Contextual Factors of Sustainable Supply Chain Management Practices in the Oil and Gas Industry

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Cover photo: Sunset over Trinidad oilfield by Nathan Paculba
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Proefschrift

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door

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Preface

The relationship between sustainability and the oil and gas industry fascinates me because of their contradiction. How can oil and gas be sustainable because everything right from their exploration to their use could harm the environment. However, we rely heavily on these natural resources in economic activities and in our daily lives, and may still need to depend on them in the coming decades until commercially viable alternative energy sources become more accessible. We need to, therefore, improve our understanding of the challenges that confront the oil and gas industry in its efforts to minimize (or eliminate) the negative impacts, as well as enhance its compatibility with a sustainable future. In my PhD research, I tried to find some answers on how the industry can address these issues by focusing on its sustainable supply chain management practices. It took me nearly 6 years to find that potential answers, which is not possible without the help of so many people.

Without doubt, my promotor and supervisors have played a huge role in guiding me throughout this journey. Lori, I could never ask for a better promotor. The many discussions and talks we had have not only guided me in my research endeavor, but also helped me survive some major setbacks in my research and my life. Your enthusiasm and ability to visualize a problem clearly are the traits I hope to acquire myself. Jafar, I am so lucky to have you as my supervisor! I have said this to you before, I wish I could be a better student to you. I could never thank you enough for your support and patience during the last 4 years. Finally, Marisa, thank you so much for your guidance, support and patience, especially during the early years of my PhD journey. You were instrumental in shaping the focus of my research. Thank you very much for being involved in the research and always showing great interest in my progress even after you left TU Delft.

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Karimah
Delft, August 2016
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1. Introduction

1.1 Research background

Modern society is built upon the use of energy to satisfy our needs for transport, light, heat and power. Energy is so fundamental to our lives, without which disruptions in economic activities and reduction in quality of life could occur. Traditional sources of energy include, among others, human and animal labour, biomass from wood stocks, oil kerosene, windmill and watermill (Fouquet, 2010). The period of the nineteenth century saw the inventions of new energy technologies such as electric dynamo, steam engine and internal combustion engine that allow us to exploit energy sources more efficiently, especially from fossil fuels (Fouquet, 2010, Smil, 2005). Fossil fuels became the world’s major source of energy approximately around the 1890s, mainly from coal, which was then gradually replaced by crude oil and natural gas as primary energy by the 1970s (Smil, 2005).

Advances in exploration, refining and transportation technologies of oil and gas (O&G) enabled rapid development of these sources to fulfill our growing demand for energy. BP projected that global consumption of energy will grow by 37% between 2013 and 2035. The O&G industry is estimated to account for approximately 55% of the total energy sources in that period (BP, 2015). Crude oil has high energy density and easy to be transported, while natural gas has low sulphur content compared to other fossil fuels (Smil, 2005). These advantages are among the factors that contribute towards the prevalence of O&G especially in transportation, heating and electricity generation. Concerns regarding future availability of conventional O&G and increased competition to access existing reserves have led to oil transition in the industry where greater focus is put on the development of unconventional O&G (Farrell and Brandt, 2006, Wolf, 2009). This has unlocked reserves located in unconventional locations such as deep water and the arctic, as well as from unconventional sources like shale and tar sands (Farrell and Brandt, 2006, Ziegler et al., 2009). However, O&G exploitation comes at great expense to the environment as well as public health and safety.

Exploration, production, transportation and conversion of O&G can cause negative impacts to the environment such as water pollution, biodiversity degradation, and emissions of
greenhouse gases (GHG). This can affect societal wellbeing, especially to host communities due to, for example, exposure to the release of toxic substance and gases, displacement of traditional community structure and loss of provisions for local communities that depend on nature for their livelihood.

Therefore, there are growing concerns regarding the compatibility of the O&G industry in sustainable future. This has led to the call for O&G to be replaced with low carbon and renewable alternative energy. The current development of alternative energy is slow and cost-intensive; it would take years for the energy to be developed economically and to achieve energy efficiency levels that would allow it to replace O&G. Even though the alternatives will gain increasing share in the future energy mix, O&G however, are projected to remain as the most important sources of energy for decades to come (BP, 2015, Fouquet, 2010). This implies that the sustainability of the O&G industry’s operations and products are pressing issues that must be addressed promptly to minimize or eliminate the risks involved.

One way that this can be done is through the integration of sustainability dimensions in supply chain management (SCM) practices in the O&G industry. SCM is defined as the systemic and strategic coordination of traditional business functions and the tactics across these functions to improve the long-term performance of a supply chain and its members (Mentzer et al., 2001). It is a bi-directional integrative function of material, information and service processing links of not only the internal supply chain of a business, but also all of the upstream and downstream members of the supply chain (Chen and Paulraj, 2004).

SCM plays a substantial role in facilitating the globalization of the world economy (Halldórsson et al., 2009), since production processes are often dispersed around the globe (Mentzer et al., 2001, Seuring and Müller, 2008). However, society is paying a high price in terms of environmental shortcomings for the economic advantages gained from this phenomenon. Consequently, the issues occurring outside organizational boundaries with regard to SCM have attracted growing academic and corporate interest, which has resulted in increasing efforts to integrate sustainability principles into SCM practices (Dakov and Novkov, 2008). This extension to SCM, generally known as sustainable supply chain management (SSCM), concerns supply chain design and operations that emphasize environmental and social responsibility beyond the ownership and uses of a particular product or services throughout the supply chain, to also include its end-of-life considerations.

SSCM can be defined as strategic and transparent integration and achievement of economic, environmental and social goals of an organization through systemic integration of key business functions and processes, and cooperation among supply chain members (Carter and Rogers, 2008). The adoption of SSCM strategy is facilitated by managerial actions and decisions that are taken to manage material, information and capital flows, as well as cooperation with supply chain partners to create a sustainable supply chain and achieve sustainability goals based on customer and stakeholder requirements (Seuring and Müller, 2008, Pagell and Wu, 2009).

Sustainability is becoming a key survival issue for companies amid the mounting pressure by the public for more responsible practices (Dhiman, 2008), and from increasing awareness of environmental and social burden associated with their activities (Seuring and Müller, 2008). Perhaps more than any other industries, the sustainability of the O&G supply chain should be a major concern since it has become a deeply entrenched foundation from which many industries and lives are built. The challenges in the implementation of sustainable practices in the O&G industry is not just to arrive at environmentally and socially responsible operations throughout its supply chain, but also to enable the industry to adapt to the changes in its business environment in timely manner. This is to ensure that it could evolve and remain relevant in sustainable future alongside cleaner energy options to deliver sustainable energy supply.
Despite its importance, little attention is given to the O&G industry in the sustainable operations and SCM literature (Hussain et al., 2006). Therefore, there is a lack of understanding of the sustainability issues and challenges confronting the industry in its supply chain activities, as well as the SSCM strategy that can be adopted according to its operating context.

1.2 Problem statement

The O&G supply chain is characterized by complex networks of companies, involved in highly specialized activities at every stage of the chain, from upstream exploration and production activities to downstream refining and distribution practices. This complexity has necessitated research into supply chain modelling aimed at, among others, improving its logistics systems, production and operation planning, inventory management and minimizing disruptions in supply networks. The first study on supply chain management within the O&G industry context was conducted by Sears in 1993, which focused on the downstream logistics planning of oil companies (Neiro and Pinto, 2004). Generally, the goal of this and many latter studies were to achieve efficiency improvements through lead time and cost reductions, involving optimization modelling or simulation approaches. As yet, little attention has been devoted to the sustainability aspects of the supply chain.

Lakhal et al. (2007) note the lack of research in the area of sustainable supply chain of O&G. They conducted the first study on green supply chain management (GSCM) in the industry, specifically for oil refineries application. However, GSCM studies do not consider the social aspect of supply chain sustainability, and largely focused on the environmental aspect. Other sustainability-related studies include integration of corporate social responsibility in supply chain practices (Midttun et al., 2007), life cycle analysis (Vlasopoulos et al., 2006, Lakhal et al., 2009), closed-loop GSCM (Li and Jianming, 2009), GHG emissions (Brandt et al., 2010, Sealy and Dunlop, 2010), laws and regulations (Wagner and Armstrong, 2010), and risk management (Cigolini and Rossi, 2010). Recent studies are about the adoption of sustainable measures and performance outcomes (Yusuf et al., 2013), sustainable sea transport outsourcing strategy (Tesfay, 2014), and local content practices (Ngoasong, 2014, Ablo, 2015). Overall, sustainable supply chain studies in the O&G industry context is still fragmented where there is a lack of systemic or multidimensional research that focus on:

1. Triple bottom line of sustainable practices, i.e. economic, environmental and social dimensions;
2. Internal and external factors that can affect the implementation of sustainable supply chain strategy in the O&G industry;
3. Sustainability strategy of different functional areas in O&G supply chain; and
4. Development of SSCM strategies that facilitate the alignment of companies’ internal organizational environment with their external business environment to achieve supply chain sustainability goals.

Halldórsson et al. (2009) propose that further studies should be conducted to identify the contextual factors of a sustainable supply chain strategy. They note that most SSCM studies concentrate on micro perspective; i.e. stakeholder concern regarding the impact of companies’ activities on the environment and society, and the approach to achieving SSCM, such as reverse logistics, carbon footprint reduction and green supply chain. Research from macro perspective is needed since sustainability may be an external factors that could affect supply chain design and operation (Halldórsson et al., 2009). For example, researchers could
examine how the interplay between factors within business environments creates sustainability pressure on supply chain management practices.

Surana et al. (2005) suggest that every company can affect the overall performance of its supply chain by engaging in the chain activities through localized decision-making practices. It is therefore important to identify the contextual factors within the external business environment and internal organizational environment that could affect SSCM practices. This will allow us to understand the relationship between the contextual factors and sustainable supply chain strategies adopted by the company. Consequently, we will be able to understand a supply chain’s collective behaviour towards SSCM practices.

SSCM studies specific to the O&G supply chain context are needed because the industry may be facing sustainability pressures that are different than other industries. The O&G industry operates in diverse environmental, socio-economic, political and regulatory settings (Wagner and Armstrong, 2010). These external forces, including technology progress, emergence of alternative energy, social and environmental concerns (Edwards et al., 2010), may determine companies’ responses to the pressure to operate sustainably in their supply chains.

For example, the O&G industry is highly regulated compared to automobiles industry (Zhu et al., 2007). It is also a truly international industry, e.g. a Dutch company may be developing O&G reserves in the Middle East that will be transported to Asia to be further refined into products to satisfy demands in Europe. Companies in the industry, therefore, can be subjected to different regulatory requirements that can cause uncertainties to the sustainability of their supply chain operations. Increased competition from cleaner alternative energy may force companies to improve their environmental sustainability. However, O&G are carbon-intensive sources that can never compete with the alternatives in environmental areas. Therefore, they might respond to the pressure through strategies that can help secure their competitive position, which might cause trade-off between economic, environmental and social sustainability.

The inherent carbon-intensive nature of O&G 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 the industry can achieve an acceptable level of sustainability if conducted on a smaller scale, complemented by a transition to low carbon energy systems that include more prominent role of alternative energy. That is in essence, one of the resolutions achieved by the recently concluded 2015 United Nation Climate Change Conference (COP21) in Paris. Although energy transition can affect all industries, the O&G industry is essentially at the core of the transition. Any regulatory or fiscal policies introduced to spur the speed of the transition and promote the development of alternative energy will affect the industry and its future survival. 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 (CA, 2015).

It can be argued that companies that are equipped with appropriate internal resources and competences will be able to manage the sustainability pressure resulted from their external environment complexities. As of yet, little is known about the interplay between these internal and external contextual factors in influencing companies’ sustainable supply chain strategies. Thus, a study is needed to operationalize these factors. Understanding the relationships between the factors is one of the first steps towards identifying the O&G industry’s responses to the pressure to operate sustainably. In addition, it will help us identify how SSCM strategies can be integrated and implemented more effectively in the management of its supply chains.
1.3 Research objectives and questions

The lack of understanding on the contextual factors that could affect the adoption of SSCM practices in the O&G industry must be addressed. Therefore, the main aim of this thesis is:

*To explore the influence of the contextual factors within the O&G industry’s external business environment and internal organizational environment on its implementation of SSCM practices.*

Based on the main research objective, several research questions are formulated in order to achieve it. The questions, which mirror the more specific objectives of this thesis, are as follows.

RQ1: *What are the factors within the O&G industry’s external business environment and internal organizational environment that can influence its implementation of SSCM practices?*

RQ2: *What are the sustainable supply chain strategies adopted by companies in the O&G industry?*

Galbraith (1973) argues that the best way for an organization to organize itself is contingent upon the environment in which it operates. A strategy that works for a product, a company or an industry, for example, may not be equally effective for others (Galbraith, 1973). With these questions, we are therefore interested in exploring and identifying the internal and external contextual factors that could drive (or hinder) the implementation of SSCM practices in the O&G industry. In addition, we aim to identify the sustainable supply chain strategies that are being applied in the O&G industry context.

RQ3: *To what extent do companies in the O&G industry communicate their commitment and performance related to sustainable practices?*

Through the third research question, we aim to obtain an overview of sustainable practices in the O&G industry, by examining the disclosure of its commitment and performance related to the practices. By answering this question, we will be able to determine whether the commitments expressed are consistent with the disclosure of their actual performance. In addition, it will allow us to understand how the pressures for sustainable practices are addressed through public disclosure of sustainability initiatives and performance.

RQ4: *What are the most important external factors that can influence the O&G industry’s adoption of SSCM practices?*

As every company or industry operates within an environment that is unique to its characteristics, the challenges involved in achieving sustainable supply chain may be different for each. This is especially true when we consider the various factors that companies have to deal with from their external environment, which are often beyond their control. Therefore, through the fourth research question, we are interested in identifying the most important external factors that can influence SSCM practices in the O&G industry. This will help us identify the factors that companies should pay more attention to or should be prioritized in decision making processes related to SSCM implementation.
RQ5: What are the relationships between the external and internal factors with sustainable supply chain strategies?

The fifth and final research question concerns the relationship between the three central elements of this thesis: external factors, internal factors and sustainable supply chain strategies. We argue that SSCM strategies result from the interplay of factors within the external and internal contextual environments, as well as companies’ interaction with the environments. Through this research question, we aim to identify the relationships between the contextual factors and sustainable supply chain strategies. This allows us to understand how the factors can drive or hinder the adoption of SSCM practices among companies that operate in the O&G industry.

1.4 Research methodology

This research is a cross-sectional study that uses a mixed methods approach to answer the research questions and to achieve its objectives. In order to clearly understand research problems, this approach uses inquiry strategies that involve simultaneous or sequential data collection of both quantitative and qualitative information (Creswell, 2009). The use of a mixed methods approach enables a researcher to test consistency of findings obtained through different instruments as well as provides detailed explanation of a scenario being studied.

Generally, this thesis begins with the formulation of research objectives and research questions, followed by a more thorough review of literature related to SSCM and sustainable practices in the O&G industry. The literature review allows us to identify the state-of-the-art of research in these areas, and identify the internal organizational factors, external business environment factors, and SSCM strategies that are relevant to this research. In addition to literature review, a content analysis of sustainability reports of O&G companies is conducted to obtain an overview of sustainable practices in the industry. This is accomplished by analysing companies’ disclosure of their commitment and performance related to the practices.

The factors found through the review form the basis of the conceptual framework of this thesis. The framework illustrates the relationship between contextual factors within O&G industry’s environments and SSCM strategies. We discuss the framework from organizational perspectives, specifically its linkages to three complementary organizational theories: institutional theory, stakeholder theory and dynamic capabilities theory.

Institutional theory and stakeholder theory help us describe how external business environment factors can influence companies’ strategies related to SSCM practices. According to institutional theory, business strategy can be affected by external forces such as political, economic, regulatory agencies, competitors, and industry norms that create isomorphic response to coercive, mimetic and normative pressure (DiMaggio and Powell, 1983, Scott, 2005). Oliver (1991) argue that firm’s response to the pressure varies and may be driven by active organizational behaviour and interest-seeking nature of the firm in order to obtain stability and legitimacy. Stakeholder theory is about groups that can affect or be affected by organization actions, and about managerial behaviour as they respond to those groups to create value (Freeman et al., 2004, Donaldson and Preston, 1995). Institutions and stakeholders are interdependent and together they could determine how organizations develop their strategy to respond to external influence and sustainable development pressure (Lee, 2011, Wu et al., 2012).

Dynamic capabilities theory, on the other hand, helps us explain how internal organizational factors (i.e. resources and capabilities) can facilitate the implementation of
SSCM practices in the companies. Dynamic capabilities include firm’s ability to sense, seize and reconfigure itself in order to develop and exploit internal and external competences, as well as adapt to and shape its environment (Teece et al., 1997). The application of dynamic capabilities theory is relevant to SSCM field since both share similar environmental and organizational conditions that allows companies to adapt to changing environment and pressures (Beske, 2012).

In order to test the influence of the external factors and internal factors on sustainable supply chain strategies proposed in the conceptual framework, we develop a questionnaire that contains their measurement items based on the literature and feedback from industry experts. A survey among companies that operate along the upstream and downstream O&G supply chain is conducted to collect the necessary data using the questionnaire. Data gathered are analysed using descriptive and inferential statistical analysis.

In the broader SSCM field, there is a growing literature that explores the internal and external factors that could affect SSCM practices. However, studies with regard to the importance of the external factors in influencing SSCM practices in the O&G industry context are limited. Therefore, we conduct a survey to assess the importance of the factors. The survey is conducted among academic experts in the supply chain and O&G field due to their accessibility and familiarity with the issues being studied. Data gathered from academic perspectives can provide valuable insights that can be compared with data from industry perspectives. We analyze the data using a new multi-criteria decision-making (MCDM) method called Best Worst Method (BWM).

Overall, this thesis develops a conceptual framework of the contextual factors of SSCM practices in the O&G industry based on a review of literature and industry reports. It then explores the relationships proposed in the framework by testing the relationships through empirical analysis and examining its linkages with three organizational theories. Based on the results of our analysis, we identify several implications for SSCM practices in the O&G industry and for further investigations of this research area.

1.5 Research significance

This thesis contributes towards furthering our understanding of the contextual factors that could drive or hinder SSCM practices in the O&G industry. There are three aspects in which it helps in achieving such understanding.

![Conceptual framework of SSCM in the O&G industry](image)

**Figure 1.1 – Conceptual framework of SSCM in the O&G industry**

First, we develop a multidimensional conceptual framework of SSCM in the O&G industry operationalizing the contextual factors that can influence its adoption of sustainable supply
chain strategy, as shown in Figure 1.1. While various studies have been conducted to examine the internal and external drivers of SSCM, studies in the O&G supply chain context are scarce. Furthermore, the framework incorporates different supply chain functional areas that are involved in acquisition of materials/resources, their conversion and distribution into products or services to satisfy customer requirements. Currently, there is no study that examines SSCM practices in the O&G industry context from this multidimensional perspective.

The second aspect that differentiates this research from the existing SSCM studies is the inclusion of supply chain sustainability goals as a distinct internal factor that can affect supply chain strategies. Sustainability goals are often discussed in SSCM literature with regard to its integration in corporate and functional strategies (Wolf, 2011, Harms et al., 2013), supply chain performance measurement (Wittstruck and Teuteberg, 2012, Darnall et al., 2008) and in resources and capabilities development (Paulraj, 2011). Very few studies incorporate sustainability goals as an explicit factor in SSCM framework, notably Hervani et al. (2005) and Pagell and Wu (2009) studies. We extend these studies by examining the role that sustainability goals can play in aligning companies’ internal and external environment. We argue that understanding this role can facilitate the formulation of more effective sustainable supply chain strategies.

Third, the O&G industry occupies a unique position in sustaining the world’s economy and our lives, but it is also the cause of sustainability problems we face today. Through this research, we want to understand how companies in the industry respond to the sustainability pressure exerted by the factors within their external environment using internal resources and capabilities to implement sustainable supply chain practices. While all industries might seem to operate within similar external environment, we think that the O&G industry experiences greater external pressure for sustainable practices compared to other industries due to its strategic importance and prevalence in social as well as economic activities. The interactions among factors within the external environment create contextual uncertainties that can increase sustainability pressure on the O&G industry. We operationalize the factors to gain some insights on how it can influence the industry’s adoption of SSCM practices.

Overall, this thesis can contribute towards furthering our understanding of SSCM practices in the O&G industry context. The conceptual framework proposed aims to explore the O&G industry’s external and internal environments that can affect its SSCM practices from multidimensional perspective. Specifically, this thesis adds to the discussions that SSCM strategies result from the interplay between the internal and external factors within companies business and organizational environments, and their interaction with the environments.

1.6 Outline of thesis

Figure 1.2 shows the outline of this thesis, which is based on the work conducted to understand the internal and external contextual factors of SSCM practices in the O&G industry.

In Chapter 2 this thesis discusses the conceptual framework proposed to study the contextual factors of SSCM practices in the O&G industry. The framework operationalizes the internal and external factors in the industry’s business and organizational environment that can influence its adoption of sustainable supply chain strategies.

Next, Chapter 3 presents the results of a content analysis of sustainability reports of O&G companies. It is an exploratory study that aims to gain an overview of the sustainability reporting practices of companies in the industry, and the integration of sustainable practices in their supply chain management.
Chapter 4 focuses on the importance of external factors in influencing SSCM practices in the O&G industry. This chapter sheds some light on this issue based on a study among academic experts in the field of O&G and SSCM.

In Chapter 5 and Chapter 6, this thesis discusses the results of an industry survey conducted to understand the relationships between contextual factors and supply chain sustainability strategies. Specifically, Chapter 5 focuses on the relationships between external business environment factors and supply chain sustainability goals. Chapter 6, on the other hand, discusses the relationships between internal organizational factors (commitment to sustainability and management preparedness) and sustainable supply chain strategies adopted by companies. The results of the survey are presented in two separate chapters to allow for more detailed discussions of the relationships between the factors examined in this thesis.

Finally, Chapter 7 discusses the substantive findings regarding the contextual factors of SSCM practices in the O&G industry as well as the drivers and barriers to the practices. This is based on the studies discussed in the previous chapters. It also presents the scientific and managerial implications of the studies, as well as opportunities for further research.
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2. Conceptual Framework for Sustainable Supply Chain Management Practices in the Oil and Gas Industry


2.1 Introduction

This chapter presents the conceptual framework of this thesis. It discusses the internal and external contextual factors that can influence the implementation of sustainable supply chain management (SSCM) practices in the oil and gas (O&G) industry. The framework is developed based on a literature review around the key topic areas of SSCM and sustainability practices within the industry. We identify the relevant factors through the literature, classify them, describe their interactions, and map the factors in a framework. This chapter will also discuss the framework from organizational theory perspectives. Specifically, it linkages to three theories namely institutional theory, stakeholder theory and dynamic capabilities theory. The following research questions guide our literature search and conceptual framework development:

1. What are the factors within the O&G industry’s external business environment and internal organizational environment that can influence its implementation of SSCM practices?

2. What are the sustainable supply chain strategies adopted by companies in the O&G industry?
The structure of this chapter is as follows. Section 2.2 defines SSCM, followed by Section 2.3 that describes the methodology used to develop the conceptual framework. Section 2.4 discusses current SSCM studies related to the O&G industry. In Section 2.5 we discuss the conceptual framework, and in Section 2.6 discuss the framework from organizational theory perspectives. The final Section 2.7 concludes this chapter with a summary of its main highlights.

2.2 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 triple-bottom-line (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 in a broader context when various, often conflicting, issues need to be considered simultaneously.

Carter and Rogers (2008, p. 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 & Muller (2008b, p. 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), meanwhile, 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 society wellbeing. 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 (Srivastava, 2007), which in essence are part of supply chain management (SCM) (Markley and Davis, 2007).

A sustainable O&G supply chain practices is crucial because the demand for energy will continue to increase in the future. 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 unsustainable exploitation of these resources can be devastating. The implementation of SSCM practices should help to 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 to deliver a more sustainable O&G supply.

2.3 Conceptual framework development

According to Meredith (1993, p. 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 thesis 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 Muller (2008b) in our literature search 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 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 four major academic databases and Google Scholar were chosen because of the extensiveness of their coverage of academic literature related supply chain management, O&G industry and sustainable development. The journal articles found through the databases were examined for their relevance 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 the integration of sustainability within the SCM field has only gained prominence during recent years. This is confirmed by the results of the literature search, where the earliest study found was conducted by Min and Galle (2001). However, the study includes other manufacturing industries besides the oil/gas extraction and 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 2.1.

<table>
<thead>
<tr>
<th>Focus area</th>
<th>Author</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable/green SCM of O&amp;G</td>
<td>Lakhal et al. (2007); Midttun et al. (2007); Lakhal et al. (2009); Deng and Liu (2011)</td>
<td>4</td>
</tr>
<tr>
<td>O&amp;G is part of researched area</td>
<td>Min and Galle (2001); Zhu et al. (2007b); Matos and Hall (2007); Hartman et al. (2007); Zhu et al. (2008b); Zutshi et al. (2009)</td>
<td>6</td>
</tr>
</tbody>
</table>

Due to the lack of literature, we included all of the papers found. For that same reason, we also referred to the broader O&G studies, industry reports, such as the sustainability reports and industry guidelines related to O&G development. This is to increase our understanding of its supply chains and the sustainability issues involved. Additionally, we referred to the SSCM literature from other industrial areas (the search used the same databases mentioned earlier). This is 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. Based on the findings, we developed the first version of a conceptual framework that proposes the relationship between the contextual factors and SSCM practices in the O&G industry.
The framework was refined through discussions with colleagues and academic experts in areas ranging from SCM, transport and logistics to energy systems. Discussions were also conducted with operations, supply chain or sustainable development managers and practitioners who work in the O&G industry. These discussions helped us to ensure that relevant factors are included in the framework and the relationships between those factors are mapped correctly. This resulted in the final version of the conceptual framework. Throughout this process, we sought to ensure that the framework maintained its integrity with reference to the literature and industry reports consulted earlier.

2.4 Synthesis of literature on sustainable supply chain management in the oil and gas industry

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 et al., 2010). They can be categorized into operators (oil companies), main contractors, subcontractors 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 2.2 (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 thesis.

Figure 2.2 – Oil and gas supply chain and its industry segments (Kilponen, 2010)
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 to 40 years. The decommissioning process involves building and equipment removal, site restoration, implementation of site revegetation measures and continuous 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 et al., 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 et al., 2002). In these cases there is a need for inter-departmental integration, since local improvements would not necessarily help in improving supply chain overall performance. Table 2.2 summarizes the characteristics of downstream O&G supply chain.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long product life cycles</td>
<td>Stable and static product mix</td>
</tr>
<tr>
<td>Non-perishable products</td>
<td>Costly inventory holding, but costs are recoverable; downstream companies are not affected by aging and stock rotation issues</td>
</tr>
<tr>
<td>Less volatile demand</td>
<td>Demand may vary among petroleum companies, but market demand is more stable; demand does not change based on product innovation and consumer tastes</td>
</tr>
<tr>
<td>Less product to track</td>
<td>Stable and static product mix</td>
</tr>
<tr>
<td>Few methods of viable transport</td>
<td>Products are flammable, with a large distance between supply sources and consumer markets</td>
</tr>
<tr>
<td>Commodity-based and fungible inventory</td>
<td>Competitors can trade with each other; associated financial markets for both crude and refined products play a large part in how supply chains are managed, and these markets can be exceptionally volatile</td>
</tr>
<tr>
<td>Discontinuous supply chains</td>
<td>Inventory is often traded or resold several times before it is consumed (it can move in and out of companies’ systems several times, which can increase transaction volume but not necessarily increase or reduce actual inventory)</td>
</tr>
<tr>
<td>Process-based and non-discrete inventory</td>
<td>Inventory is not packaged and can’t be separately identified</td>
</tr>
<tr>
<td>Reversed production flow</td>
<td>Inventory starts as few products (crudes) and creates many products that can be combined – an end product can be created in many different ways</td>
</tr>
<tr>
<td>Legal and environmental regulations</td>
<td>Mandate minimum inventories, raise antitrust concerns, require unique reporting, and emphasize safety and quality of the end product</td>
</tr>
<tr>
<td>Inflexible assets</td>
<td>Inherent processing complexities of a refinery only permits narrow ranges of capacity changes; difficult and risky production stopping and restarting</td>
</tr>
<tr>
<td>Transportation costs and low relative value</td>
<td>By limiting the number of locations, products can be shipped cost-effectively</td>
</tr>
</tbody>
</table>

Currently, very few research on the sustainability of the O&G supply chain is reported in the scientific literature. Table 2.3 summarizes the studies related to sustainable or green SCM in the O&G industry found through literature search. We find that none of the existing 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 involved.

Table 2.3 – Summary of SSCM of O&G papers found through literature search

<table>
<thead>
<tr>
<th>Author</th>
<th>Year</th>
<th>TBL dimension</th>
<th>Supply chain stage (SCS)</th>
<th>No focus on any SCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Min &amp; Galle</td>
<td>2001</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Zhu et al.</td>
<td>2007b</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Hartman et al.</td>
<td>2007</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Lakhal et al.</td>
<td>2007</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Midttun et al.</td>
<td>2007</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Matos &amp; Hall</td>
<td>2007</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Zhu et al.</td>
<td>2008b</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Zutshi et al.</td>
<td>2009</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Lakhal et al.</td>
<td>2009</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Deng &amp; Liu</td>
<td>2011</td>
<td>• ECO, ENV</td>
<td>x</td>
<td></td>
</tr>
</tbody>
</table>

+Papers specific to O&G supply chain

Lakhal et al. (2007) conducted one of the first studies specific to the O&G supply chain. They note that there were no green supply chain management (GSCM) studies in the petroleum industry prior to their research. Their study 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 et al., 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 et al., 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 under-communicated within the industry (Midttun et al., 2007).

Deng & 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 et al. (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 support. The process and technology are also inadequate, especially for energy conservation and emissions reduction (Deng and Liu, 2011).

Apart from the studies discussed above, several researchers include the O&G industry as part of the research areas in their studies. These studies focus on green purchasing/supply chain management (Min and Galle, 2001, Zhu et al., 2007b, Zhu et al., 2008b), life cycle analysis (Matos and Hall, 2007) and corporate social responsibility (Hartman et al., 2007, Zutshi et al., 2009). Among the studies, only Zhu et al. (2007b), Zhu et al. (2008b) and Matos and Hall (2007) distinguish their findings according to the researched industries.
Our review of the existing literature related to sustainability of 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) external and internal factors that can affect its SSCM strategies, and (3) the joint improvement of economic, environment and social performance of supply chains.

The lack of research necessitates studies specific to the O&G industry context to enable better understanding of how the industry’s external and internal environments could affect its SSCM practices. The existing literature from other industry context could help us identify possible responses to pressures from these environments. However, the appropriate strategy needed to address supply chain sustainability issues may be different for every industry and product (Halldórsson et al., 2009). Therefore, a study must be conducted to understand the relationship between contextual factors and SSCM practices in the O&G industry. This will allow us to identify supply chain solutions that are more applicable to the industry context, thus help improve its implementation of SSCM practices.

The O&G supply chain 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, the products are highly toxic and flammable, which causes considerable environmental and safety risks in their production and transportation processes. There are also fewer transport modes that can be used to transport the products as the distance between supply sources and consumer markets becomes larger. In addition, the logistical requirements are more complicated and risky in offshore O&G exploration and production activities because it can be affected by factors such as oil platform space availability, weather conditions and access to logistical bases. Therefore, efficient routes planning and scheduling is very important in the O&G industry. The inflexibility of O&G infrastructure and the cost-intensive nature of its activities may require that the industry focuses on improving supply chain sustainability through supplier and logistics management practices. The strategies that can be used include supplier selection based on environmental and social criteria, supplier development in quality and environmental management systems, use of multi modal transports to reduce emissions, and safety training for drivers. Companies can also employ product stewardship strategies that focus on minimizing product impacts from extraction processes to its end of life, using less polluting alternative chemicals, and on waste management.

In the next section, we propose a conceptual framework for the study of the internal and external factors that can affect the implementation of SSCM practices in the O&G industry.

### 2.5 Conceptual framework

This section presents the conceptual framework of this thesis. The discussion focuses on the positioning of the framework within the broader context of SSCM and O&G sustainability research.

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 et al. (2009) for 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 2.3.

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 discuss these factors further in the following subsections.

2.5.1 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 the environmental and social factors as 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. This relates to the increased attention to the development of unconventional O&G sources and the advances in alternative energy development. In addition, we include stakeholder pressure because it is one of the most often cited external pressures for sustainable practices in 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. This factor 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 factor selected is as follows.

a. Political stability
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). According to Pascual and Zambetakis (2008), the relationship between energy with politics is apparent in the event of crisis. There are two
sources of political risks that could affect the O&G industry. The risks could result from: (1) governmental sources related to official decisions and activities that could affect capital or profits, and (2) societal sources spurred by public interest groups that could cause unrest, civil war, industrial protest or boycotts (Iankova and Katz, 2003).

O&G reserves are concentrated in a few countries. Most of these countries depend on O&G revenues for economic development, and to some extent gain political power through their control of the reserves. Conflicts of interests in the management of local O&G company may arise due to the needs to safeguard national and, often, political interests of government (Wolf, 2009). In addition, these countries often have limited administrative capacities or a highly authoritarian political structure with weak civil societies and poor enforcement of environmental controls (Correljé and van der Linde, 2006, Sovacool, 2011, Wagner and Armstrong, 2010).

Bhatnagar and Sohal (2005) find that government’s decisions and actions related to fiscal policies, protection of foreign investment, administrative efficiency and transparency are extremely important to companies’ decision regarding their plant location. Similarly, a study by Urciuoli et al. (2014) on O&G supply chain resilience reveals that political instability can threaten the security of the supply chain. Conflicts resulting from the instability could lead to adverse events that can cause financial loses, ecological disasters as well as affect employee and infrastructure safety (Urciuoli et al., 2014, Al-Damkhi et al., 2009). An example is Iraq’s invasion of Kuwait in 1990 (Al-Damkhi et al., 2009). This could create an uncertain business environment as the supply chain is exposed to disruption risks (Kleindorfer and Saad, 2005, Abbasi and Nilsson, 2012). The effect of instability is further worsened by choke points in oil transit routes that could be affected by how international security and conflict is handled (Pascual and Zambetakis, 2008). Correljé and van der Linde (2006) stress that it is difficult to conduct international O&G development cooperation in this unstable environment.

b. Economic stability
Many oil producing countries rely on their O&G revenue to finance development projects and subsidies (Correljé and van der Linde, 2006, Wolf, 2009). Economic slowdown will cause reduction in energy demand and price. 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). This could affect government revenue and their political will to create incentives for the development of sustainable energy and innovations (Pascual and Zambetakis, 2008).

Economic instability can also 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). The slowdown could affect company ability to maintain and invest in O&G development technology and infrastructure, for example in field development (Lukoil, 2011), as well as limit its ability to invest in restructuring initiatives towards low carbon energy system (Pascual and Zambetakis, 2008). Halldórsson et al. (2009) question whether a company can afford to maintain its commitment to sustainable practices during economically uncertain times.

The effect of economic instability on supply chain operations is of particular interest in studies related to its resiliency and flexibility. As companies face economic uncertainties that force them to reduce spending and downsize operations, a strategy based on scalable and variable-cost structure through strategic shared services and outsourcing practices could help the companies to minimize supply chain risks (Olson, 2010). Jüttner and Maklan (2011) found that economic recession affects demand and prices, which causes ripple effects throughout supply chains that lead to supplier insolvencies. Their study reveals that the risks involved can be mitigated through supply chain resilience capabilities such as flexibility to shift to cost-
effective supply sources and to optimize capacity utilization, supply chain visibility through information sharing, and collaboration (Jüttner and Maklan, 2011).

c. Stakeholder pressure
The external micro-environment of business consists of various stakeholders, where the relationships between these stakeholders can affect the costs, quality and overall success of a business (Gillespie, 2011). Donaldson and Preston (1995) define stakeholders are any persons or groups that may actually or potentially benefit or be harmed by firm’s actions or inactions. This may include governments, investors, suppliers, political groups, communities and competitors. The level of company engagement with a stakeholder group could indicate the saliency of the stakeholder, thus the actual pressure that they exert upon the company. According to Mitchell et al. (1997), stakeholder salience depends on the power that they hold, and the legitimacy and urgency of their claim. These attributes could determine the degree to which managers prioritize competing stakeholder claims (Mitchell et al., 1997).

Stakeholder pressure is one of the most frequently mentioned drivers of SSCM in the literature (Seuring and Müller, 2008b). Companies will become more proactive towards environmental strategy when they perceive greater pressure from stakeholders (Garcés-Ayerbe et al., 2012). Increasingly more companies in the O&G industry are involved in corporate social responsibility (CSR) practices that aim to address issues such as employment, environmental protection and local community development (Frynas, 2005). Although considerable efforts are put into CSR initiatives, Frynas (2005) found that the impact is rather short-lived and philanthropic in nature due to the companies’ failure to consider, among others: (1) country and context-specific issues, (2) involvement of beneficiaries of CSR, and (3) integration of CSR initiatives into overall company development plans.

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.

d. Competition
According to Seuring and Muller (2008a), competition can influence a company’s SSCM strategy; and the O&G industry is a highly competitive business (Wagner and Armstrong, 2010). Almost 80% of the world’s oil supply comes from just three areas namely Russia, the Persian Gulf and West Africa (Xu, 2008). The growing attention on different groups of O&G companies, i.e. national O&G companies (NOCs) and international O&G companies (IOCs), indicates the broader shifts that are currently happening in the industry (Wolf, 2009, Kjärstad and Johnsson, 2009, Edwards et al., 2010). Many believe that the future competition will be between these groups, especially in terms of access to energy sources.

An increasing share of global O&G reserves is controlled by NOCs, while IOCs are facing deteriorating fiscal terms and increasing difficulty in accessing the reserves (Kjärstad 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 et al., 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, as well as technology and infrastructure (Farrell and Brandt, 2006). To address the competition pressure, IOCs are putting more efforts on developing unconventional O&G sources such as from oil sands and shale O&G. These sources are more economically viable when oil price is high. This is because greater risk control is needed to reduce the environmental and economic risks, as well as strategic risks related to energy security (Farrell and Brandt, 2006).

Companies in the O&G industry are also facing more competition from the broader energy industry due to increased interest in the development of renewable and low carbon energy. Edwards et al. (2010) found that the emergence of alternative energy as among the most important external factors that could impact O&G companies in the future. Companies would be able to develop a competitive advantage over other energy players if their core values are centred on sustainability and by improving their supply chain performance (Beske and Seuring, 2014).

The current advances in alternative energy development is 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 safeguard its position in the market due these factors. However, there might be greater focus among companies in the industry to improve the sustainability of their supply chains and their ‘green competitiveness’. For example, through carbon emission reduction and energy efficiency measures that can help offset the negative attention of O&G development, thus secure their legitimacy as responsible corporate citizens.

e. Energy transition

The current energy system regime is dominated by fossil fuels, especially the O&G industry, which gives them the ability to guide decision making and direction of the energy market. However, concerns regarding unsustainable exploitation of O&G sources and energy security have increased the call for a transition to a more sustainable energy system. This transition encourages the development of renewable and low carbon alternative technology niches. During a transition process, Kemp (2010) suggests that regime actors (e.g. the O&G players) will increase their competitiveness through non-disruptive system improvement instead of system innovation to address the threat from the niches (e.g. alternative energy players). However, Pinkse and van den Buuse (2012), found that it is not unusual for an incumbent to invest in technologies that are incompatible with its core business; for example, Total and Chevron involvement in solar energy.

Our dependency on oil and gas has created technological lock-ins such as in electricity grids and transport infrastructure. In order to achieve a successful transition to low carbon energy systems, government intervention and policy supports are needed because progress in emerging energy technologies is difficult when left to be determined by the market (Roy et al., 2013). The use of transitional support for alternative energy through fiscal instruments could help in generating market forces and provide incentives for new and existing energy players to pursue low carbon energy projects (Roy et al., 2013).

Fiscal instruments could be in the form of taxes, market based instruments such as green certificates, subsidies and tax exemptions, as well as loans (Roy et al., 2013). Waisman et al. (2014) note that the policy measures used should provide correct incentives for long-term investments and incorporate sectoral measures that complement pricing scheme measures. Although this would create an uneven playing field that favours low carbon energy, it could help sectors that face biased market behaviours to have a stronger foothold in the energy market, thus help to jump start its growth. Fouquet (2010) anticipates that the O&G industry will respond to the energy transition by improving its competitiveness and making O&G sources harder to be replaced.
The O&G industry activities are highly risky to the environment and public safety and health, which leaves little to no room for any incidents to occur. The Deepwater Horizon accident in 2010 illustrates the severity of an O&G industrial accident. It also exposed the lack of regulations and institutional pressure with regard to safety, health and environment (SHE) protection, in this case for offshore O&G operations (Lin-Hi and Blumberg, 2011).

Studies have found that regulatory pressure is one of the external factors that encourage the adoption of more sustainable practices in supply chains (Seuring and Müller, 2008a, Zhu et al., 2007a, Wu et al., 2012). However, the factor is also found to have the potential to inhibit novel environmental practices by lowering their competitive value (Grekov et al., 2014).

In the case of O&G industry, most companies operate in several countries with different jurisdictions and regulatory requirements. This requirements are often ambiguous and overlapping, which can cause delays and cost increases (Harris and Khare, 2002). The companies have to deal with considerable regulatory, financial and reputational risks related to legal, fiscal, safety, environment, and corporate governance (Repsol, 2011, Wagner and Armstrong, 2010). The cost of compliance with regulatory requirements varies widely and is especially financially draining for smaller companies (Harris and Khare, 2002). 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 change the technical and trade requirements in supply chains, increase operating costs and reduce companies’ overall competitiveness (Petrobras, 2011).

Cross-functional integration within organizations and cooperation across supply chain is needed to address the regulatory risks (Wu et al., 2012, Zhu et al., 2010, Zhu et al., 2005). For example, through purchasing practices that considers sustainability-related requirements of other departments like production, logistics and suppliers capabilities. The use of environmental management systems that enable, for instance, the assessment of suppliers’ environmental performance and that track waste could also help to reduce the risks (Darnall et al., 2008).

The discussions on the O&G supply chain and its external business environment show that the industry faces considerable challenges that could affect its ability to operate sustainably. The strategy used to integrate sustainable practices in the management of O&G supply chain must enable the alignment of companies’ internal organizational environment and capabilities with their external operating context. This is to ensure that the companies are able to anticipate, plan and respond to the changes in the external environment proactively. In the next subsection, we discuss these internal factors in more detail.

2.5.2 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) their implementation of SSCM strategy. The definitions of SSCM suggest that managerial decisions and behaviours must be directed towards achievement of economic, environmental and social goals through systemic integration of key business processes and cooperation among supply chain members. Therefore, an inventory was made of internal factors that are used by researchers to measure 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) organization-related factors, and (2) supply chain function related factors. These are summarized in Table 2.4 and Table 2.5, respectively. We define the factors as
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