                                                 |
|-----------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------|
| Commitment                  | Top management commitment                                           | Zhu, Sarkis, and Lai (2008a), Faisal (2010), Hussain (2011),            |
|                             |                                                                     | Wittstruck and Teuterberg (2012), and Walker and Jones (2012)          |
| Culture                     |                                                                      | Carter and Rogers (2008), Pagell and Wu (2009)                        |
| Transparency                |                                                                      | Carter and Rogers (2008), Pagell and Wu (2009), and Wolf (2011)        |
| Risk management             | Risk management                                                     | Seuring and Muller (2008b), Carter and Rogers (2008), Hussain (2011), |
|                             |                                                                     | Wolf (2011), and Walker and Jones (2012)                              |
| Cross-functional integration| Strategic alignment                                                  | Carter and Rogers (2008), Faisal (2010), Hussain (2011), and Walker   |
|                             |                                                                     | and Jones (2012)                                                      |
|                             | Internal integration                                                | Pagell and Wu (2009), and Walker and Jones (2012)                     |
|                             | Cross-functional cooperation                                        | Zhu, Sarkis, and Lai (2008a) and Wolf (2011)                          |
| Performance management      | Performance measurement/Performance measurement and reward system linked to sustainability | Pagell and Wu (2009), Wolf (2011), and Walker and Jones (2012)         |
|                             | Metrics to quantify sustainability benefits in an SC                | Faisal (2010) and Wolf (2011)                                         |
Table 5. Supply chain function-related factors.

| Factor                  | Construct                                    | Authors                                                                 |
|-------------------------|----------------------------------------------|-------------------------------------------------------------------------|
| Supplier management     | Cooperation with suppliers                   | Zhu, Sarkis, and Lai (2008a), Pagell and Wu (2009), Halldórsson, Kotzab, and Skjøtt-Larsen (2009), Faisal (2010), Hussain (2011), Colicchia et al. (2011), and Wittstruck and Teuterberg (2012) |
|                         | Supplier certification of environmental and/or social standards | Zhu, Sarkis, and Lai (2008a), Seuring and Muller (2008a), Seuring and Muller (2008b), Pagell and Wu (2009), Halldorsson, Kotzab, and Skjøtt-Larsen (2009), and Colicchia et al. (2011) |
|                         | Supplier selection, including environmental & social criteria | Seuring and Muller (2008a), Pagell and Wu (2009), Halldorsson, Kotzab, and Skjøtt-Larsen (2009), Colicchia et al. (2011), and Wolf (2011) |
|                         | Information sharing                           | Halldorsson, Kotzab, and Skjøtt-Larsen (2009), Faisal (2010), and Hussain (2011) |
|                         | Supplier audit                                | Zhu, Sarkis, and Lai (2008a), and Seuring and Muller (2008a)            |
|                         | Supplier integration & development            | Seuring and Muller (2008a), and Pagell and Wu (2009)                    |
|                         | Continuity                                    | Pagell and Wu (2009) and Wolf (2011)                                   |
| Logistics management    | Consolidation of shipments                    | Halldorsson, Kotzab, and Skjøtt-Larsen (2009) and Colicchia et al. (2011) |
|                         | Choice of environmentally friendly types of transport |                                                                 |
|                         | Respecting driving and resting time rules     |                                                                 |
|                         | Choice of environmentally friendly distribution channel |                                                           |
|                         | Reuse of transport packaging materials        |                                                                 |
|                         | Carrier selection                             |                                                                 |
| Production management   | 3R of material, component parts               | Zhu, Sarkis, and Lai (2008a), Halldorsson, Kotzab, and Skjøtt-Larsen (2009), and Colicchia et al. (2011) |
|                         | Reduce consumption of energy/material         | Zhu, Sarkis, and Lai (2008a) and Colicchia et al. (2011)               |
|                         | Avoid/reduce use of hazardous products and/or their manufacturing process | Zhu, Sarkis, and Lai (2008a) and Halldorsson, Kotzab, and Skjøtt-Larsen (2009) |
|                         | Elimination of waste & overuse of resources in production | Halldorsson, Kotzab, and Skjøtt-Larsen (2009) and Colicchia et al. (2011) |
|                         | Eco-efficient production                       | Halldorsson, Kotzab, and Skjøtt-Larsen (2009) and Colicchia et al. (2011) |
|                         | Environmental management system/standards      | Zhu, Sarkis, and Lai (2008a) and Hussain (2011)                        |
| Product stewardship     | Total-life cycle                              | Seuring and Muller (2008a) and Pagell and Wu (2009)                    |
The supply chain sustainability goals are hypothesized as a moderating factor that determines how the companies in the O&G industry address the external forces by employing and harnessing internal capabilities and resources to implement SSCM strategy. According to Porter (1991, 96), company success is conditioned by the development and implementation of an “internally consistent set of goals and functional policies.” This is necessary for the integration of the company’s various functional departments towards common goals that allow the alignment of its strength and weaknesses with the threats and opportunities in the external environment (Porter 1991). The term management preparedness is used to denote company readiness in planning and implementing SSCM strategy, as well as its ability to respond in a timely manner to changes in its environment. Both commitment to sustainability and management preparedness enable the company to address the pressure caused by the external forces and facilitate the achievement of the company’s sustainability goals through SSCM practices.

Supply chain managers’ responsibility has increased as a result of the development in today’s global economy and its impact on the environment and society (Halldórsson, Kotzab, and Skjott-Larsen 2009). Management commitment to sustainability is crucial in ensuring that initiatives to tackle the issues are supported by the key decision-makers in the organization (Wittstruck and Teuteberg 2012; Hussain 2011; Walker and Jones 2012). This commitment must be communicated to, and embraced by, all employees in the organization where sustainability becomes part of its culture (Cuthbertson 2011). Supportive culture and core values are an important facet of SSCM implementation to enable successful implementation of sustainability strategies and initiatives (Carter and Rogers 2008; Pagell and Wu 2009).

Since the secrecy of corporate wrongdoings is becoming difficult and risky to maintain, many companies are disclosing their information to stakeholders. Transparency in SSCM includes reporting to and actively engaging stakeholders as well as using their feedback and input to improve supply chain performance (Carter and Rogers 2008). They suggest that vertical integration across supply chain and horizontal integration across networks will facilitate improvement in supply chain transparency. Local optimization of environmental factors in environmental management and operations must be moved to the entire supply chain in order for the supply chain and sustainability to be converged (Linton, Klassen, and Jayaraman 2007). This further stresses the importance of transparency and cooperation in the management of the supply chain in order to minimize its related risks.

Carter and Rogers (2008) defined supply chain risk management as a firm ability to understand and manage its economic, environmental, and social risks. According to Kleindorfer and Saad (2005), a supply chain is subjected to the coordination of a supply and demand problem and disruption risks, such as operational risks and risk caused by natural hazards, terrorism, and political instability. Since supply chain networks are becoming longer and clock speeds are shorter, it has resulted in the increased probability of supply chain disruptions and a smaller margin for error if a disruption occurs (Kleindorfer and Saad 2005). Thus, risk management in a supply chain must be able to facilitate alignment and collaboration for risk avoidance and reduction among supply chain partners.

Seuring and Muller (2008b) found that barriers to SSCM include coordination effort and complexity, and insufficient or missing communication in the supply chain. Therefore, cross-functional integration is crucial within and across companies (Pagell and Wu 2009; Walker and Jones 2012; Wolf 2011; Zhu, Sarkis, and Lai 2008a). SSCM implies that an individual business is no longer operating solely as an autonomous entity,
but rather as part of an interrelated and intertwined group of businesses (Chen and Paulraj 2004; Li et al. 2006). It is therefore important for each company to be able to measure its performance, because that will ultimately determine the overall performance of the supply chain.

Every company should have metrics that enable them to quantify the benefits of implementing SSCM (Faisal 2010). To encourage sustainability culture and behaviour, they could also link sustainability performance with a rewards system (Pagell and Wu 2009). Organizations in general are still struggling to measure the noneconomic impacts of sustainability (Pagell and Wu 2009). While there are tools that can be used to measure sustainability performance, such as LCA, the application of the tools is rather limited due to the absence of formal metrics that could guide measurement, or the lack of understanding of sustainability in organizations. Furthermore, it is difficult to monitor and measure sustainability performance and identify which sustainability initiatives contribute to performance (Zhu, Sarkis, and Lai 2007a). Nevertheless, adoption of metrics that enable such measurements should be considered to ensure effective SSCM implementation and informed decisions can be made for future initiatives.

Table 5 shows aspects of supply chain functions which are studied in SSCM. Seuring and Muller (2008a) found that proactive companies are the ones who first develop sustainable products and supply chains. They emphasize that supplier development and integration should be a focus of a proactive approach to sustainability. Reactive approaches are motivated by the supplier’s non-conformance that could cause delay, increase costs and is detrimental to achieving sustainability goals. A proactive approach to supplier management, for example supplier monitoring, is therefore more relevant than a reactive approach in SSCM (Seuring and Müller 2008a). A focus on environmental responsibility in the supply chain is found to have led to a new approach to collaborations with suppliers, such as in environmental technology development, environmental audits and training (Kovács 2008). This is important because SSCM should facilitate collaboration between supply chain partners in finding supply chain solutions that can improve their capabilities and competitiveness (Gold, Seuring, and Beske 2010).

As can be seen in Table 5, many SSCM studies concentrate on supplier management. Little attention is paid to other supply chain functions, especially logistics. Min and Kim (2012) examined the literature on green logistics. They note that there is a lack of research on sustainable transportation and warehousing and the life cycle assessment of logistics activities from an environmental perspective (Min and Kim 2012). In addition, climate change and energy efficiency should be addressed by logistics and SCM professionals as convergent agendas, since both logistical performance, and supply chain strategies and structure will be affected by emission mitigation strategies, such as carbon pricing, and efficient use of energy sources (Halldórsson and Kovács 2010).

Logistics can contribute greatly to the planning process, especially in terms of issues related to the dynamics of the energy economy and of climate protection (Delfmann et al. 2010; Colicchia, Melacini, and Perotti 2011). This is especially true in view of the fact that a decision would affect the costs of operations (Möst and Perlwitz 2009; Remme, Blesl, and Fahl 2008); for example, a decision to develop unconventional O&G in deep water. The risk associated with the energy supply chain is directly connected to the cost of acquiring and delivering the energy. The location of the supply plays an important role, because dependency on energy from a difficult and unstable environment increases the risks, which eventually results in higher costs to secure supply. There is also an environmental burden associated with transportation activities, since it involves the distribution and discovery of new and used products (Tsoulfas and Pappis 2008).
SSCM implementation could lead to improvement in products, process and supply quality and productivity. According to Sarkis (2003), there are numerous ways in which the sustainability of the supply chain can be influenced by production processes. This includes the capability of the processes to use certain materials, integrate reusable or remanufactured components and prevent waste (Sarkis 2003; Tsoulfas and Pappis 2008). The strategy used in a production activity can also affect other supply chain functions. For example, packaging of a product such as in terms of size, shape and materials has a strong relationship with logistics (Sarkis 2003). A study was conducted by French (2008) on reuse of product returns in the chemical blending business. Although the manufacturer is concerned about the additional cost, such as, to provide a tracking system and extra labour to handle and process returned products, it benefits from reusing a “free product” which remains in the returnable container in its blending process, thus eliminating waste and reducing disposal cost (French 2008). In addition, it could also reduce the customer burden to dispose the surplus product and its containers (French 2008).

The life cycle of products should be taken into consideration as early as during the design process to minimize its negative impact on the environment. LCA is a decision-making tool that is developed for the integration of environmental concerns throughout the supply chain. Matos and Hall (2007) found that LCA can be applied for companies operating under different circumstances and approaches in terms of sustainability practices in SCM. The managerial challenge in implementing LCA, thus ensuring product stewardship, is in exploring the interdependencies of the parameters used to measure sustainability and the broader sustainable development concerns of society (Matos and Hall 2007).

5. Discussion
The O&G industry occupies a unique position among all industries because it powers the world’s economic and social activities. Its refined products are also used as raw materials in many things that we use today, such as plastics and even fertilizers for agriculture. However, it also causes many environmental problems, such as greenhouse gas (GHG) emissions, groundwater contamination and loss of biodiversity. Since the industry will continue to provide us with the energy and products that we need daily, it is therefore crucial to find solutions to the many sustainability problems that it is causing.

In this paper, we proposed a conceptual framework that identifies the contextual factors of the industry business and organizational environment that can help companies address the complexity of managing their supply chain. We will discuss the implications of the changes in the contextual factors to SSCM according to the four supply chain functions included in the framework.

5.1. Supplier management
The O&G supply chain is dispersed globally where it has to deal with differences in business environment, such as regulation requirements and stakeholder expectations. The need for externally focused process capabilities in the supply chain is greater in this condition (Kleindorfer and Saad 2005). Companies must be able to adapt their supplier management practices so as to effectively respond to the changes in their environment (Reuter et al. 2010). The configuration of supplier management processes, i.e. supplier selection, evaluation and development, are not influenced by the stakeholder pressure that companies have to deal with (Reuter et al. 2010). Each stakeholder may have different requirements and an O&G company may integrate the requirements in its sustainability
objectives. However, managers will implement known supplier management best practices to address sustainability issues in SCM (Reuter et al. 2010).

Instability in host countries also might not influence the configuration. However, it will be difficult to implement local supplier strategy under such conditions, especially if it involves armed conflicts and social unrest. Often, these conditions cause a devastating impact on the local economy. Local content strategy could be more comprehensive under stronger pressure by local governments and NGOs. However, local suppliers might lack the necessary skills and capabilities to serve technologically demanding and environmentally stringent industry such as the O&G industry. Therefore, O&G companies might need to spend more resources in local supplier development.

Supplier selection decisions during uncertain economic conditions can be influenced by factors such as the relative price/cost offered by a supplier, its financial conditions, cost reduction capabilities and delivery performance. Suppliers who are able to satisfy these conditions might be favoured where their environmental and social performance might be less important in selection criteria. However, environmental and social performance can help companies to gain competitive advantage in the market. In a competitive market, companies have to compete not only in terms of cost, but also sustainability performance. Furthermore, regulation requirements, such as in the use and production of chemical substances, labour protection and emissions reduction, call for suppliers who are able to satisfy these requirements. The environmental and social performance of suppliers might be as important as their financial capabilities in these conditions.

5.2. Logistics management

Logistics play a significant role in the transition to low carbon economy, especially because the transport sector is one of the main contributors of GHG emissions. Therefore, companies need to adjust to the changes in their environment due to tighter regulations for emissions reduction. In these cases, green logistics practices are expected to be more prevalent. Among the external forces, regulation requirements could be the main driver of the greening of logistics.

The long distance between O&G production facilities and the market requires solutions that are able to reduce emissions from logistics operations. Cooperation between companies operating in close geographic locations would be favoured in tighter environmental regulations. Collaboration in logistics operation can result in cost savings and benefits associated with longer term contracts, safety, quality, operations and economies of scale (Dauda and Yusuf 2009). It can also improve the effectiveness of procurement activities and resource sharing for waste management and warehousing (Dauda and Yusuf 2009). Therefore, companies could gain competitive advantage by collaborating with other companies in the industry.

Logistics operations of O&G companies can be affected by the conditions in their host countries. Instability resulting from political conflicts had caused major loss of transport infrastructures and communication networks (Al-Damkhi, Abdul-Wahab, and Al-Khulaifi 2009). The conflicts could lead to closure of loading ports and pipelines due to sabotage and theft, and increase security threats at O&G installations. Pipeline sabotage could lead to oil spills that can cause land, air and water pollution, and affect the livelihoods of surrounding communities. Companies operating in unstable countries would also experience frequent disruption in supply delivery. Under these conditions, minimizing economic and environmental risks might be the main priorities among O&G companies.
5.3. Production management

The impact of unstable conditions in host countries on production operations for O&G could be similar to the impact on its logistics operations — i.e. companies have to minimize economic risks and, therefore, prioritize their economic goals to enable them to fulfil their contractual and commercial obligations. Environmental and social aspects would receive more attention in stable economic conditions, higher regulatory and stakeholder pressure.

The O&G production and refining operations generate hazardous waste and emissions, such as ammonia and sulphur dioxide, which are toxic and can cause a severe impact on the environment. The O&G operations are also water and energy intensive. Regulations on the use of chemicals require that O&G companies report and register the chemicals used in their supply chain. Close cooperation with suppliers is crucial to ensure that these requirements are fulfilled. Companies must also treat and/or dispose of the by-products of production processes according to local, state or international laws imposed on the industry. Effective management of water sourcing and measurement will help companies to assess water supply availability and potential environmental problems it could cause. The availability of water recycling facilities will help companies to gain economic benefits from water reuse and also reduce the environmental impact on water bodies. O&G companies could also increase their use of electricity generated from renewable sources in their production processes.

To improve sustainability, O&G companies must be able to evaluate, monitor and issue information about the health and environmental risks of their products and production processes. The capability of processes to use certain materials, prevent waste and integrate reusable or remanufactured components in production processes can help reduce the environmental impacts of production processes (Sarkis 2003; Tsoulfas and Pappis 2008). As competition in the market increases, a company’s ability to differentiate itself through sustainable production processes is very important, especially in an industry such as O&G where there is very little variation in products offered.

5.4. Product stewardship

The life cycle of a product is closely dependent on each of the processes and materials used in its production. Product stewardship is therefore determined by how the three supply chain functions discussed earlier are conducted. In fact, all these functions are interdependent on each other. A company’s product stewardship strategy should involve evaluation and monitoring of product environmental and safety risks throughout its life cycle. For example, in terms of GHG emissions from end use of fuel, and risks posed by raw materials and end products. The use of a product safety data sheet will help in the communication of risks throughout supply chain. This includes to those who transport, use and dispose of the product.

An integrated approach to product safety and health is especially important for the O&G industry. Companies in the industry must consider the movement of products throughout their life cycle and the associated management issues that might occur. It is also important to manage the quality of products from production through storage and transport to sale. Again, regulations would play a huge role in ensuring product environmental and safety impacts are monitored and evaluated. However, companies must also be able to develop their own standards where laws and regulations are considered inadequate or do not exist, i.e. through self-governance or self-regulation.
6. Conclusions

This paper presents a conceptual framework of key contextual factors for SSCM of the O&G supply chain. The framework sheds light on the external and internal factors that can play a role in SSCM implementation. Currently, there is a lack of research on SSCM in the O&G industry from a multidimensional point of view. Even though there are a few studies related to SSCM, they are fragmented where none incorporates all three TBL dimensions of sustainable development and studies all the stages in the supply chain. In addition, frameworks are lacking in terms of the contextual aspects of the industry’s business and organizational environment. Our research suggests an overarching framework operationalizing these factors to address the gap. A systemic view of SSCM implementation in the O&G industry is needed in order to understand: (1) How the industry addresses the pressure to operate sustainably throughout its supply chain, and (2) How the contextual factors of its operating environment influence its SSCM strategy.

Since every company within the O&G industry belongs to various supply networks, there exist interdependencies between the companies as their paths cross. In order to understand the network, we need to understand its individual members, as each company is operating within its own context and engages in the network through its localized decision-making processes (Surana et al. 2005). This will eventually help us identify and understand the O&G industry’s collective behaviour in the SSCM practices.

From a scientific perspective, the research is of value to researchers who are interested in understanding sustainability-related issues in the supply chain for O&G. It incorporates both the internal and external contextual factors of the O&G industry’s operating environment that can influence its SSCM practices in four supply chain functions: supplier management, production management, logistics management and product stewardship. From a managerial perspective, the proposed framework helps O&G companies assess their contextual environment, which is a key to formulating an effective SSCM strategy. It can, therefore, be used as a tool in decision-making processes to improve supply chain sustainability through: (1) an analysis of the key business and organizational factors that can play a role in SSCM practices; and (2) the development of more effective management measures and capabilities. The framework is also useful for identifying and interpreting differences between the SSCM practices of companies operating in different contexts.

Future research will be aimed at gaining an empirical understanding of the validity and importance of the different relationships identified in the proposed framework. It can be followed by case studies that shed light on the way the contextual factors influence the SSCM of O&G.

Disclosure statement
No potential conflict of interest was reported by the authors.

ORCID
Nurul K. Wan Ahmad <http://orcid.org/0000-0003-1130-0669>

References
Al-Damkhi, A.M., S.A. Abdul-Wahab, and N.M. Al-Khulaifi. 2009. “Kuwait’s 1991 Environmental Tragedy: Lessons Learned.” Disaster Prevention and Management 18 (3): 233–48.
Anderson, E. 2003. “Supply Chain Strategy in the Oil and Gas Sector.” In Business Briefing: Exploration and Production 2003, 108–11. London: Business Briefings Ltd.
BP. 2015. “BP Energy Outlook 2035.” In BP Statistical Review, 1–98. London: British Petroleum plc.

CA. 2015. “Fossil Fuel Industry Facing $33trn Hit After Paris Climate Deal.” Climate Action GreenMedia Ltd. Accessed December 21. http://www.climateactionprogramme.org/news/fossil_fuel_industryFacing_33trn_hit_after_cop21_climate_deal?utm_source=Feeds&utm_campaign=News&utm_medium=rss.

Carter, C.R., and D.S. Rogers. 2008. “A Framework of Sustainable Supply Chain Management: Moving Toward New Theory.” International Journal of Physical Distribution and Logistics Management 38 (5): 360–87.

Chen, I.J., and A. Paulraj. 2004. “Towards a Theory of Supply Chain Management: The Constructs and Measurements.” Journal of Operations Management 22 (2): 119–50. doi:10.1016/j.jom.2003.12.007.

Colicchia, C., M. Melacini, and S. Perotti. 2011. “Benchmarking Supply Chain Sustainability: Insights from a Field Study.” Benchmarking: An International Journal 18 (5): 705–732. doi:10.1108/14635771111166839

Cuthbertson, R. 2011. “The Need for Sustainable Supply Chain Management.” Sustainable Supply Chain Management: Practical Ideas for Moving Towards Best Practice, edited by B. Cetinkaya, R. Cuthbertson, G. Ewer, T. Klaas-Wissing, W. Piotrowicz, and C. Tyssen, 3–13. Berlin: Springer.

Darnall, N., G.J. Jolley, and R. Handfield. 2008. “Environmental Management Systems and Green Supply Chain Management: Complements for Sustainability?” Business Strategy and the Environment 17 (1): 30–45.

Dauda, M., and Y. Yusuf. 2009. “Alliances and Logistics Performance: A Case Study of the UK Upstream Oil and Gas Logistics Operations.” Paper presented at POMS 20th Annual Conference, Orlando, FL, May 1–4, 2009.

Delfmann, W., W. Dangelmaier, W. Günther, N. Klaus, L. Overmeyer, W. Rothengatter, J. Weber, and J. Zentes. 2010. “Towards a Science of Logistics: Cornerstones of a Framework of Understanding of Logistics as an Academic Discipline.” Logistics Research 2 (2): 57–63. doi:10.1007/s12159-010-0034-5.

Deng, M.M., and L.J. Liu. 2011. “The Analysis and Discussion About Green Supply Chain Management of Oil Industry in China.” Applied Mechanics and Materials 65: 32–5.

Dhiman, S. 2008. “Product, People and Planet: The Triple-Bottom Line Sustainability Imperative.” The Journal of Global Business Issues 2 (2): 51–7.

Edwards, S., O. Ishaq, and O. Johnsen. 2010. Oil and Gas 2030: Meeting the Growing Demand for Energy in the Coming Decades. New York: IBM Institutes for Business Value.

Ekins, P., and R. Vanner. 2007. “Sectoral Sustainability and Sustainability Assessment Methodologies: A Review of Methodology in Light of Collaboration with the UK Oil and Gas Sector.” Journal of Environmental Planning and Management 50 (1): 87–111. doi:10.1080/09640560601048440.

Elcock, D. 2007. Life-Cycle Thinking for the Oil and Gas Exploration and Production Industry. Chicago, IL: Argonne National Laboratory.

Elkington, J. 2004. “Enter the Triple Bottom Line.” In The Triple Bottom Line: Does it All Add Up? edited by A. Henriques and J. Richardson, 1–16. London: Earthscan Publications Ltd. 1–16.

Escobar, L.F., and H. Vredenburg. 2011. “Multinational Oil Companies and the Adoption of Sustainable Development: A Resource-Based and Institutional Theory Interpretation of Adoption Heterogeneity.” Journal of Business Ethics 98 (1): 39–65.

Faisal, M.N. 2010. “Sustainable Supply Chains: A Study of Interaction Among the Enablers.” Business Process Management Journal 16 (3): 508–29.

Farrell, A.E., and A.R. Brandt. 2006. “Risks of the Oil Transition.” Environmental Research Letters 1 (1): 6.

Fouquet, R. 2010. “The Slow Search for Solutions: Lessons from Historical Energy Transitions by Sector and Service.” Energy Policy 38 (11): 6586–96. doi:10.1016/j.enpol.2010.06.029.

French, M.L. 2008. “Improving Sustainability Through Effective Reuse of Product Returns: Minimizing Waste in a Batch Blending Process Environment.” Journal of Cleaner Production 16 (15): 1679–87.

Gazprom-Neft. 2010. 2010 Sustainability Report. Moscow: Gazprom Neft.

Gillespie, A. 2011. Foundations of Economics. Oxford: Oxford University Press.
Giunipero, L.C., R.E. Hooker, and D. Denslow. 2012. “Purchasing and Supply Management Sustainability: Drivers and Barriers.” *Journal of Purchasing and Supply Management* 18 (4): 258–69. doi:http://dx.doi.org/10.1016/j.pursup.2012.06.003.

Gold, S., S. Seuring, and P. Beske. 2010. “Sustainable Supply Chain Management and Inter-Organizational Resources: A Literature Review.” *Corporate Social Responsibility and Environmental Management* 17 (4): 230–45. doi:10.1002/csr.207.

Halldorsson, A., H. Kotzab, and T. Skjøtt-Larsen. 2009. “Supply Chain Management on the Crossroad to Sustainability: A Blessing or a Curse?” *Logistics Research* 1 (2): 83–94. doi:10.1007/s12159-009-0012-y.

Halldorsson, A., and G. Kovacs. 2010. “The Sustainable Agenda and Energy Efficiency: Logistics Solutions and Supply Chains in Times of Climate Change.” *International Journal of Physical Distribution and Logistics Management* 40 (1/2): 5–13.

Harms, D., E.G. Hansen, and S. Schaltegger. 2013. “Strategies in Sustainable Supply Chain Management: An Empirical Investigation of Large German Companies.” *Corporate Social Responsibility and Environmental Management* 20 (4): 205–18.

Hartman, L.P., R.S. Rubin, and K.K. Dhanda. 2007. “The Communication of Corporate Social Responsibility: United States and European Union multinational corporations.” *Journal of Business Ethics* 74 (4): 373–89.

Hervani, A.A., M.M. Helms, and J. Sarkis. 2005. “Performance Measurement for Green Supply Chain Management.” *Benchmarking: An International Journal* 12 (4): 330–53.

Hussain, M. 2011. “Modelling the Enablers and Alternatives for Sustainable Supply Chain Management.” Masters diss., Concordia University.

IBM. 2005. “Downstream Petroleum Supply Chains - Incremental Optimization Leads to Greatest Gains.” IBM Corporation. Accessed 18 September 2012. http://www.ibm.com/services/us/bcs/pdf/g510-6366-downstream-petrol-supply-chains-incr-opt-leads-great-gains.pdf.

Julka, N., I. Karimi, and R. Srinivasan. 2002. “Agent-Based Supply Chain Management — 2: A Refinery Application.” *Computers and Chemical Engineering* 26 (12): 1771–81. doi:10.1016/s0098-1354(02)00151-5.

Kilponen, G. 2010. “Energy, Oil and Gas Industry Update: SCOR for Energy.” Paper presented at Forum for Benchmarking and Practices, May 21. http://docslide.us/documents/energy-oil-gas-industry-update-scor-for-energy-oil-gas-forum-for-benchmarking-and-practices-gary-kilponen-scc-director-treasurer-may-21-2010.html

Kjaerstad, J., and F. Johnsson. 2009. “Resources and Future Supply of Oil.” *Energy Policy* 37 (2): 441–64. doi:10.1016/j.enpol.2008.09.056.

Kleindorfer, P.R., and G.H. Saad. 2005. “Managing Disruption Risks in Supply Chains.” *Production and Operations Management* 14 (1): 53–68.

Kovacs, G. 2008. “Corporate Environmental Responsibility in the Supply Chain.” *Journal of Cleaner Production* 16 (15): 1571–8.

Kumar, S., and V. Putnam. 2008. “Cradle to Cradle: Reverse Logistics Strategies and Opportunities Across Three Industry Sectors.” *International Journal of Production Economics* 115 (2): 305–15. doi:http://dx.doi.org/10.1016/j.ijpe.2007.11.015.

Lakhal, S.Y., S. H’Mida, and M.R. Islam. 2007. “Green Supply Chain Parameters for a Canadian Petroleum Refinery Company.” *International Journal of Environmental Technology and Management* 7 (1–2): 56–67. doi:10.1504/ijetm.2007.013236.

Lakhal, S.Y., M. Khan, and M.R. Islam. 2009. “An ‘Olympic’ Framework for a Green Decommissioning of an Offshore Oil Platform.” *Ocean and Coastal Management* 52 (2): 113–23.

Li, S., B. Ragu-Nathan, T.S. Ragu-Nathan, and S. Rao Subba. 2006. “The Impact of Supply Chain Management Practices on Competitive Advantage and Organizational Performance.” *Omega* 34 (2): 107–24. doi:10.1016/j.omega.2004.08.002.

Lin-Hi, N., and I. Blumberg. 2011. “The Relationship Between Corporate Governance, Global Governance, and Sustainable Profits: Lessons Learned from BP.” *Corporate Governance* 11 (5): 571–84.

Linton, J.D., R. Klassen, and V. Jayaraman. 2007. “Sustainable Supply Chains: An Introduction.” *Journal of Operations Management* 25 (6): 1075–82. doi:10.1016/j.jom.2007.01.012.

Lior, N. 2010. “Sustainable Energy Development: The Present (2009) Situation and Possible Paths to the Future.” *Energy* 35 (10): 3976–94. doi:10.1016/j.energy.2010.03.034.

Lukoil. 2011. *2009—2010 Sustainability Report*. Moscow: Lukoil.
Manzano, F.S. 2005. *Supply Chain Practices in the Petroleum Downstream*. Masters diss. Massachusetts Institute of Technology.

Markley, M.J., and L. Davis 2007. “Exploring Future Competitive Advantage Through Sustainable Supply Chains.” *International Journal of Physical Distribution and Logistics Management* 37 (9): 763–74. doi:10.1108/09600030710840859.

Matos, S., and J. Hall. 2007. “Integrating Sustainable Development in the Supply Chain: The Case of Life Cycle Assessment in Oil and Gas and Agricultural Biotechnology.” *Journal of Operations Management* 25 (6): 1083–102. doi:10.1016/j.jom.2007.01.013.

Meredith, J. 1993. “Theory Building Through Conceptual Methods.” *Review of International Journal of Operations and Production Management* 13 (5): 3–11. doi: 10.1108/eum0000000005923.

Midttun, A., T. Dirdal, K. Gautesen, T. Omland, and S. Wenstøp. 2007. “Integrating Corporate Social Responsibility and Other Strategic Foci in a Distributed Production System: A Transaction Cost Perspective on the North Sea Offshore Petroleum Industry.” *Corporate Governance* 7 (2): 194–208.

Min, H., and W.P. Galle. 2001. “Green Purchasing Practices of US Firms.” *International Journal of Operations and Production Management* 21 (9): 1222–38. doi:10.1108/eum0000000005923.

Min, H., and I. Kim. 2012. “Green Supply Chain Research: Past, Present, and Future.” *Logistics Research* 4 (1): 39–47. doi:10.1007/s12159-012-0071-3.

Möst, D., and H. Perlwitz. 2009. “Prospects of Gas Supply Until 2020 in Europe and its Relevance for the Power Sector in the Context of Emission Trading.” *Energy* 34 (10): 1510–22. doi:10.1016/j.energy.2009.06.045.

Neiro, S.M.S., and J.M. Pinto. 2004. “A General Modeling Framework for the Operational Planning of Petroleum Supply Chains.” *Computers and Chemical Engineering* 28 (6-7): 871–96. doi:10.1016/j.compchemeng.2003.09.018.

Neubauer, F.F., and N.B. Solomon. 1977. “A Managerial Approach to Environmental Assessment.” *Long Range Planning* 10 (2): 13–20. doi:http://dx.doi.org/10.1016/0024-6301(77)90116-9.

Pagell, M., and Z. Wu. 2009. “Building a More Complete Theory of Sustainable Supply Chain Management Using Case Studies of 10 Exemplars.” *Journal of Supply Chain Management* 45 (2): 37–56. doi:10.1111/j.1745-493X.2009.03162.x.

Paulraj, A. 2011. “Understanding the Relationships between Internal Resources and Capabilities, Sustainable Supply Management and Organizational Sustainability.” *Journal of Supply Chain Management* 47 (1): 19–37. doi:10.1111/j.1745-493X.2010.03212.x.

Petrobras. 2011. “Sustainability Report 2010.” In *Corporate Communication/Social Responsibility/ Sector Management for Guidelines and Practices of Social Responsibility*. Rio de Janeiro, Brazil: Petrobras.

Porter, M.E. 1991. “Towards a Dynamic Theory of Strategy.” *Strategic Management Journal* 12 (S2): 95–117. doi:10.1002/smj.4250121008.

Remme, U., M. Blesl, and U. Fahl. 2008. “Future European Gas Supply in the Resource Triangle of the Former Soviet Union, the Middle East and Northern Africa.” *Energy Policy* 36 (5): 1622–41. doi:10.1016/j.enpol.2008.01.017.

Repsol. 2011. *Repsol Corporate Sustainability Report*. Madrid: Repsol.

Reuter, C., K. Foerstl, E. Hartmann, and C. Blome. 2010. “Sustainable Global Supplier Management: The Role of Dynamic Capabilities in Achieving Competitive Advantage.” *Journal of Supply Chain Management* 46 (2): 45–63.

Salter, E., and J. Ford. 2000. “Environmental Pollution Challenges and Associated Planning and Management Issues Facing Offshore Oil and Gas Field Development in the UK.” *Journal of Environmental Planning and Management* 43 (2): 253–76. doi:10.1080/096405600107002.

Sarkis, J. 2003. “A Strategic Decision Framework for Green Supply Chain Management.” *Journal of Cleaner Production* 11 (4): 397–409.

Seuring, S., and M. Müller 2008a. “Core issues in Sustainable Supply Chain Management: A Delphi Study.” *Business Strategy and the Environment* 17 (8): 455–66. doi:10.1002/bse.607.

Seuring, S., and M. Müller. 2008b. “From a Literature Review to a Conceptual Framework for Sustainable Supply Chain Management.” *Journal of Cleaner Production* 16 (15): 1699–710. doi:10.1016/j.jclepro.2008.04.020.

Surana, A., S. Kumara, M. Greaves, and U.N. Raghavan. 2005. “Supply-Chain Networks: A Complex Adaptive Systems Perspective”. *International Journal of Production Research* 43 (20): 4235–4265. doi:10.1080/00207540500142274.
Total. 2011. *Society and Environment Report 2010*. Courbevoie: TOTAL S.A.

Tsoulfas, G.T., and C.P. Pappis. 2008. “A Model for Supply Chains Environmental Performance Analysis and Decision Making.” *Journal of Cleaner Production* 16 (15): 1647–57.

UNEP. 1997. *Environmental Management in Oil and Gas Exploration and Production: An Overview of Issues and Management Approaches*. Oxford, United Kingdom: Oil Industry International Exploration and Production Forum (E&P Forum) and United Nations Environment Programme Industry and Environment Centre (UNEP IE).

Verbruggen, A., M. Fischedick, W. Moomaw, T. Weir, A. Nadaï, L.J. Nilsson, J. Nyboer, and J. Sathaye. 2010. “Renewable Energy Costs, Potentials, Barriers: Conceptual Issues.” *Energy Policy* 38 (2): 850–61. doi:10.1016/j.enpol.2009.10.036.

Wagner, J., and K. Armstrong. 2010. “Managing Environmental and Social Risks in International Oil and Gas Projects: Perspectives on Compliance.” *The Journal of World Energy Law and Business* 3 (2): 140–65. doi:10.1093/jwelb/jwq002.

Walker, H., and N. Jones. 2012. “Sustainable Supply Chain Management Across the UK Private Sector.” *Supply Chain Management: An International Journal* 17 (1): 15–28.

Wittstruck, D., and F. Teuteberg. 2012. “Understanding the Success Factors of Sustainable Supply Chain Management: Empirical Evidence from the Electrics and Electronics Industry.” *Corporate Social Responsibility and Environmental Management* 19 (3): 141–58. doi:10.1002/csr.261.

Wolf, C. 2009. “Does Ownership Matter? The Performance and Efficiency of State Oil vs. Private Oil (1987-2006).” *Energy Policy* 37 (7): 2642–52. doi:10.1016/j.enpol.2009.02.041.

Wolf, J. 2011. “Sustainable Supply Chain Management Integration: A Qualitative Analysis of the German Manufacturing Industry.” *Journal of Business Ethics* 102 (2): 221–35. doi:10.1007/s10551-011-0806-0.

Yüksel, I. 2012. “Developing a Multi-Criteria Decision Making Model for PESTEL Analysis.” *International Journal of Business and Management* 7 (24): 52–66.

Zhu, Q., J. Sarkis, and K.H. Lai. 2007a. “Green Supply Chain Management: Pressures, Practices and Performance within the Chinese Automobile Industry.” *Journal of Cleaner Production* 15 (11–12): 1041–52.

Zhu, Q., J. Sarkis, and K.H. Lai. 2007b. “Initiatives and Outcomes of Green Supply Chain Management Implementation by Chinese Manufacturers.” *Journal of Environmental Management* 85 (1): 179–89.

Zhu, Q., J. Sarkis, and K.H. Lai. 2008a. “Confirmation of a Measurement Model for Green Supply Chain Management Practices Implementation.” *International Journal of Production Economics* 111 (2): 261–73. doi:10.1016/j.ijpe.2006.11.029.

Zhu, Q., J. Sarkis, and K.H. Lai. 2008b. “Green Supply Chain Management Implications for ‘Closing the Loop’.” *Transportation Research Part E: Logistics and Transportation Review* 44 (1): 1–18.

Zutshi, A., A. Creed, and A. Sohal. 2009. “Child Labour and Supply Chain: Profitability or (Mis) Management.” *European Business Review* 21 (1): 42–63. doi:10.1108/09555340910925175.