# Title

# Examining The Impact Of Supply Chain Integration On Organization Structure And Operational Performance in Oil and Gas Supply Chains: A Contingency Approach

**By**

## Seyed Mohammad Ebrahimi

A thesis submitted in partial fulfilment of the requirements for the degree of Doctor of Philosophy

The University of Sheffield
Faculty of Social Sciences
School of Management

Funded by E-futures (EPSRC)

Submission Date
09/06/2015

# Table of Contents

## List of Figures

## List of Tables

## Table of Abbreviations

| Abbreviation | Full Form |
|---|---|
| ABC | Activity-Based Costing |
| ABS | Association of Business Schools |
| AVE | Average Variance Extracted |
| BP | British |
| CDA | Confirmatory Data Analysis |
| CEO | Chief Executive Officer |
| CFA | Confirmatory Factor Analysis |
| CFI | Comparative Fit Index |
| CFI | Comparative Fit Index |
| CIMA | Chartered Institute of Management Accountants |
| CLF | Common Latent Factor |
| CR | Composite Reliability |
| EDA | Exploratory Data Analysis |
| EFA | Exploratory Factor Analysis |
| EPC | Engineering Procurement Constructing |
| EU | European Union |
| GDP | Gross Domestic Product |
| GFI | Goodness-of-Fit |
| GLS | Generalised Least Square |
| IEA | International Energy Agency |
| IOC | International Oil Company |
| IP | Internet Protocol |
| IRR | Internal Rate of Return |
| IT | Information Technology |
| KMO | Kaiser-Meyer-Oklin |
| NFI | Normed Fit Index |
| NNFI | Non-Normed Fit Index |
| NOC | National Oil Company |
| NPV | Net Present Value |
| OPEC | Organization of Petroleum Exporting Countries |
| OS | Organization Structure |
| PCA | Principal Component Analysis |
| PMS | Performance Measurement System |
| POS | Point of Sales |
| RMSEA | Root Mean Square Error of Approximation |
| ROA | Return on Assets |
| ROI | Return On Investment |
| SC | Supply Chain |
| SCI | Supply Chain Integration |
| SCM | Supply Chain Management |
| SCOR | Supply Chain Operations Reference |
| SCV | Statistical Conclusion Validity |

| | |
|---|---|
| SEM | Structural Equation Modeling |
| TCO | Total Cost of Ownership |
| TQM | Total Quality Management |
| UAE | United Arab Emirates |
| UK | United Kingdom |
| US | United States |
| VIF | Variance Inflation Factor |

## Abstract

This study adopts a contingency approach in order to analyze the mediating role of internal, customer and supplier integration on the relationship between organization structure (OS) (centralization, formalization and hierarchical relationship) and operational performance. Using a global sample from the oil and gas industry, this research examines the direct relationship between the dimensions of organization structure (centralization, formalization and hierarchical relationship) and operational performance. In addition the direct relationship between the dimensions of supply chain integration (SCI) and operational performance is also examined. A quantitative approach using structural equation modeling is used to test the research hypotheses. Data was collected using a questionnaire survey and explored using statistical techniques. Findings revealed that centralization, formalization, and hierarchical relationship negatively impact operational performance of oil and gas supply chains, and that SCI dimensions positively affect operational performance. By further testing for the mediation this study found that by increasing internal and external SCI, oil and gas companies can mitigate the negative effect of high centralization, formalization and hierarchical relationship, on operational performance. More specifically by classifying OS into the "structuring" and "structural" aspects, this research provides evidences on which of the two (the physical or the process) has a stronger negative impact on operational performance. From a practical point of view, it may be a difficult and daunting task for oil and gas companies to restructure and reform their OS (physical aspect), since this process might be timely and expensive to implement. Therefore oil and gas companies by investing in higher internal and external integration create more inter and intra collaboration and communication which could ultimately encourage organizational restructuring and the move towards organic structures.  Therefore instead of viewing organizational theory (OS) and operations management (SCI) in isolation, this study endorses a combined approach (OS and SCI) to improve the operational performance of the oil and gas supply chains. Theoretical contributions to the field of operations management and organizational studies are provided.

## Dedication

For God almighty who gave me the will and strength.
To my parents for their endless prayers and support.
To my wife Zohre for all her love, patience, and belief.
To my brothers Mahdi, Mohsen, and Meysam for putting up with me!

## Acknowledgements

I would like to express my appreciation to all, who have directly and indirectly contributed towards completing this thesis:

- My dear supervisor, Prof. SC Lenny Koh, for her endless support, guidance and feedbacks throughout the duration of this study.
- My dear supervisors Dr. Andrea Genovese and Dr. Niraj for the overall comments, and the more specific technical support, especially during the quantitative analysis.
- My father, Prof. Seyed N Ebrahimi, for his endless support and assistance, especially in providing insights and also contacts in the oil and gas industry.
- My wife Zohre, for the important role she played in proofreading, fixing styles, and also formatting the layout of the thesis.
- My brothers Raymond, Yash, and Mahdi for helping me with ideas, and the overall suggestions at different stages of this long endeavor.
- All the oil and gas managers that kindly participated in this research and that cannot be named for confidentiality purposes.
- Lastly I would like to thank the University of Sheffield, for hosting, providing infrastructure, and facilitating the successful completion of this study.

# Chapter 1: Introduction

This chapter presents an introduction to the theoretical context, the aim, and the objectives of this study. First, for a better understanding of the research aim and objectives, a background is provided on the impact of uncertain environments on organization structure and performance. The contingency theory and related views of organization as a protuberant concept for organizational theory and supply chain management is also presented. Secondly, an overview of the research context (the oil and gas industry) is provided. This is followed by a brief discussion on supply chain integration (operations management) and organization structure (organizational theory). The first chapter therefore attempts to set the scene on the two areas examined under this research:

A. The direct relationship between organization structure (centralization, formalization and hierarchical relationship) and operational performance.
B. The direct relationship between supply chain integration (internal, supplier and customer) and operational performance.
C. The direct relationship between organization structure (centralization, formalization and hierarchical relationship) and supply chain integration (internal, supplier and customer).
D. The mediating role of supply chain integration (internal, supplier and customer) on the relationship between organization structure (centralization, formalization and hierarchical relationship) and operational performance.

Subsequently, the aim and objectives of this research are presented, followed by the research questions and a brief outline of the research significance. Accordingly this chapter concludes with an insight on the research methodology adopted.

## 1.1 Organizations in Uncertain Environment: A Contingency View

Due to increasing external pressures resulting from globalization, a growing number of practitioners and academics have placed emphasizes on the impact of environmental uncertainty (moderating) on the relationship between organization practices and performance (Cosh et al., 2012; Claver-Cortés et al., 2012; Drazin and Van de Ven, 1985; Galbraith, 1973;

Germain et al., 2008; Liao et al., 2011; Walker and Ruekert, 1987; Yang et al., 2014). Grant (1996) argued that structural changes in organizations usually result from environmental uncertainties within the industries, which they operate. Consequently several studies have focused on exploring the different approaches to restructuring the internal processes of organizations, in order to deal with external uncertainties (e.g. sudden changes in number of players/competitors) (Baum and Wally, 2003; Chandler, 1962; Germain et al., 2008; Gordon and Narayanan, 1984; Lawrence and Lorsch, 1967; Lin and Germain, 2003; Negandhi and Reimann, 1972; Wilden et al., 2013).

Researchers from different fields have explored the impact of environmental uncertainty on the relationship between organization structure (OS) and performance (e.g. organizational theory, operations management, strategic management, organizational leadership and management). However, organizational theory specifically offers an interdisciplinary view on, how individuals (roles and actions) affect the organization; how the social organization affects individual behavior; organizational success factors; and the role that the environment plays on the organization (see Pfeffer, 1981). Since the late 1960's, most organization theory studies on the impact of uncertainty on the relationship between OS and performance have taken an *"open system theory"* perspective (Von Bertalanffy, 1969). The main body of literature before the early 1960s illustrates that authors generally viewed organizations as closed-systems, separated from and, unrelated to their external surroundings (Weber, 1947). Nevertheless, such traditional perspective on organizational theory changed quickly, as researchers suggested that it was incomplete, because it did not account for the effect of the external environment on organizational performance (Ansoff, 1991; Chandler, 1962). Along this line Checkland (1999) argued that such a shift in opinion (from close ended to open ended systems) was as a result of increasing operational complexity (i.e. globalization in business processes) and environment uncertainty. Therefore proponents of this view argue that each organization is unique with respect to the specific environment (surrounding) it operates in, and also the exclusive OS it implements in accordance to its environment (Csaszar, 2012; Checkland, 1999; Wilden et al., 2013).

Several studies have adopted a contingency approach in exploring the impact of environmental uncertainty on the relationship between OS and performance. Contingency theory views that, a single most effective method to design an organization does not exist, instead, the best OS suited to a firm is dependent (contingent) on external and internal factors (Donaldson, 2001; Drazin and Van de Ven, 1985; Hofer, 1975; Lin and Germain, 2003). In other words no theory or approach can be practical in all cases (Cole and Scott, 2000; Lawrence and Lorsch, 1967; Thompson, 2011). This implies that firms wanting a better level of organizational performance need to match their internal structures, strategies, and procedures with the (specific conditions of) external environment (Chandler, 1962; Child, 1972; Droge and Calantone, 1996; Flynn et al., 2010; Ruekert et al., 1985; Walker and Ruekert, 1987). Accordingly two instinctively interesting statements could underlie the contingency approach: (1) there is no such thing as the best OS or and (2) a specific OS or strategy would not be equivalently applicable in varying environmental or institution-specific circumstances (Galbraith, 1973; Galbraith and Nathanson, 1978).

Furthermore the contingency approach suggests that, when there is a suitable ‘‘fit’’ between OS and environment, organizations tend to perform better (Van de Ven and Drazin, 1984). So instead of accepting the deterministic logic or an approach in which one believes “all cases differ”, based on the contingency theory it is suggested that a middle ground exists in which the variances in OS could be analyzed in an orderly method (Drazin and Van de Ven, 1985; Ruekert et al., 1985; Sinha and Van de Ven, 2005). Therefore it is understood that an organization’s external environment outlines its internal processes and structures, and since customers and suppliers form a significant part of such environment (see Porter, 1979) they are required to be closely aligned with. In simpler terms the contingency theory suggests the interaction between a firm’s internal structure (processes) and external surrounding (customer, supplier) affects its performance. For example, a company with better levels of internal integration (cross-functional integration) can take more advantage of supply chain integration (SCI) with its customers and suppliers, and ultimately achieve better operational performance (Devaraj et al., 2007; Germain and Iyer, 2006; Flynn et al., 2010). Based on this understanding, it could be argued that aligning external and internal planning would become even more complicated in uncertain environments. Numerous authors have suggested that in uncertain environments, less formal internal planning should take place. In simpler terms, decisions should be made as conditions evolve since it is difficult to predict the future pattern of the environment (Ansoff, 1991; Grant, 1996; Khandwalla, 1977; Mahmoudi and Miller, 1985; Mintzberg, 1983; Wilden et al., 2013). However, no study has empirically investigated the relationship between OS and SCI and the impact on performance.

## 1.2 Research context

Energy is considered an essential input in the process of producing almost all goods and services globally. In the words of Peter Voser the former CEO of Royal Dutch Shell,

*… "Energy is the Oxygen of the Economy, without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable."* (World Economic Forum, 2012).

The oil and gas industry plays a significant role in supplying global energy and therefore contributes enormously to global economic growth. Yergin (2011) argued that the oil and gas forms the world's most pervasive and largest business industry. The author went on to label the whole global society as a "hydrocarbon society" in which oil has made it possible, for us to decide where we live, how we transport, and how we make and produce stuff (e.g. basic necessities such as fertilisers needed for agriculture).

However a number of challenges have been associated to such significant industry. For example, ongoing political unrest in the Middle East, unstable production capacity of oil producers, long and unpredictable lead times due to regional supply and global demand, restrictions on transportation method (ships or railway), and volatile oil prices, amongst many other challenges. Such challenges have made the this industry to be considered as one of the most dynamic, risky and unpredictable industries globally (Mitchell et al., 2012). This has resulted in rigid supply chain linkages throughout the industry (Jenkins and Wright, 1998; Mitchell et al., 2012; Morton, 2003).

Generally speaking, oil and gas companies have very complex supply chains with two interconnected streams - the upstream (e.g. exploration and appraisal, fabrication, installation, drilling, production and logistics management) and downstream supply chains (e.g. refining the crude oil into usable products, delivering it to final consumers). In order to effectively manage the flow of information across both streams, oil and gas managers would require strategic data and information sharing; higher collaboration and better flow of communication; and integrated process management systems with their key supply chain members (see Chima, 2011; Coia, 1999; Ikram, 2004). Studies have shown that inter and intra firm (e.g. cross functional) communication and information sharing may be affected by the level of supply chain integration and the structure of the organizations within the supply chain. However, despite the complexity and challenges associated to oil and gas supply chains, very little attention has been given to such a significant industry in both organizational theory and operations management research.

## 1.3 Operations Management

In recent years, supply chain management (SCM) has received substantial attention from academics and practitioners. It could be defined as the flow of materials, goods, information, and resources within a company, as well as across organization from suppliers to manufacturers, and manufactures to customers, in order to increase the long-term performance of the companies and the supply chain as a whole (Mentzer et al., 2001). Supply chain integration (SCI) has turned into one of the most significant features of SCM and its enablers and outcomes have been researched quite extensively (e.g. Das et al., 2006; Droge et al., 2004; Droge et al., 2012; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002; Swink et al., 2007; Vickery et al., 2003; Zhao et al., 2011). Due to the increasing level of competition and the continuous requirement to improve innovation (i.e. new technologies and know-how) in product and processes in uncertain industries such as the oil and gas, it has become extremely significant for focal companies to share capabilities and strategic resources through better integration with their key supply chain partners (Cousins and Menguc, 2006; Flynn et al., 2010; Koh et al., 2006; Lau et al., 2010; Thun, 2010; Zhao et al., 2008). Hence, competition can no longer be viewed as just among different companies, but also between supply chains (Alfalla-Luque et al., 2013).

Additionally in order for companies to better manage (focus more on) their core competencies, an increase in outsourcing and fragmentation of their supply chain could be helpful. This is prominent in complex and uncertain industries such as the oil and gas, where a focal company may not be individually capable in handling the diverse products, procedures, or technologies, on its own. This may lead to the company becoming too "unfocused" and ultimately ceding market share to rivals with better focused capabilities (Stonebraker and Liao, 2006). As argued above, the oil and gas industry is global; therefore the focal company's location, the actual location of the oil and gas project, and the location of its key suppliers and customers could all differ. Therefore such companies would require a closer coordination and a better relationship with their key supply chain members in order to receive essential data and know-how related to their operational activities (Alfalla-Luque et al., 2013; Frohlich and Westbrook, 2001; Koufteros et al., 2007a; Swink et al., 2007).

For this reason SCI has been transformed into a very useful practice because it promotes joint planning, value creation, and the development of cross-firm problem-solving processes (Cao and Zhang, 2011; Wong et al., 2011; Wu et al., 2010). Hence, during the past decade different scholars have been emphasizing on the strategic significance of close integrative associations between supply chain partners (Bernon et al., 2013; Childerhouse and Towill, 2011; Fawcett and Magnan, 2002; Harland et al., 2007; Lambert and Cooper, 2000; Palomero and Chalmeta, 2014; Zhao et al., 2011). For instance, Frohlich and Westbrook (2002) argued that firms that link their suppliers and customers in decisively integrated networks could turn into the most competitive and valued companies in the industry. Several authors empirically agree that SCI improves performance (e.g. Das et al., 2006; Flynn et al., 2010; Frohlich and Westbrook, 2001; Koufteros et al., 2007a; Koufteros et al., 2007b; Lee et al., 2007; Petersen et al., 2005; Swink et al., 2007), others have however not reported such a relationships (Chen et al., 2007; Cousins and Menguc, 2006; Sezen, 2008). In some cases investigation on this issue reported a negative relationship between SCI and performance (Rosenzweig et al., 2003; Vickery et al., 2003). Nevertheless, the majority of existing studies in this area have reported a positive association between SCI and performance.

Furthermore some studies on SCI have focused on developing definitions and dimensions of SCI (Flynn et al., 2010). While some authors have viewed SCI as a single construct (e.g. Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006), few researchers have examined the effects of internal, customer, and supplier integration on performance outcomes (Flynn et al., 2010; Koufteros et al., 2005; Wong et al., 2011). Additionally a small number of studies have employed the same SCI dimensions and variables for specific region, country or industry (Alfalla-Luque et al., 2013). However Flynn et al. (2010) argued that most of such empirical research overlook the role of internal integration, and emphasize supplier and customer integration.

Therefore, some researchers argue that the unclear definition and understanding of the dimensions of SCI has resulted in mixed and in some cases, contradicting outcomes on the impact of SCI on organizational performance (Das et al., 2006; Devaraj et al., 2007; Fabbe-Costes and Jahre, 2008; Germain and Iyer, 2006; Pagell, 2004). Even though SCI has been a field of both academic and managerial interest for a while (Cousins and Menguc, 2006; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002), there have been a number of recent calls from scholars for a systematic review in this field of study (Alfalla-Luque et al., 2013; Flynn et al., 2010; Kim, 2013; Palomero and Chalmeta, 2014; Shub and Stonebraker, 2009; van der Vaart and van Donk, 2008). Thus it is essential to periodically review SCI taxonomy and empirical measures used in previous studies, in order to improve and provide better advice for future practitioner and researchers. Therefore in this study a systematic review of the current debates on SCI dimensions will be carried out.

## 1.4 Organizational Theory

Organization structure (OS) is the way in which responsibility and power are assigned, and work processes executed, among individuals in the organization (Blau, 1970; Blau and Schoenherr, 1971; Champion, 1975; Daft, 2006; Dewar and Werbel, 1979; Fredrickson, 1986; Germain, 1996; Gerwin and Kolodny, 1992; Hall, 1996; Robbins, 1990; Ruekert et al., 1985; Skivington and Daft, 1991; Walton, 1984). Similarly OS can be defined as an organization's internal pattern of relationships, authority, and communication (Goldhaber and Shaner, 1993; Thompson, 1965). Dalton et al. (1980) suggested that OS was the anatomy of the organization, providing a foundation within which the organization functions. They argued that OS affects how members tend to behave. In literature the main two functions of structure (affecting performance of the organization and individual behaviors) that have been commonly discussed are (Hall, 1996): (1) OS are designed or at least regulate the influence of individual variations on the organization and (2) structure is the setting in which power is exercised, decisions are made and the organization's activities are carried out.

It is generally agreed that firms must fit their structures and processes in order to achieve positive strategy outcomes (Csaszar, 2012; Chandler, 1962; Channon, 1973; Huang et al., 2010; Yang et al., 2014). Nevertheless the relationship between structure and performance cannot be considered straightforward because it is contingent on several factors (Dalton et al., 1980). When discussing OS one cannot disregard the effect of the organization's external environment (Bourgeois et al., 1978; Duncan, 1972; Hrebiniak and Snow, 1980; Lawrence et al., 1967). An "organization" or "task" environment refers to the conditions that are external to the organization, but nevertheless affect the organizations internal processes. For instance these could include the suppliers, consumers, competitors, regulatory bodies (Thompson, 2011), and technical reference groups (Lawrence and Lorsch, 1967). Therefore a number of studies focused on justifying the differences in OS as a result of variations in environment (Cosh et al., 2012; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Liao et al., 2011; Lin and

Germain, 2003; Wilden et al., 2013). This resulted in a rich stream of literature, consistently suggesting that environmental uncertainty and OS are critical strategic factors of organizational performance (e.g. Chandler, 1962; Child, 1972; Dwyer and Oh, 1987, 1988; Dwyer and Welsh, 1985; Galbraith and Nathanson, 1978; Miles et al., 1978; Porter, 1979; Thompson, 2011).

Therefore the association between environmental uncertainty and structure has received significant attention from researchers, investigating these relationships using the contingency theory (e.g. Cao et al., 2015; Duncan, 1972; Hrebiniak and Snow, 1980; Lawrence and Lorsch, 1967; Miles et al., 1974). Pugh et al. (1969b) argued that the context in which a company functions, strongly influences their OS, and therefore organizational context has a significant impact on the specific OS adopted in different industries (Cosh et al., 2012; Bourgeois et al., 1978; Germain et al., 2008; Hrebiniak and Snow, 1980; Wilden et al., 2013).

The notion that organizations prefer to embrace rigid structures that afford them greater control and maintenance of resources is a tenacious theme in organizational theory. Nevertheless some have argued that such approaches may not always be effective, especially in organizations such as oil and gas companies, where the external environment is highly uncertain and dynamic (D'Aunno and Sutton, 1992; Staw et al., 1981). However authors such as Gordon and Narayanan (1984) and Spekman and Stern (1979) proposed that organizations structured in dealing with consistent and steady environments might not be as successful in complex and unstable ones. Accordingly, Lawrence and Lorsch (1967) argued that in more stable environments there are higher chances an OS would be centralized in hierarchy and have formalized rules and processes. In contrast organizations operating in a great level of environmental uncertainty tend to have decentralized decision-making processes (Claver-Cortés et al., 2012; Huang et al., 2010; Ruekert et al., 1985; Yang et al., 2014), operate using informal rules and policies (Daugherty et al., 2011; Hempel et al., 2012; Jaworski, 1988; Liao et al., 2011), and have flattened hierarchical relationships as opposed to taller ones (Foss et al., 2014; Huang et al., 2010; Jacobides, 2007; Walton, 1984).

The organizational literature proposes that the nature of OS in industrial versus post-industrial firms can be also defined as mechanistic (inorganic) versus organic structures (Burns and Stalker, 1961; Daft, 2006; Huang et al., 2010; Nemetz and Fry, 1988; Zammuto and O’Connor, 1992). Authors such as Galbraith (1973) have argued that the inherent flexibility of organic structures (opposed to mechanistic) provided organizations with better capability in relation to processing information and allowing richer communication flow in more dynamic environments (i.e. oil and gas industry). For this reason there is a consensus in organizational theory that suggests the higher the level of perceived uncertainty, the greater the chance for organizations to be organic (Coah et al., 2012; Burns and Stalker, 1961; Galbraith, 1973; Gordon and Narayanan, 1984; Hall, 1963; Huang et al., 2010; Koufteros et al., 2007b; Lawrence et al., 1967; Leifer and Huber, 1977; Spekman and Stern, 1979).

In order to better understand the organic or the mechanistic forms of OS, the organizational theory illustrates an extensive and rising interest on the significance of evaluating and appraising organizational dimensions (Hage and Aiken, 1967a, b; Hall, 1963). Although developing an extensively acceptable methodology for studying OS relies on consensus at the conceptual level, many of the different opinions and approaches may suggest differences in jargon (Hickson et al., 1969). Nevertheless a broad and varying literature exist on the main dimensions of OS, and since a universal understanding on such dimensions is hard to come across, it has made it a difficult and daunting task to appropriately conceptualize this field of study. As a result researchers have sometimes named and classified similar dimensions differently. Therefore this study systematically reviews the OS literature on different dimensions, based on Campbell et al. (1974) "structural" and "structuring" dimensions. The structural elements are the physical characteristics of an organization, such as the size, span of control and flat/tall hierarchy of the organization. On the other hand "structuring" refers to the policies and actions that occur inside an organization, which permit or limit the behavior of individuals. In order to examine the impact of OS dimensions (in oil and gas SCs) on SCI and operational performance, three key dimensions are appraised using the above typology. For the structural dimension, this research examines the relationship among *organizational hierarchical relationships, SCI and operational performance. For* the structuring dimension, the study further examines *formalization and centralization* in relation to SCI and operational performance. Centralization measures the degree to which decision-making autonomy is dispersed or concentrated. Formalization is the degree to which the roles, behaviors and activities of members of an organization are clearly documented, coded and reported by way of written rules and procedures. A hierarchical relationship is the extent in which a firm has a few or many levels of management hierarchies.

## 1.5 Research Aim, Questions and Objectives

As argued above the oil and gas industry makes a significant contribution to the global energy demand and consequently global economic growth. However, very little attention has been given to such a significant industry in both organizational and operations management research. Furthermore challenges such as instability in the Middle East, and varying prices of oil (amongst other important factors), affects the daily operational activities of oil and gas companies, which results in more rigid supply chain linkages throughout the industry (Jenkins and Wright, 1998; Mitchell et al., 2012; Morton, 2003).

As discussed earlier studies focusing on OS, especially in uncertain environments have noted that rigid structures could negatively impact performance. On the other hand, studies on SCI illustrate, stronger internal and external integration increases operational performance. Therefore, in the context of the oil and gas, managers would require better strategic data and information sharing, and integrated process management systems with their supply chain members, in order to improve operational performance (Chima, 2011; Coia, 1999; Ikram, 2004). In summary, a review of the management literature suggests that in both the fields of OS and SCI, evolving conceptualizations have resulted in mixed outcomes in the association between OS and performance (e.g. Germain et al., 2008; Koufteros et al., 2007b; Lin and Germain, 2003); as well as SCI and performance (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Koufteros et al., 2005; Koufteros et al., 2010). Furthermore a number of authors have suggested that in order to achieve a better level of organizational performance, companies need to match their internal structures, strategies, and procedures with the external environment (Baum and Wally, 2003; Chandler, 1962; Child, 1972; Droge and Calantone, 1996; Flynn et al., 2010; Germain et al., 2008; Ruekert et al., 1985; Walker and Ruekert, 1987; Wilden et al., 2013). This study argues that, while OS and SCI both affect operational management and explain the dynamics of communication, collaboration and information sharing within firms and across firm boundaries, very little is understood about the relationship between OS and SCI. This calls for an investigation into the relationship between OS and SCI and their effects on operational performance of companies, operating in the oil and gas industry. Therefore the aim of this study is to:

Investigate the mediating role of SCI on the association between OS and operational performance of oil and gas supply chains.

Based on the above aim, this research attempts to answer the following four research questions:

*RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?*
*RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?*
*RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?*
*RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?*

More specifically this research is carried out with the following objectives:

1. To ascertain the direct impact of OS dimensions (centralization, formalization and hierarchical relationship) on SCI (internal, customer and supplier), in order to suggest improvements in operational performance of oil and gas supply chains.
2. To empirically examine why and how SCI (internal, customer and supplier) mediates the impact of OS (centralization, formalization and hierarchical relationship) on operational performance in uncertain industries, such as the oil and gas. Therefore shedding some light on the level of integration or structural reconfiguration needed for better performance in such context.
3. Develop and test a conceptual framework based on the first two objectives, in order to progress the current understanding of OS, SCI and operational performance in oil and gas supply chains.

By recognizing the antecedents of OS as drivers for SCI, this research attempts to bridge the gap between the organizational theory and operations management field. The conceptualization of the dimensions of OS (centralization, formalization and hierarchical relationship) is based on a number of studies notably, Ferrell and Skinner (1988), Huang et al. (2010), John (1984), Koufteros et al. (2007b), Lee and Grover (1999), Liao et al. (2011), Nahm et al. (2003), and Turkulainen and Ketokivi (2012). Additionally the conceptualization of the SCI dimensions (internal, customer and supplier) is adapted from Flynn et al. (2010), Morash and Clinton (1998), and Narasimhan and Kim (2002). Four process-based and qualitative measures of performance were explored as a single construct called "operational performance", as they apply to the oil and gas supply chain operations (adapted from Beamon, 1999; Gunasekaran et al., 2004; Gunasekaran et al., 2001; Neely et al., 1995; Shepherd and Günter, 2011). These measures include operational cost (industry standards such as ISO 15663-2, 2001), process lead-time (e.g. Tersine, 1994), process quality (e.g. Ho et al., 2001; Kaynak, 2003; Kim et al., 2012; Lewis et al., 2006; Rahman and Bullock, 2005; Talib and Rahman, 2010) and process flexibility (e.g. Olhager and West, 2002; Sanchez and Perez, 2005).

### 1.6 Research Significance

This study adopts a contingency approach in order to analyze the mediating role of internal, customer and supplier integration on the relationship between OS (centralization, formalization and hierarchical relationship) and operational performance. Using a global sample from the oil and gas industry, this study makes the following contributions to the operations management and organizational theory:

First this research examines the direct relationship between the dimensions of OS (centralization, formalization and hierarchical relationship) and operational performance. In addition the direct relationship between the dimensions of SCI and operational performance is also examined.

Second, by utilizing a global sample from the oil and gas industry, this research illustrates the importance of SCI in mediating the negative impact of high centralization, formalization and hierarchical relationship on operational performance.

Third by classifying OS into the structuring and structural aspects, this research provide evidences on which of the two (the physical or the process) has a stronger negative impact on operational performance. Also this classification will enable researchers and practitioners to determine which of the two is affected more by the positive role of SCI (internal, customer and supplier).

Fourth by using the conceptual framework developed under this study, a hybrid OS that combines elements from the mechanistic and organic structures (based on Campbell et al., 1974 classification structural and structuring dimensions) is proposed. Accordingly this research argues that in volatile and uncertain environments, such as the oil and gas industry, firms require OS that are flexible enough to be organic (e.g. non-routine policies to cope with sudden fluctuations) and mechanistic when needed (quality assurance, quality control, health and safety).

The findings from this study are significant for managers and operational decision makers, since they offer perceptions concerning tactics for implementing SCI. Therefore instead of viewing organizational theory (OS) and operations management (SCI) in isolation, this study endorses a combined approach (OS and SCI) to improve the operational performance of the oil and gas supply chains.

### 1.7 Research Methodology

This research reviewed the relevant literature in OS and SCI, in order to clearly define the concepts under investigation. Based on the gaps identified in the literature review this study developed a conceptual framework with 15 direct and 9 mediating hypotheses on the relationship among OS, SCI, and operational performance. A quantitative approach using structural equation modeling is used to test the research hypotheses. Data were collected using a questionnaire survey and explored using statistical techniques. A panel of experts from the oil and gas industry and academics reviewed the survey questionnaire after which a pilot and trial run of the questionnaire was carried out (amongst a group of industrial experts). The questionnaire was then uploaded on Qualtrics (an online survey tool) and in some cases directly emailed to the target respondents (C-level, and operational level managers in the oil and gas industry).

## 1.8 Summary and Report Structure

The first chapter provided an introduction to this research. Relevant operations management and organizational theories have been discussed and the aims and objectives of the research have been presented. This chapter provided a background to the research; the theoretical lens utilized; the main research questions; the research theoretical and practical (oil and gas) significance; and also a summary of the research methodology adopted.

The second chapter provides an introduction to the oil and gas industry and its significance towards the global economy. It provides justifications of why such context was chosen for this study. A background to the oil and gas industry is provided, with some figures highlighting the distribution of proved oil and gas reserves (also key producers and consumers). Subsequently the relevance of SCM to the oil and gas industry to SCM, and key upstream and downstream challenges are also discussed.

The third chapter is the literature review carried out under this research. It provides a detailed discussion of relevant theoretical arguments on OS (centralization, formalization and hierarchical relationship), SCI (internal, supplier and customer) and operational performance. Accordingly the gaps in the literature are identified and presented.

The fourth chapter illustrates the theoretical framework, which captures the research hypotheses under investigation. The conceptual framework builds on the literature review carried out in the third chapter. By drawing on OS and SCI literature, hypotheses are developed to explore the direct and mediating relationship amongst OS, SCI and operational performance.

The fifth chapter presents a discussion on the choice of survey methodology. The requirements and constraints in designing the survey, and also how the research constructs were operationalized, is presented under this chapter. Additionally a section is provided to explain how the questionnaire was designed and administrated (online Qualtrics). Lastly a section is presented to describe the survey sample and the approach to data analysis (exploratory and confirmatory factor analysis).

The sixth chapter presents the result of the data analysis carried out under this research. This includes the data collected, managed and prepared for the initial descriptive analysis. This chapter also provides a discussion on the reliability and validity of the data, before the actual inferential analysis. Lastly the findings of the data inferential analysis is also presented and discussed.

The seventh and last chapter discusses the findings and outcomes of the research analysis. This chapter underlines the research theoretical and managerial contribution. It also presents a section on the research limitations and recommendations on the direction for future empirical studies (expanding the concepts investigated under this study).

# Chapter 2: Research Context: The Oil and Gas Industry

In Chapter 1, a concise introduction of the research background, aim, objectives and rationale was presented. To reiterate, the research aims to examine the mediating role of supply chain integration (SCI) (internal, customer and supplier) on the relationship between organization structure (OS) (centralization, formalization and hierarchical relationship), and operational performance of oil and gas supply chains. There are a number of reasons to examine such an association in the context of oil and gas, the most significant being:

- Several operations management studies have examined the role of SCI in improving operational performance. However the majority of such research predominantly focuses on the manufacturing industries (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Flynn et al., 2010; Koufteros et al., 2010). As argued previously the oil and gas industry as one of the main source of energy supply, is considered as the lifeblood of the world economy. It is an essential input in the production processes of almost all goods and services globally. Therefore it seems slightly surprising that such an essential sector has been short of empirical investigation, especially in organizational theory and operations management field of research.
- The high levels of uncertainty and the dynamic nature of the oil and gas industry have resulted in challenges (Chima, 2011; Morton, 2003), such as rigid supply chain linkages between key partners in the industry (Jenkins and Wright, 1998; Mitchell et al., 2012).
- In addition on-going political unrest in the Middle East, unstable production capacity of oil producers, sudden decline in oil price, rising operational costs, long and unpredictable lead times, regional supply and global demand of oil, and logistical limitations (e.g. transportation, pipelines) have made it essential for companies to effectively manage the flow of resources (e.g. information, products, technology, know-how) across their supply chains (i.e. upstream, downstream). This uncertain, dynamic and essential industry provides a unique learning opportunity for academics and practitioners to improve current understanding of operations management (SCI) and organizational theory (OS).

- Another major issue in the oil and gas supply chains is the attitude concerning collaboration and information sharing amongst supply chain members. While such activities are closely tied to supply chain efficiency, oil and gas companies are sometimes cautious in implementing them (Ikram, 2004). It is argued that poor collaboration and information sharing could diminish a company's ability to effectively reduce its capital and operational costs. It is therefore important to examine the impact of OS on operational performance and the mediating role of SCI in such association.

In summary the oil and gas industry presents a suitable opportunity to explore and examine the effects of OS, SCI, and operational performance from a contingency perspective. Most current studies on SCI have been carried in the manufacturing and retail sector. Therefore this study would add a new perspective to the current debates on SCI. This study also contributes to organizational theory by proposing a novel OS framework based on the direct relationships between the dimensions of OS and operational performance and the mediating role of SCI.

## 2.1 The Importance of the Energy Industry on Global Economy and Growth

From the 2008 financial crisis to date, the global economy has been stumbling. The repercussion of such crisis has been felt throughout the real economy on production, manufacturing, consumption, and jobs (Obstfeld and Rogoff, 2009). At such tough times, it is often useful to reflect on how the global economic development suffered so greatly. During the past decades the living standards of millions of individuals has significantly improved (especially emerging and developing economies). It is generally understood that globalization and market liberalization have been fundamental to this improvement; however one should not forget the vital and supporting role of the energy sector in such process. Energy can be considered the lifeblood of the world economy. It is an essential and vital input in the processes of producing almost all products and services around the globe. Accordingly, Peter Voser the former chief executive officer (CEO) of Royal Dutch Shell noted:

…"Energy is the Oxygen of the Economy, without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable." (World Economic Forum, 2012).

Global economic growth is therefore tied closely to the decisions made in the energy industry and vice versa. For example the recent financial forecast of poor world economic growth directly impacted the energy sector and its associated capital market (i.e. Russia's looming recession, and ongoing weaknesses in Euro zone) (World Economic Outlook, 2014). As a result of such events, oil prices became unstable, which then led to gloomy global economic outlook. For a better understanding on how the energy industry affects global economic growth, it is important to examine and compare the current global energy consumption across different energy sources. Global energy consumption could be defined as the total amount of energy that is used by every single individual. This unit is usually measured every year, and represents all the energy exploited from varying sources (e.g. Fossil fuels, conventional/primary, renewable and sustainable) that is directed towards human civilization (across different countries) and its attempt to progress living standards.

Figure 2.1 provides an illustration of the global energy consumption (British Petroleum- BP Statistical Review, 2014), measured in million tonnes oil equivalent per year. The total energy consumption was reported to be 12730.4 (oil or oil equivalent). The highest contributor to the energy demand is oil with a share of 32.87% (4185.1) of total demand. This was followed closely by coal 30 % (3826.7) and natural gas 23.72 % (3020.4). The remaining portions of the energy mix are hydro-electricity with 6.7% (855.8), nuclear with 4.4% (563.2) and renewables with a total of 2.2% (279.3) of the total global demand. Based on such statistics, the oil and gas industry supplies approximately 57 % of the global energy consumption, and consequently forms the main segment of the world's energy mix.

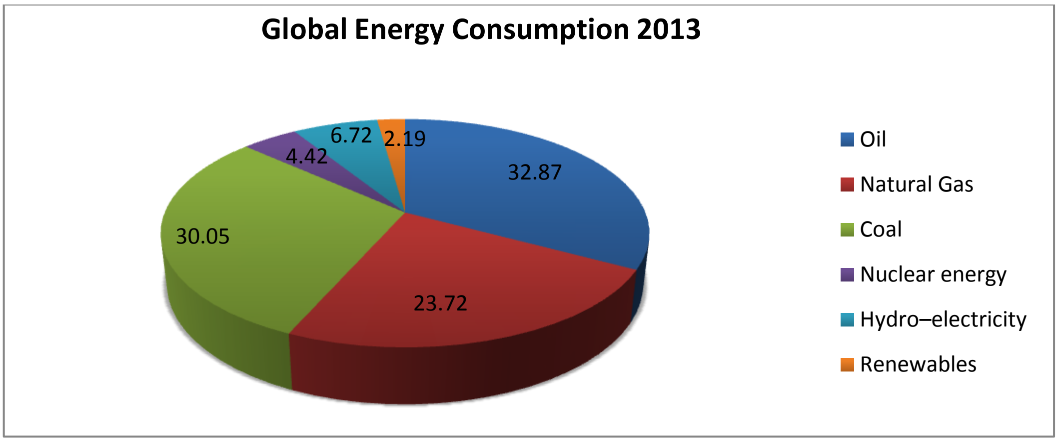



**Figure 2. 1: Global Energy Consumption (source: BP Statistical Review, 2014)**

As argued above the oil and gas industry forms a significant portion of the global energy demand and economic growth. The oil and gas industry produces a large number of high skilled and paid jobs from upstream oil exploration, development, production, to downstream, logistics, refining and services. Therefore as a result of worldwide supply chain and the spending power of oil and gas companies and their suppliers, the energy sector underpins more jobs (across different industries) than it creates directly. According to senior United States (US) Senator John Hoeven in World Economic Forum (2012):

…"Jobs in the oil industry create spending power and generate the need for services of many other kinds. Thus, many more jobs are created – a multiple of those in the oil industry itself."

For example, in Venezuela the oil and gas sector accounts for 35% of the Gross Domestic Product (GDP) (see The World Factbook, 2015b). In Kuwait however this figure is higher with the oil and gas export accounting for approximately half of the country's GDP (see The World Factbook, 2015a). Therefore it is argued that the oil and gas industry immensely contributes to the global economy as an employer, a direct investor, and as the buyer of goods and services.

Furthermore the energy sector reinforces the rest of the global economy. As argued earlier oil and gas are essential sources of input for producing and maintaining life, as we know it. However the industry is often overlooked until there are sudden disruptions in oil supply or changes in price. Accordingly it has been argued that that the typical view of postindustrial society does not sufficiently acknowledge the (continual) importance of oil and gas to our everyday existence (see Bridge, 2001).

For example in countries such as India that face persistent electricity deficiencies, energy supply difficulties can become very costly. A more fitting example would be China, one of the world's largest manufacturing and production countries that rely heavily on fossil fuels (approximately 10116 thousand barrels of oil consumed daily, see BP Statistical Review, 2014). According to figures published by IEA (2014) demand for energy has been growing steadily for the past four decades. This may be partially due to the increase in energy demand of developing countries (e.g. China and India) and other emerging markets (Middle Eastern and other oil producing nations). Therefore if countries such as China and India continue to develop at the current rate, demand for energy (particularly oil and gas) will increase exponentially (Obstfeld and Rogoff, 2009).

Furthermore one can argue that better technologies and collaboration amongst supply chain partners, has improved the capacity and capabilities of upstream oil and gas players (e.g. oil and gas reserves and expertise) (Chima, 2011). In other words technological advancement in this industry, have improved the ability of companies to recover and maintain oil and gas reserves (producing fields) and extended the reach of such companies to discover and produce unconventional reserves (frontier locations). New technologies and better collaboration between organization of petroleum exporting countries (OPEC), and non-OPEC oil producing nations (western international oil companies) have also resulted in more oil and gas reserves being identified (oil and gas reserves doubled from 1980 much faster than production). Consequently, reserves that were not accessible for production a few of years ago have now become available. This further highlights, the importance of close collaborations amongst national oil companies (NOCs) (with oil reserves) in production economies and international oil companies (IOCs) (advanced technologies, and know-how) that are eager to venture into the oil and gas project.

It is important to note that a wider and more balanced energy mix, is required to provide a more secure, cost-effective, sustainable, and low carbon society. For instance the European Union has taken initiatives to reduce carbon emissions by 80% in 2050 (The Climate Change Act 2008) (EU, 2050). This is a clear indication that the there is a movement towards greener (sustainable) process of producing and consuming energy. Therefore focusing on the oil and gas sector should not be viewed as a movement away from sustainability, but rather on how we can develop a sector that is still very essential to the global economic existence (57% of world's energy dependency). This could provide more efficient supply chain management

(SCM) in the oil and gas industry, and more effective ways of producing resources (e.g. higher process quality, lower operational costs). For instance developing technological processes could assist oil and gas companies in providing cleaner (less carbon intensive) petroleum products, and reducing the overall carbon emission of their operations. Thus understanding the relationship between OS and SCI in the oil and gas industry may enable researchers to better understand SCM in similar energy producing industries. The next section outlines some global industry-wide statistics on the supply (production) and demand (consumption) of oil and gas.

## 2.2 Oil and Gas Statistics

By providing a background on the oil and gas industry, this subsection will start by presenting a brief historical trend of the global oil and gas supply and demand. As shown in figure 2.2 the demand for oil has increased dramatically during the past century.

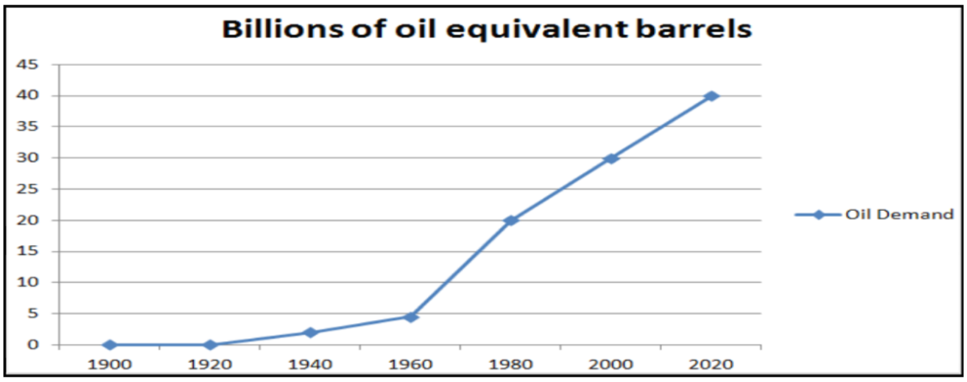



**Figure 2. 2: 100 Years of Oil Demand (source: Longwell, 2002)**

Until the 1950's the demand for oil remained relatively flat. However after the World War II, demand spiked and has continued to rise ever since. It could be argued that this period of increased oil consumption facilitated extraordinary economic growth (Hamilton, 1996). Furthermore there was a pause in demand during the 1979 (or second) oil crisis, but demand carried on growing again by mid-1980s. Figure 2.3 below compares 100 years of demand curve, to the volumes of oil discovered in the period.

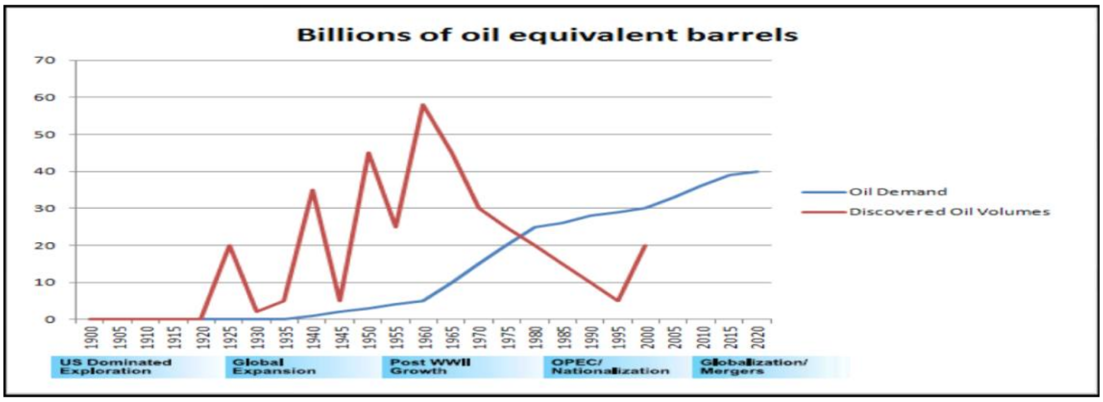



**Figure 2. 3: 100 Years of Oil Supply and Demand (source: Longwell, 2002)**

As illustrated, the most successful exploration occurred before the creation of OPEC. The post-World War II growth period drove great discoveries of oil and gas reserves in the Middle East, Russia and on the North Slope of Alaska. The energy intensive process of rebuilding nations after the world war, alongside the obvious technological and scientific advancement in exploration (matched by technology progress in development) increased the demand for oil. This led to the discovery of new oil reserves in Africa, and certain parts of the former Soviet Union, increasing the global oil supplies.

Furthermore, nuclear output contributed approximately 4.4% toward the global energy consumption, which was the smallest growth during the past 3 decades. While global biofuel production increased by 6.1%, the total contribution of renewable energy towards global energy consumption still remains below 3% (Appendix A). Thus the world still relies heavily on fossil fuels to supply its current and future energy demands. Some experts argue that the growing demand for oil and gas could pit powerful buyers (e.g. United States and other developed nations) against the developing and oil producing nations (e.g. Africa, China, India, and the rest of Asia). Accordingly Luft (2004) argued that,

… "While the U.S. is absorbed in fighting the war on terror, the seeds of what could be the next world war are quietly developing. By 2030, China is expected to have more cars than the U.S. and import as much oil as the U.S. does today"

India may have experienced a slower growing economy in comparison to China but its oil consumption is still very high (see BP Statistical Review, 2014). Thus, the increase in demand of developing countries (e.g. China and India) and other emerging markets further justifies the importance of the oil and gas industry.

### 2.2.1 Global Oil and Gas Production

The Middle East is one of the main producers and contributors to the global oil and gas supplies and reserves. Based on Figure 2.4 (BP Statistical Review, 2014), the Middle East has the highest crude oil reserves in the world, approximately 47.9% (808.5 thousand million barrels). The South and Central American region is the second largest producer of crude oil with approximately 19.5% of the total world reserves (329.6). A more recent data released by OPEC (2015), showed that the current proven oil reserves stands at 1490 billion barrels. Figure 2.5 illustrates the distribution of crude oil reserves. It provides a comparison between OPEC and Non-OPEC oil reserves (OPEC 1206 billion, 284 billion Non-OPEC). In terms of natural gas (figure 2.6) reserves the Middle East contributes the highest proportion with 43.2% (80.3 Trillion cubic meters), followed by Europe and Eurasia with 30.5% (56.6 Trillion cubic meters) of total world reserves (BP Statistical Review, 2014) (see Appendix A).

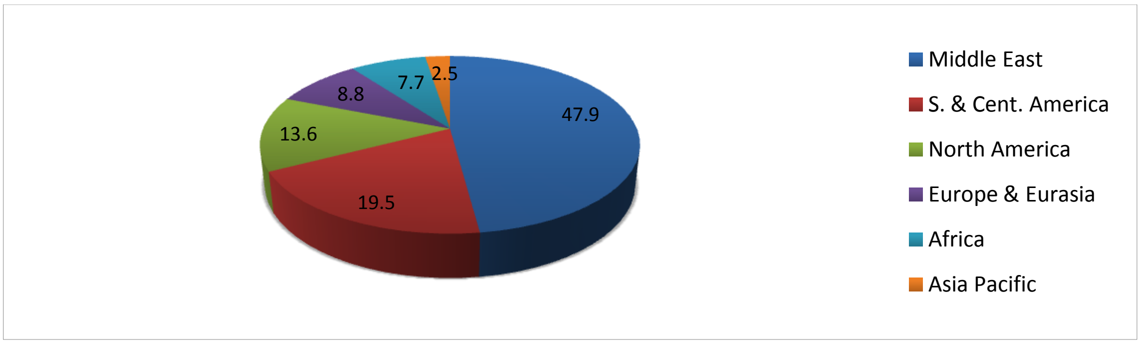
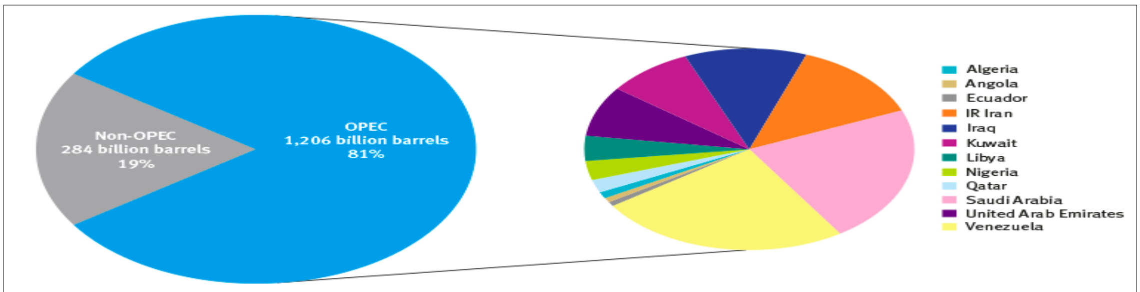



**Figure 2. 4: Distribution of Proved Oil Reserves (source: BP Statistical Review, 2014)**




OPEC proven crude oil reserves, at end of 2013 *(billion barrels, OPEC share)*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Venezuela | 298.4 | 24.7% | Iraq | 144.2 | 12.0% | Libya | 48.4 | 4.0% | Algeria | 12.2 | 1.0% |
| Saudi Arabia | 265.8 | 22.0% | Kuwait | 101.5 | 8.4% | Nigeria | 37.1 | 3.1% | Angola | 9.0 | 0.7% |
| IR Iran | 157.8 | 13.1% | UAE | 97.8 | 8.1% | Qatar | 25.2 | 2.1% | Ecuador | 8.8 | 0.7% |

*Source: OPEC Annual Statistical Bulletin 2014.*

**Figure 2. 5: comparison between OPEC and Non-OPEC oil reserves (source: OPEC Annual Statistical Bulletin 2014)**

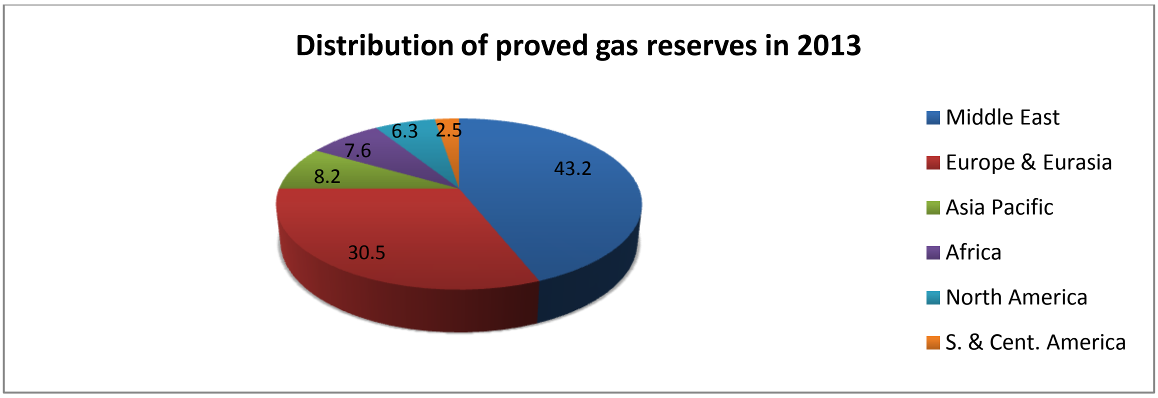



**Figure 2. 6: Distribution of Proved Natural Gas Reserves (source: BP Statistical Review, 2014)**

### 2.2.2 Oil Supply and Demand

Worldwide demand and consumption for oil grew by 1.4% (1.4 million barrels a day) from 2012 to 2013, taking it just above the historical average. During 2013 the US became the largest consumer of oil (+400,000 b/d) overtaking China (+390,000 b/d) for the first time since 1999. As illustrated in figure 2.7, Asia pacific has the largest oil demand;

approximately 33.8% (mainly because of China and India), followed by North America, which consumes 25.4% of total world reserves (Appendix A).

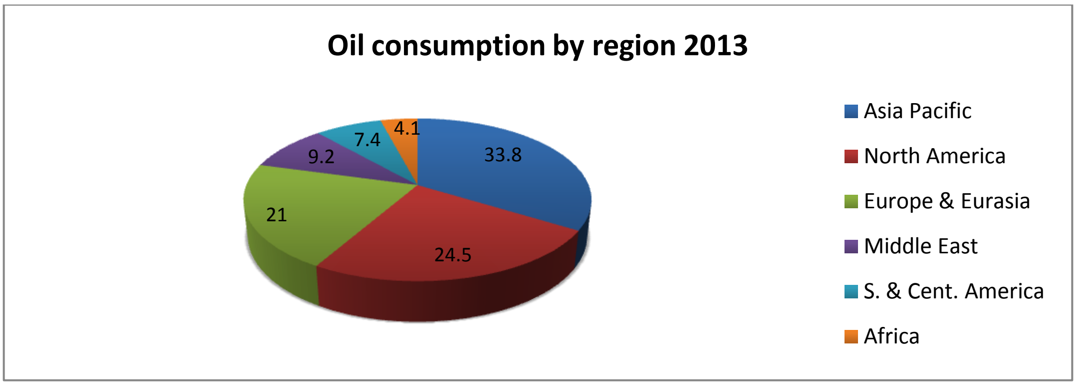



**Figure 2. 7: Oil Consumption by Region (source: BP Statistical Review, 2014)**

However worldwide oil production could not keep up with global demand, which grew 0.6% in 2013. During this year the US accounted the biggest growth in oil production, reaching a record 49.9 million barrels. In the same year production growth in Russia and Canada, offset reductions in Syria, United Kingdom (UK), Norway, and Australia. For the first time since 2009 OPEC faced a reduction in oil production. This was mainly due to the decreased production in Libya, Iran, and Nigeria. Nevertheless as illustrated in figure 2.8, Middle East is the largest oil producer contributing 32.2%, followed by Europe and Eurasia that produces 20.2 % of the global oil production. (Appendix A)

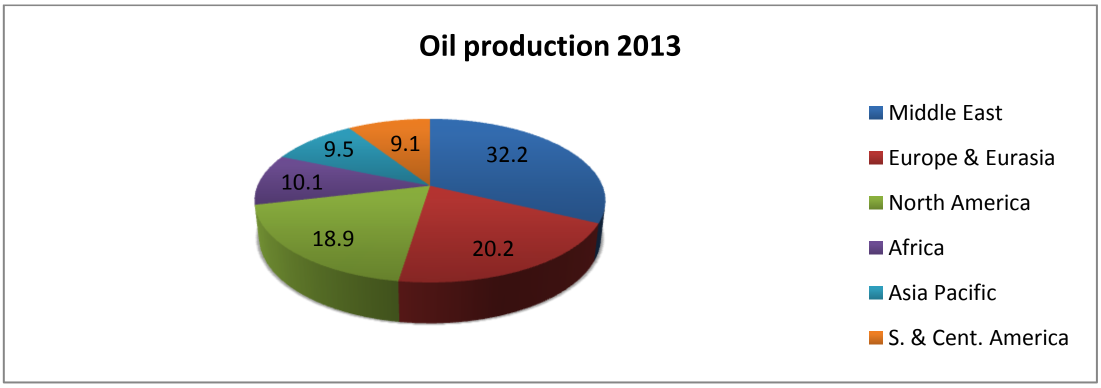



**Figure 2. 8: Oil Production by Region (source: BP Statistical Review, 2014)**

### 2.2.3 Natural Gas Supply and Demand

Worldwide demand and consumption for natural gas grew by 1.4 % (from 2012). Likewise, demand for natural gas increased by 1.8% for OECD and 1.1% for Non-OECD. The biggest growth increments were recorded in China (+10.8%) and the US (+2.4%). As illustrated in figure 2.9 Europe and Eurasia are identified as the regions with the largest natural gas consumption (31.7%) followed by North America (27.8% of the global gas production) (Appendix A).

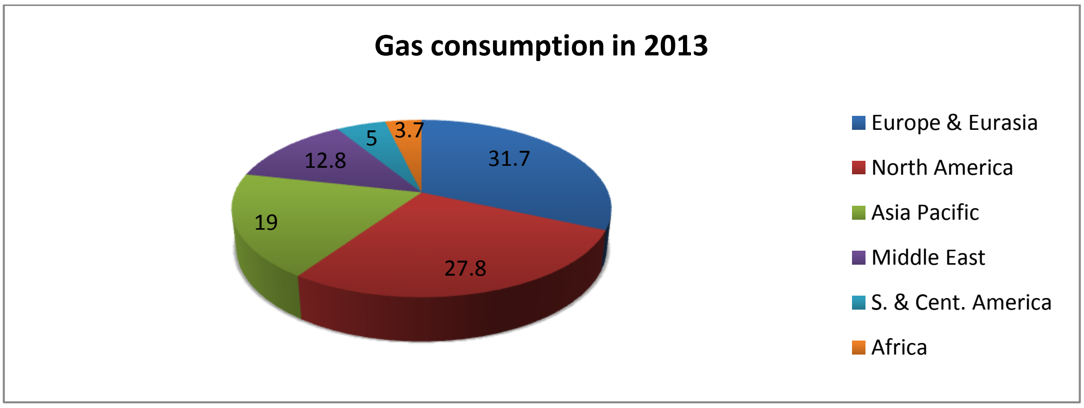



**Figure 2. 9: Gas Consumption by Region (source: BP Statistical Review, 2014)**

With an increase of 1.3% the US continued to be the world's largest gas producer, but both China (+9.5%) and Russia (+2.4%) attained larger growth increments. During this year Nigeria accounted the biggest volumetric reduction (-16.4%). As illustrated in figure 2.10 Europe and Eurasia are identified as the region with the largest natural gas production with 30.6% (mainly because of Russia's gas reserves) followed by North America that produces 26.9% of the total gas production (BP Statistical Review, 2014) (refer to Appendix A).

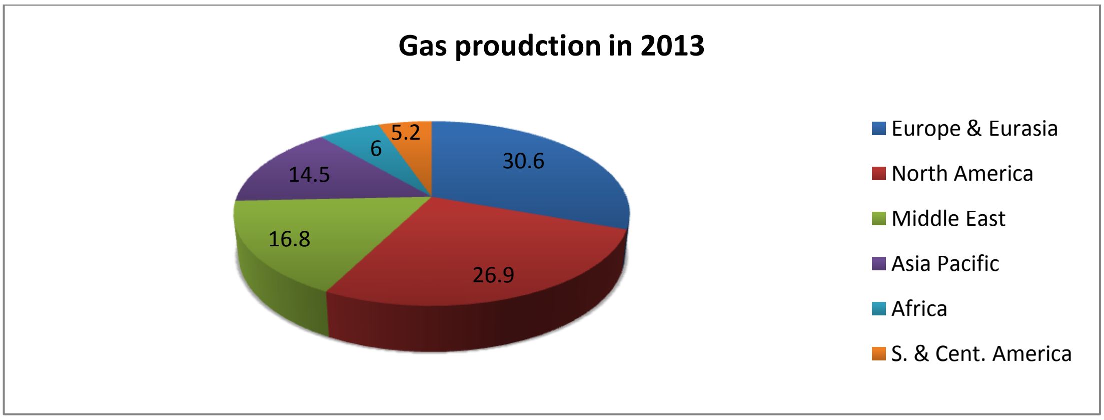



**Figure 2. 10: Gas Production by Region (source: BP Statistical Review, 2014)**

According to forecast by OPEC (2012), by 2035 conventional energy demand will grow by 54%. Furthermore as argued above, from a supply perspective the world has sufficient oil and gas reserves to meet the growing and future energy demand. Therefore it is important for researchers in the area of SCM and organizational theory to examine such a significant industry. This provides further rationale for this study in to the mediating role of SCI on the relationship between OS and operational performance. In a recent North Sea oil summit chief executive of Oil and Gas UK, Malcom Webb echoed the above concern and recommended change in government policies to tackle the sudden drop in oil price and the sharp rise in costs.

…"If we are to avoid lasting damage to this industry and its £35bn supply chain, now is the time for meaningful action. The industry is having to take tough decisions and implement necessary cost reduction and efficiency improvement measures" (Webb, 2015).

## 2.3 Supply Chain Management in the Oil and Gas

Despite the rising importance of SCM and the role of SCI in improving performance, oil and gas supply chains remain fairly under researched. For instance Schwartz (2000), noted that the oil and gas company's understanding of their supply chain is still in its infancy and needs much improvement (Chima, 2011; Mitchell et al., 2012). As presented in the previous chapter global energy demand is increasing, this alongside the recent political unrest in the Middle East makes it difficult to guarantee sustainable global oil supply. Additionally oil and gas products need specific methods of transport (i.e. pipes, tanker ships, and railway). This is an essential feature of such industry since oil and gas production are limited to regions (e.g. Middle East) and demanded in all parts of the globe (source of energy for other industries). Thus costly and complex logistics, and lengthy lead-times have been commonly associated to oil and gas operations (e.g. Chima, 2011; Yergin, 2011). For such reasons, oil and gas companies have been forced to restructure their processes, preserve higher safety stock, and identify alternative sourcing supplies amongst many other activities (Ikram, 2004). The oil and gas supply chain is much more complex in comparison to other sectors. For instance the upstream supply chain includes several multi-tiered nodes (each node has its own structure and supply chain) such as, exploration and appraisal, fabrication, installation, drilling, production and logistics management. Similarly the downstream supply chain includes refining the crude oil into usable products (e.g. diesel, benzin), storage, transportation, and delivery to final consumers globally.

## 2.4 Upstream and Downstream Supply Chain Challenges

"Frontier acreage" and gaining access to oil reserves is a common challenge in the upstream oil and gas industry. Frontier acreage are the issues related to exploring and developing oil fields, that were once viewed too expensive, remotely located, technologically challenging or politically unstable. Therefore unconventional reserves, such as oil sands, shale gas and coalbed methane, which were not economically feasible until a decade ago, are now due to technological advancement (i.e. hydraulic fracturing) (Chima, 2011). For instance, recent decline in oil prices has been associated to rise of shale oil and gas production (especially in the US). As mentioned above political instability across regions such as the Middle East (e.g. Iraq and Syria) and Africa (e.g. Libya and Nigeria) has also made it difficult to attract finance and investment in upstream operations. That alongside the increase in demand of developing countries (e.g. China and India) and other emerging markets has created an uncertain and competitive environment for oil and gas companies.

Another significant challenge is the NOC and IOC cooperation. NOCs act as gatekeepers of national oil and gas reserves, however IOCs have the technological know-how and capability. Collaboration between the two is therefore a critical one, since ones development could endanger the others survival. Therefore in this collaboration operational difficulties such as, the production capacity and capability of oil producers, long and unpredictable lead times, and the restrictions on transportation method (ships or railway), has created extremely rigid logistics linkages in the oil and gas industry, in which every link in the supply chain could offer difficulties of its own (Chima, 2011; Jenkins and Wright, 1998). Thus, not many industries exist that are required to deal with the level of logistics complexity associated to oil and gas companies (Morton, 2003; Yergin, 2011). When discussing challenges in oil and gas supply chain, logistics function is one of the many sections impacting supply chain performance. Other issues such as data and information sharing, collaboration, effective communication, integrated process management, and organizational restructuring have all been suggested as equal important features in enabling supply chain success (Chima, 2011; Ikram, 2004). Therefore by considering the importance of the energy industry on global economy, the necessity for SCI amongst different supply chain members, from procurement of raw materials to releasing the final product becomes even more vital. However in practice the oil and gas industry lags behind in utilizing integrated supply chain planning across members (Coia, 1999). Accordingly Coia (1999) suggested that lack of SCI could result in higher levels of cost for purchasing oil that will ultimately have an impact on prices for final consumers.

Another major issue in the oil and gas supply chains is the attitude concerning collaboration and information sharing amongst supply chain members. While such activities are closely tied to supply chain efficiency, oil and gas companies are sometimes cautious in implementing them (Ikram, 2004). It could be argued that such unwilling attitude in relation to collaboration and information sharing (e.g. demand, costs, and time) could ruin chances to save capital and operational costs. Therefore it is important to investigate whether or not companies in the oil and gas industry practice SCI and if such practices actually improve supply chain performance. By doing so this study further looks into the OS of such companies to see whether such structures enable or disable SCI.

To overcome the challenges and conditions in the oil and gas industry, a clear understanding of OS and SCI will be beneficial. Since most of such challenges are either related to information sharing (affected by OS), collaboration (SCI), or resource deployment (utilization affected by OS).

## 2.5 Chapter Conclusion

Chapter 2 presented a brief introduction to the context of the oil and gas industry. The chapter began with a discussion on the importance and relevance of the oil and gas industry to the global economy. It was argued that energy is vital for sustaining and developing the global economy. An analysis of global oil and gas statistics revealed that the Middle East is the main contributor to global oil and gas reserves (47.9% of global reserves, 808.5 thousand million barrels). Additionally it was argued that governments, especially developed nations around the world have developed policies aimed at reducing carbon emission and the reliance of fossil fuels (i.e. The Climate Change Act 2008). However it was demonstrated that the demand and supply for oil and gas has been steadily increasing and is projected to continue rising (OPEC, 2012). In the later part of the chapter challenges facing oil and gas supply chains were also presented. Under this study it was suggested that the high levels of uncertainty and the dynamic nature of the oil and gas industry had resulted in enormous operational challenges (Morton, 2003) and created rigid supply chain linkages throughout the industry (Chima, 2011; Jenkins and Wright, 1998; Mitchell et al., 2012) (i.e. political unrest in the Middle East, unstable production capacity of oil producers).

In order to overcome the challenges identified it was argued that oil and gas firms would require better inter and intra firm communication, information sharing (improved OS) and collaboration through SCI. However as argued above the oil and gas companies have been slow in adopting integrated supply chain planning strategies (Coia, 1999; Morton, 2003; Schwartz, 2000). This could be associated to the cautious attitude oil and gas companies, the uncertainties facing the industry, the complex IOC-NOC relationship, as well as the risk and time constraints in oil and gas projects. This therefore presents an interesting context to observe the mediating impact of SCI (if any at all) on the relationship between OS and operational performance of oil and gas supply chains. This research further proposes that investing into such an uncertain and volatile environment requires a contingency theory approach. This is because there are several contingent factors at play in the industry, which can affect the relationship under investigation.

# Chapter 3: Literature Review

In the first chapter the context and significance of supply chain integration (SCI) and organization structure (OS) was introduced. The second chapter provided the rationale and relevancy of the oil and gas industry. In this chapter, literatures in the area of OS, SCI, and operational performance are systematically reviewed to identify the research gap, and formulate the conceptual framework for this study. As presented in the first chapter, this research attempts to answer the following four questions:

*RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?*
*RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?*
*RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?*
*RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?*

To address the first, third, and fourth research question, the chapter starts by systematically reviewing literature on organizational theory, in order to define and conceptualize OS and its dimensions. The objective here is to identify the main classifications and dimensions of OS, which have been predominately examined in this field of study (formalization, centralization and hierarchical relationship). Studies exploring the impact of these dimensions on operational performance are also examined. In addition other dimensions of OS are reviewed to select the relevant dimensions for this study.

To address the second, third, and fourth research question, this study systematically reviews literature on SCI from the operations management and supply chain management (SCM) fields. The abundance of SCI studies, varying methodologies used, and different conceptualization of SCI dimensions, have consequently led to unclear definitions and understanding of this concept (Fabbe-Costes and Jahre, 2008; Pagell, 2004). Therefore a systematic literature review approach (Denyer and Tranfield, 2009) is adopted, in order to identify the main dimensions of SCI (internal, customer and supplier) and how they impact operational performance.

To address the fourth research question, which explores the mediating impact of SCI on the relationship between OS and operational performance, this research systematically reviews literature on the four key operational performance indicators used in operations management, organizational theory, and SCM studies (quality, cost, lead-time, flexibility). Reviewing the literature in the above three areas, enables this study to identify the current gaps in knowledge and therefore justifies and supports the aim and objectives of this study. This research adds to the current literature in organizational studies and operations management by examining these concepts in the uncertain oil and gas industry.

## 3.1 Organization Structure: Background and Definition

Organization structure (OS) is the way in which responsibility and power are assigned, and work processes executed, amongst individuals in an organization (Blau, 1970; Blau and Schoenherr, 1971; Champion, 1975; Daft, 2006; Dewar and Werbel, 1979; Fredrickson, 1986; Germain, 1996; Gerwin and Kolodny, 1992; Hall, 1996; Robbins, 1990; Ruekert et al., 1985; Skivington and Daft, 1991; Walton, 1984). Similarly OS can be defined as an organization's internal pattern of relationships, authority, and communication (Goldhaber and Shaner, 1993; Thompson, 1965). In simpler terms Dalton et al. (1980) described OS as the anatomy of the organization, providing a foundation within which the organization functions. They argued that OS affects how members tend to behave. Accordingly Hall (1996) also used an interesting analogy in relation to OS; the author noted that buildings contain hallways, stairs, entries, exits, walls, and roofs. It was also suggested that the structure of a building plays a major role in the way individuals act (how they behave) within it. Thus it could be argued that OS influences organizational behavior. The impact of such structural influences in organizations, even though not as evident as that of a building, is expected to be significant. In literature the two main functions of structure that have been commonly discussed are: (1) OS regulate the impact of variations in (individual) subdivisions on the entire organization, and (2) structure is the setting in which power is exercised, decisions made, and organizational activities carried out (Hall, 1996). Nevertheless researchers have frequently asserted that roles and work interdependencies forced by internal strategy and external environment, impact OS (Aiken and Hage, 1966; Burns and Stalker, 1961; Khandwalla, 1977; Miles et al., 1978; Thompson, 2011; Zaltman et al., 1973). For example in a study carried out by Grant (1996) it was reported that OS affects organizational processes, by shaping the degree and pattern of communication between individuals (and subdivisions), and specifying the hierarchy of decision making.

In earlier days many organizational theorists paid close attention to the development of OS. The majority of these works were based on bivariate comparisons (e.g. two aspects of structure such as differentiation and size) (Blau, 1968, 1970; Blau and Schoenherr, 1971; Child, 1972, 1973a, b; Meyer, 1968a, b; Meyer, 1972; Pugh et al., 1969a; Pugh et al., 1968). However, research by Child (1973a), Inkson et al. (1970a) and Pugh et al. (1969b) proposed more comprehensive models of OS. These studies established the primary associations between strategy and structure, structure and operational performance, and the impact of strategy and structure on performance outcomes. Based on these associations authors generally agree that firms must fit their structures in order to achieve positive strategy outcomes (Chandler, 1962; Channon, 1973; Daft, 2006; Fredrickson, 1986; Thompson, 2011). However the relationship between structure and performance cannot be considered straightforward, because it is contingent on several factors (Cosh et al., 2012; Csaszar, 2012; Dalton et al., 1980; Huang et al., 2010; Koufteros et al., 2007b; Wilden et al., 2013). Therefore it can be argued that organizational theorists and researchers may have overlooked significant mediating variables, which could impact the association between OS and operational performance.

When discussing OS it is important to consider the effect of the organization's external environment (Bourgeois et al., 1978; Cosh et al., 2012; Duncan, 1972; Germain et al., 2008; Hrebiniak and Snow, 1980; Lawrence et al., 1967; Liao et al., 2011; Lin and Germain, 2003). An "organization" or "task" environment refers to the conditions that are external to the organization, but nevertheless affect the organizations internal processes (Thompson, 2011). These could include suppliers, customers, competitors, regulatory bodies, and technical reference groups (Lawrence and Lorsch, 1967). Accordingly organization theorists highlighted the impact of environmental uncertainty on OS and the hierarchy of decision-making within the OS (Burns and Stalker, 1961; Hall, 1963; Lawrence et al., 1967; Leifer and Huber, 1977; Weick and Kiesler, 1979). For this reason a number of studies have focused on exploring the differences in OS as a result of variations in the external environment (Cosh et al., 2012; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Liao et al., 2011; Lin and Germain, 2003; Wilden et al., 2013). This resulted in a rich stream of literature, consistently suggesting that environmental uncertainty and OS are critical strategic factors affecting organizational performance (e.g. Chandler, 1962; Child, 1972; Dwyer and Oh, 1987, 1988; Dwyer and Welsh, 1985; Galbraith and Nathanson, 1978; Miles et al., 1978; Porter, 1979; Thompson, 2011).

Therefore the association between environmental uncertainty and structure has received significant attention from researchers, which have primarily investigated such relationship taking a "contingency theory" approach (e.g. Duncan, 1972; Hrebiniak and Snow, 1980; Lawrence and Lorsch, 1967; Miles et al., 1974). Pugh et al. (1969b) argued that the context, in which a company functions in, strongly influences the structure they adopt. Therefore a lot of the deviation in OS could be related to contextual aspects (Cosh et al., 2012; Bourgeois et al., 1978; Germain et al., 2008; Hrebiniak and Snow, 1980; Wilden et al., 2013).

The notion that organizations prefer to embrace rigid structures (because of the assumption of greater control and maintenance of resources) is a tenacious theme in management practice and theory. Nevertheless studies have shown that rigid structuring approaches, may not be suitable for organizations that face greater external uncertainties (D'Aunno and Sutton, 1992; Staw et al., 1981). For instance, researchers such as Gordon and Narayanan (1984) and Spekman and Stern (1979) proposed that organizations structured in dealing with consistent and steady environments might not be as successful in complex and unstable ones. Accordingly Lawrence and Lorsch (1967) argued that in more stable environments, there are higher chances an OS would be *centralized* in hierarchy and have *formalized* rules and processes. In contrast organizations operating in a great level of environmental uncertainty tend to have *decentralized* decision-making processes (Claver-Cortés et al., 2012; Huang et al., 2010; Ruekert et al., 1985; Yang et al., 2014), operate using *informal rules* and policies (Daugherty et al., 2011;Hempel et al., 2012; Jaworski, 1988; Liao et al., 2011), and have *flattened hierarchical relationships* as opposed to taller ones (Foss et al., 2014; Huang et al. 2010; Jacobides, 2007; Walton, 1984). Therefore some have argued that understanding the impact of OS on performance, could enable decision-makers to better cope with external uncertainty (Bourgeois et al., 1978; Child, 1972; Miles et al., 1974; Yasai-Ardekani, 1986). The mixed views on the impact of environmental uncertainty on OS, have led some authors to question the causal association between environment and structure (Cosh et al., 2012; Germain et al., 2008; Koufteros et al., 2007b; Liao et al, 2011; Nahm et al., 2003; Schoonhoven, 1981).

Furthermore in the organizational theory literature, the nature of OS in industrial vs. post-industrial organizations has also been described as organic vs. mechanistic structures (Burns and Stalker 1961, Daft, 2006; Huang et al., 2010; Nemetz and Fry, 1988; Zammuto and O'Connor, 1992). Authors like Galbraith (1973) have suggested that the flexibility inherent in organic structures (opposed to mechanistic) enables better information processing and richer communication flow in such organizations. Similarly, research carried out by Duncan (1972) and Khandwalla (1973) noted that greater environmental uncertainty was correlated with lower mechanistic structures. For this reason the consensus in organizational theory, is that the higher environmental uncertainty results in more organic structures in organizations (Coah et al., 2012; Burns and Stalker, 1961; Galbraith, 1973; Gordon and Narayanan, 1984; Hall, 1963; Huang et al., 2010; Koufteros et al., 2007b; Lawrence et al., 1967; Leifer and Huber, 1977; Spekman and Stern, 1979).

Mechanistic OS are more applicable when environmental uncertainty is relatively low (stable), routine technologies exist, operations are large scale and relatively consistent, and staff are viewed as any other resource (are dispensable) (Daft, 2006). In such organizations internal structures are usually bureaucratic and functional (also known as vertical structures). The firm is directed by parochial principles proposed in relation to the levels of hierarchy (hierarchical layer), and top-down power divisions (firm operates on rational analysis) (Baum and Wally, 2003; Daft, 2006). In contrast the organic OS adjusts to accommodate the unbalanced, and in some cases unpredictable (hectic) conditions and within the organization's industry. In such environments the technologies available to the organization are usually non-routine, and the size (number of employees) is not considered a significant factor (e.g. the oil and gas and mining industry). Accordingly organic based organizations rely more on, human interaction, face-to-face meetings, and teamwork and collaboration. In such organizations qualities are usually considered as egalitarian in nature. Therefore factors such as empowerment, autonomy, equality, and horizontal relationship building are more significant in organic organizations, in comparison to the functional, bureaucratic approach of mechanistic firms (Baum and Wally, 2003; Burns and Stalker, 1961; Covin et al., 2006; Daft, 2006; Daugherty, 2011; Vickery et al., 1999a)

Authors have used a variety of dimensions to describe OS (Hage and Aiken, 1967a, b; Hall, 1963). Although developing an extensively acceptable methodology for studying OS relies on consensus at the conceptual level, many of the different opinions and approaches can be attributed to differences in jargon (Hickson et al., 1969). Sometimes researchers have named and classified similar dimensions of OS differently. In order to overcome the difficulties reflected above, this research will attempt to provide an up-to-date review on dimensions of OS (which have been commonly discussed in organizational theory). The focus is to review the OS literature to see how theories, understandings and conceptualizations of the different dimensions have evolved.

### 3.1.1 A Historical Review on the Dimensions of Organization Structure

One of the most common questions in organizational theory has been, *what are the dimensions of OS?* Formalization, centralization, levels of hierarchy, and complexity are the main OS dimensions that have been extensively examined by previous authors. However as shown in table 3.1 a great diversity can be observed in how previous authors have conceptualized OS dimensions. Therefore a consensus on the issue of structural dimensionality is challenging to say the least. Nevertheless if the above question, is rephrased to *why are formalization, centralization, and complexity known as dimensions of structure?* The number of answers may not be as diverse because responses could be influenced by past research, or the frequency of usage of such dimensions in the literature. To better understand the different dimensions and taxonomies OS, a chronological and systematic review of studies conduct between late 1960s to date, on the dimensions of OS is carried out (major empirical studies on the dimensions of OS began in the late 1960s). Studies were selected from top ranking publications and based on citation index (web of knowledge). As shown in table 3.1, a great number of possible taxonomies of structural dimensions exist in OS literature.

**Table 3. 1: Dimensions of Organization Structure**

| Study | OS Dimensions |
|---|---|
| Aiken and Hage (1971) | Complexity, professionalism, decentralization, scheduled and unscheduled communication, and formalization |
| Adler and Borys (1996) | Formalization |
| Andrews and Kacmar (2001) | Centralization, formalization, co-worker cooperation, role conflict, Locus of control |
| Baum and Wally, (2003) | Centralization and formalization |
| Claver-Cortés et al. (2012) | Formalization, centralization, and complexity |
| Cosh et al. (2012) | Decentralization and formalization |
| (Damanpour, 1991) | Centralization, specialization, formalization, vertical differentiation, internal and external communication, slack resources, professionalism, administrative intensity, functional differentiation, |

| | |
|---|---|
| | manager approach in relation to change, technical knowledge resources, managerial tenure |
| Daft (2006) | Standardization, formalization, complexity, specialization, hierarchy of authority, centralization, personnel ratios and professionalism |
| Daft and Lengel (1986) | Horizontal and vertical differentiation |
| Daugherty et al. (2011) | Centralization, formalization and specialization |
| Droge and Calantone (1996) | Organic and mechanistic |
| Ettlie et al. (1984) | Formalization, centralization and complexity |
| Ferrel and Skinner (1988) | Centralization and Formalization |
| Ferris and Kacmar (1992) | Centralization, formalization, hierarchal level and span of control |
| Fry and Slocum (1984) | Centralization, formalization, and complexity |
| Germain (1996) | Decentralization, and vertical/horizontal integration |
| Germain et al. (1994) | Specialization, formalization, decentralization Integration |
| Germain et al. (2008) | Formalization and cross functional integration/complexity |
| Gordon and Narayanan (1984) | Centralization, formalization of authority, and the general characteristics of bureaucracy |
| Grinyer and Yasai-Ardekani (1981) | Centralization, formalization, specialization, CEO span of control, vertical span of control, administrative intensity |
| James and Jones (1976) | Centralization, formalization, number of hierarchical levels and size |
| Hrebiniak (1974) | Job autonomy, participation, closeness of supervision, rule usage and unity of control |
| Huang et al. (2010) | Flatness, decentralization, employee multi-functionality |
| Koufteros and Vonderembse (1998) | Centralization, formalization, and complexity |
| Koufteros et al. (2007b) | Locus of decision making/centralization, number of layers in hierarchy/Flat vs. tall, level of horizontal integration, formalization |
| Lee and Grover (1999) | Complexity, centralization, formalization and vertical/horizontal integration |
| Liao et al. (2011) | Centralization, formalization, complexity and structural integration |
| Lin and Germain (2003) | Centralization and formalization |
| Lysonski et al. (1995) | Centralization of decision-making, formalization of rules and procedures, and structural differentiation |
| Marquis and Lee (2013) | Formalization and differentiation |
| Miles et al. (1974) | Complexity, formalization, centralization, and administrative intensity |
| Miller et al. (1988) | Formalization, integration, and centralization |
| Moch (1976) | Specialization, functional differentiation and centralization |
| Montanari (1978) | Formalization, centralization, complexity, configuration |
| Nahm et al. (2003) | Formalization, number of layers in hierarchy, level of horizontal integration, locus of decision making, level of communication |

| | |
|---|---|
| Nemetz and Fry (1988) | Span of control, centralization, vertical levels, specialization, standardization, integration, vertical and horizontal information flow |
| Oldham and Hackman (1981) | Centralization, formalization and number of hierarchical levels |
| Olson et al. (2005) | Centralization, formalization and specialization |
| Parthasarthy and Sethi (1992) | Horizontal and vertical integration/complexity |
| Parthasarthy and Sethi (1993) | Shop floor personnel skills- specialized or diversified; design manufacturing workflow sequential or parallel; and project teams and workgroups-rarely used or often used |
| Paswan et al. (1998) | Formalization, centralization, and participation |
| Pierce and Delbecq (1977) | Differentiation, professionalism, decentralization, formalization |
| Pugh et al. (1968) | Specialization, standardization, formalization, centralization, configuration |
| Schminke et al. (2000) | Formalization and centralization |
| Sivadas and Dwyer (2000) | Formalization and centralization |
| Vickery et al. (1999a) | Formal control, operations decentralization, layers and spans of control |
| Willem and Buelens (2009) | Coordination, centralization, formalization, and specialization |
| Zheng et al. (2010) | Centralization |
| Yang et al. (2014) | Centralization |

As illustrated in table 3.1 the majority of the studies have operationalized OS as multiple constructs (Aiken and Hage, 1971; Damanpour, 1991; Grinyer and Yasai-Ardekani, 1981; Nemetz and Fry, 1988; Pugh et al., 1968; Willem and Buelens, 2009), most of which have reviewed have conceptualized OS using the two most popular dimensions of "centralization" and "formalization" (Daft and Lengel, 1986; Lin and Germain, 2003; Parthasarthy and Sethi, 1992; Schminke et al., 2000). A few studies have also conceptualized OS as a single construct (e.g. Adler and Borys, 1996; Zheng et al., 2010). Therefore a great deal of overlap is observed between the reviewed dimensions.

**Pre 1970s: Weberian Characterization of Organization Structure and the Aston Studies**

The predominant definition of OS dimensions, views it as enablers of patterns and relationships between organizations and within department and units. Since there are several underling characteristics that enable such patterns and associations, conceptualizing OS as a multidimensional entity is commonly accepted in organizational theory. Weber (1947) was one of the first to offer a multidimensional explanation of OS, and for this reason, majority of the studies on OS adopt this multidimensional view.

Weber (1947) suggested that the “ideal” bureaucratic organization would be designed around dimensions such as well-defined hierarchy, definite norms and rules, and written and coded administrative processes. The dimensions characterized by Weber (1947) in relation to bureaucratic structures were subject to empirical validation in the late 1960s. One of such attempts was the systematic approach undertaken by a research group at Aston University. The study investigated the foundations and consequences of structural variability. Similarly, Pugh et al. (1968) carried out a research to empirically examine the underlying dimensions of OS (e.g. specialization, standardization, formalization, centralization). 64 scales were designed to thoroughly measure the diverse features of six primary OS dimensions. The authors argued that the primary dimensions chosen were all based on the Weberian characterization used in previous studies. This study involved surveys of key staff members from 52 firms in Birmingham, United Kingdom. A principal component analysis of the 64 scales, resulted in 4 factors namely, concentration of authority, structuring of activities, size of support component, and line control of workflow. Based on this finding Pugh et al. (1968) suggested that OS could have numerous dimensions in different context. This characterization of OS dimensions, suggested that further studies in such area could result in additional dimensions being identified and selected.

### 1970s: Further Conceptual Developments of Organization Structure Dimensions

Aiken and Hage’s (1971) attempt at replicating the Aston research, proposed five dimensions of OS (complexity, professionalism, decentralization, scheduled and unscheduled communication, and formalization). They used these five dimensions to characterize organic organizations, and to examine if they were associated with varying rates of innovation. The authors tested their research using a panel study of 16-health and welfare organization located in Midwest metropolis from 1964 to 1967. They interviewed 520 staff members from six public and ten private organizations. This study found other dimensions, different to those proposed in the Aston studies, such as diversity of occupations, high involvement in professional associations, high intensity of scheduled communications, and high intensity of unscheduled communications with those of higher status. In another influential study by Child (1972), an attempt was made to further the understanding developed by the researchers at Aston University. The sample in this research varied from the Aston study in the following regards: targeted firms were distributed throughout the UK; the population size was bigger (i.e. n = 82); the population sample contained only the main unit, not taking into account any subsidiaries; the population sample comprised of only business organizations. Nevertheless Child's (1972) research managed to reproduce three of the four dimensions of OS reported in the Aston studies (line control of workflow, restructuring of processes, and support component size). However unlike the Aston study, Child (1972) did not conceptualize centralization as a separate dimension. Instead centralization, formalization, standardization, vertical span of control, and specialization were all reported as one (negative) factor. Consequently the author argued that one factor could characterize all significant OS dimensions. Such understanding suggested an OS domain with a single bureaucratic dimension (composed of numerous Weberian characteristics). Therefore one can argue the assumption of independence between Weber's dimensions may be contextual.

Reimann (1973) tested a shortened set of structural measures on a sample of 19 companies in Ohio, United States. The study found that OS consists of four components, formalization, specialization, administrative density, and centralization. This differed from the outcome of the Aston studies, in which formalization and specialization emerged as distinct dimensions of OS. Miles et al. (1974) conceptually defined four OS dimensions (centralization, formalization, administrative intensity, and complexity). By reviewing the literature on organizational studies, the authors attempted to answer questions about the extent to which organizations are shaped by their environment (e.g. customers, suppliers, competitors), and the suitability of certain OS to different environments. Interestingly the study did not find a direct relationship between OS dimensions and the environment.

Research by Holdaway et al. (1975) also examined the degree to which specialization, standardization, formalization, and centralization, proposed by Pugh et al. (1968) were suitable for categorizing the OS of schools and universities. Using Aston approach, they investigated 23 educational institutes in Canada. The outcome was substantially different from the Aston findings, and 3 factors were extracted as dimensions of OS (non-work flow proportion, administrative configuration, and bureaucratic control). The study concluded the dimensions of OS are highly contextual (may change from one industry to another). In a separate study Moch (1976) explored the relationship between OS dimensions (specialization, functional differentiation and centralization) and the rate of innovation. The author tested the model against data gathered from hospitals in the US. The findings suggested that larger organizations had higher levels of specialization, functional differentiation, and decentralization.

Pierce and Delbecq (1977) examination of OS, individual attitudes, and innovation used four OS dimensions (differentiation, professionalism, decentralization, formalization). They measured the impact of organization context, structure, and member attitudes on innovation (the initiation, adoption and implementation of new ideas or activity in an organizational setting). The findings suggested that more organic organizations were better able to innovate in comparison to mechanistic ones. Similarly research by Dewar and Werbel (1979) found that formalization decreased individual satisfaction. They argued that enforcing regulations resulted in higher level of conflicts between skilled workers.

In summary the most predominant OS dimensions that were developed and explored during this period include, formalization, centralization, layers of hierarchy (functional differentiation), complexity (specialization), span of control, and size. The next section reviews the progression of organizational researchers from defining dimensions of OS, to exploring its impact on performance and strategies involved.

### 1980s: Empirical Link among Organization Structure, Organization Strategy, and Performance

From the early 80s, scholars began to focus on understanding the empirical relationship amongst OS, strategy and performance. Organization strategy has been operationalized from numerous research domains (e.g. organization theory, operation management, supply chain, marketing, strategic management). Regardless of the different domains, organization strategy is the combined set of actions a firm plans to take to achieve its long-term objectives (e.g. Ettlie et al., 1984; Germain et al., 1994).

To begin Grinyer et al. (1980) proposed a connection amongst strategy (diversification), structure (divisionalization), and other configurational variables (lateral and vertical spans). The study included a sample of 40 electrical engineering/manufacturing companies in the UK. Findings suggested a significant and positive correlation amongst structure, configuration variables and the Aston measures of bureaucracy (such as formalization, functional specialization, qualifications of office holders, and decentralization of operational decision taking). Furthermore Grinyer and Yasai-Ardekani (1981) extended the study on strategy, structure, size and bureaucracy by utilizing six OS dimensions (centralization, formalization, specialization, CEO span of control, vertical span of control, administrative intensity). Oldham and Hackman (1981) explored the impact of centralization, formalization, and number of hierarchical levels on employee's reactions to work and its context. They used an attraction-selection framework to determine if organizations with certain structural properties attract and/or select individuals with specific personal attributes. They argued that OS dimensions explained more of the variance in performance (staff reaction) in comparison to the variance explained through measures of personal attributes alone.

Gordon and Narayanan (1984) empirically investigated the relationship amongst management accounting systems, perceived environment uncertainty, and OS. The study employed Burns and Stalker's (1961) notion of mechanistic and organic and three OS dimensions (centralization, formalization of authority, level of bureaucracy). They examined the relationships amongst environment, OS, and information system. Findings indicated that information systems and OS are both a part of the environment. Thus, by controlling for the effects of the environment, no significant relationships were found between information system and OS. Ettlie et al. (1984) examined the relationship between organization strategy, OS, and the rate of innovation using three OS dimensions (Formalization, Centralization, and complexity) in the food processing industry. The authors argued that large, complex, decentralized organizations adopted innovation incrementally (due to market dominated growth strategies). On the other hand organization with more centralized decision-making, and less complexity were argued to be more radical in new process development and innovation.

Daft and Lengel (1986) employed two dimensions of OS (Horizontal and vertical differentiation) to determine the impact of OS on top management information processing. They found that OS affected the amount and richness of data provided to high-level managers. Their study proposed a model for firms to design their OS in order to meet their technological needs, arguing that the main issue for managers is not lack of data, but understanding the impact of OS on information processing and data flow (enabler/disabler). Ferrel and Skinner (1988) investigated the association between bureaucratic OS and ethical behavior, using two dimensions of OS (Centralization and Formalization). The authors argued that rules, principles, and systematic processes as a result of high formalization and centralization, improved the ability for organizations to achieve common objectives. The authors chose to examine bureaucracy (as a single construct) since it was directly linked to the development and enforcement of codes of ethics. This approach was important because several researchers had investigated OS by disaggregating bureaucracy into its component parts (separate variables of OS e.g. Hall, 1963). Findings indicated that bureaucratic OS were associated to ethical behavior, however the nature of this association varied across industries. Nemetz and Fry (1988) found that OS dimensions (horizontal linking, administrative innovation, and interventions for human resource development) had an impact on the ability of manufacturing managers to identify strategic technological opportunities (performance).

Parthasarthy and Sethi (1992) adopted two dimensions of OS (horizontal and vertical integration/complexity) in examining the impact of flexible automation on business strategy and OS. The authors presented a framework for describing the relationship amongst technology, strategy, and OS in the context of flexible automation. The authors argued that superior performance is achieved when there is a “fit” between strategy and structure, and structure and technology. In a separate study Parthasarthy and Sethi (1993) used three OS dimensions (shop floor personnel skills- specialized or diversified; design manufacturing workflow -sequential or parallel; and project teams and workgroups-rarely used or often used) to examine the relationship amongst strategy, OS, and flexible automation (operational performance). Their definition of OS fell within the mechanistic-organic continuum (Burns and Stalker, 1961). They found that OS are highly mechanistic or organic depending on the inherent attributes of the task grouping (industry, organization, and subunit), level of decision-making required, level of coordination and control, and reward systems. The data collected from 87 flexible automation operators, indicated that quality and flexibility strategies related positively with flexible automation. It was also found that firms with more organic structures achieved higher flexible automation, in comparison to mechanistic ones. However at operational level, the authors argued that organizations with higher skill diversity and team approaches were found to perform better.

Wally and Baum (1994) examined the relationship amongst OS (centralization and formalization), performance (risk tolerance, cognitive ability, propensity to act, and use of intuition) and environment. The authors found that performance was higher in more centralized and less formalized OS.  Germain et al. (1994) examined the relationship between environmental uncertainty, strategy (just-in-time), and OS dimensions (decentralization, formalization, specialization, and integration). The outcome of the study suggested that uncertainty had an impact on just in time (JIT) selling, and OS dimensions (level of control, specialization, scheduling, and decentralization). Although no relationship was found between strategy (JIT) and two dimensions of OS (levels of integration and operations decentralization), a positive relationship was found between JIT selling and other OS dimensions (formalization, specialization, and centralized decision-making). The findings of this study did not support the rigid distinction made between organic and bureaucratic structures, as suggested in the Aston studies. Therefore it could be suggested that the organic vs. mechanistic dichotomy should be viewed as a continuum, rather than fixed categorizations of OS. Similarly research by Germain (1996) attempted to describe the role of context and structure (decentralization, and vertical/horizontal integration) on performance (adopting logistical innovations). The author reported that size and environmental uncertainty had a direct impact on performance ("costly and radical" and "low-cost and incremental" innovation). The authors found that while specialization affected both performance measures, decentralization only affected low-cost and incremental innovation. Adler and Borys (1996) examined the impact of two forms of organizational bureaucracy (enabling and coercive strategies) on performance (workflow). The authors conceptualized formalization as two forms of bureaucracy (1) enabling staff to better their tasks and (2) coercing employees' effort and compliance. The authors also suggested that other forms of bureaucracy could also affect performance (e.g. internal labor markets, hierarchy, and the role of staff functions). Thus they argued that future studies should take in to account, the *nature* (or context) of structural hierarchy.

Contrary to previous studies (including Aston study) Droge and Calantone (1996) examined the relationship amongst OS, strategy, and performance, using the two classes of OS (organic and mechanistic). The authors compared the relationship amongst strategy, structure, and performance in dominant and non-dominant firms (firms that follow their competitor's lead). They argued that power played a moderating role on the relationship or "fit" amongst strategy, structure, and environment. The authors concluded that OS has a higher impact on performance (new product development) in non-dominant firms, because the impact of OS is greater in environments that are not competitive. However, firms with higher organicty operating in uncertain environments perform better (are more flexible and competitive/aggressive). Likewise Paswan et al. (1998) adopted three OS dimensions (formalization, centralization and participation) to empirically investigate the associations amongst OS, environmental uncertainty, and performance. Results indicated an interactive non-recursive association between the three constructs. The authors argued that (A) higher bureaucratization (formalization and centralization) had a negative relationship with performance, and (B) bureaucratization (formalization and centralization) positively related to environmental uncertainty.

Furthermore in examining the impact of OS on operational performance (JIT) Koufteros and Vonderembse (1998) employed 3 dimensions of OS (centralization, formalization, and complexity). They found that centralization of strategic decision-making was required better JIT implementation, however the authors also noted that low formalization and vertical differentiation facilitated the initiation and implementation of JIT. Lee and Grover (1999) utilized 4 OS dimensions (complexity, centralization, formalization and vertical/horizontal integration) in examining the mediating role of environmental uncertainty (governmental directives) on the relationship between OS and strategy (adopting new communication technologies). Using data collected from 154 manufacturing firms, the authors reported that strategy (communication technologies) had a positive impact on improving capacity for OS to cope with external uncertainties (government directives). Vickery et al. (1999a) examined the relationship between OS and operational performance (product customization), focusing on four OS dimensions (formal control-which are devices used to monitor systems on a written, codified, and rational basis; operations decentralization; layers; and spans of control). They took a contingency approach to investigate the moderating effects of environmental uncertainty and organizational size. Results indicated that operational performance was higher in organizations with greater formal control, lower layers of hierarchy, and narrower spans of control. However the study did not report a significant moderating effect of organizational size and environment. They argued that as organizations make the transition from standardization to customization, operational decision-making becomes more decentralized and the number of hierarchical layers (span of control) decreases.

Overall the studies examining the relationships amongst OS, strategy, and performance, all illustrate a significant interaction in such association. Furthermore studies have demonstrated that environmental uncertainty is an important contingent factor in the discussed relationship.

**Post 2000s and Beyond: Recent Conceptualization of Organization Structure**

A review of the more recent studies shows that researchers have now focused on defining OS dimensions (as of Aston studies) and verifying the proposed association amongst OS, organization strategy, and performance. In an attempt to clearly identify the best categorization of OS dimension and offer additional conceptual separation, Andrews and Kacmar (2001) used a selection of six theoretical dimensions of OS, organizational politics, and organization support (e.g. leader-member exchange, centralization, formalization, co-worker cooperation, role conflict, and locus of control). The findings showed a considerable overlap amongst the organizational politics, support and OS. They argued that the most logical justification for the differences amongst these variables was the distinctive reference points and research approach (politics, strategic management, organizational theory, SCM). Similarly Schminke et al. (2000) examined the association between OS (centralization, formalization, and size) and operational performance (perceptions of procedural and interactional fairness). The findings showed that higher centralization and bigger size had a negative impact on performance. However no such association was found for formalization. Furthermore in a four-year longitudinal study, Baum and Wally (2003) explored the mediating role of organization strategy (strategic decisions speed) on the relationship between OS (e.g. formalization, centralization) and performance. Results indicated that organization strategy (speedy strategic decision-making) positively mediates the association between OS and performance.

Using contingency theory approach Lin and Germain (2003) carried out a research on OS (decentralization and formalization), environment, and performance (customer orientation) in 205 Chinese stated-owned enterprises. Foreign induced industry competitiveness, technological turmoil, size (measured by operational scale, and production technology routineness) were all treated as variables of the environment. Results indicated that formalization had a positive impact on performance, however high decentralization resulted in lower performance outcomes in the surveyed state-owned enterprises. They argued that foreign induced competitiveness increased decentralization, and that technological turbulence decreased formalization. The authors also noted a positive effect from production technology routineness on formal control. Further on it was suggested that the organizational alterations as a result of environmental uncertainty do not guarantee the ‘most efficient form’ of OS, because regional differences could also impact such association.

Nahm et al. (2003) also explored how the interaction amongst 5 dimensions of OS (locus of decision making, number of layers in hierarchy, formalization, level of communication, level of horizontal integration), affected two performance measures (time-based manufacturing and plant performance). The authors reported a significant association between OS and time-based manufacturing, and consequently plant performance. Olson et al. (2005) utilized three dimensions of OS (formalization, centralization and specialization) in studying the performance implications of the relationship amongst business strategy (strategic behavior), marketing, and OS. Data was gathered from 228 senior marketing managers. By adopting a contingency view the authors suggested that firm performance is affected by the fit between business strategy and OS (i.e. each strategy type needs a different combination of OS and strategic behaviors to be successful). Koufteros et al. (2007b) empirically examined the mediating role of four OS dimensions (e.g. locus of decision making/centralization, number of layers in hierarchy/flat vs. tall, level of horizontal integration, formalization) on the relationship between culture variables, and performance (level of communication, practice of pull production, and firm performance). The research was carried out with data from 224 manufacturing executives from the US. They argued that customer orientation (i.e. manifestation of underlying expectations in a firm) influences culture variables (e.g. management control, teamwork, and making global decisions). It was further suggested that such culture variables have an impact on the four OS dimensions, and consequently on organizational performance. Their findings were consistent with the existing literature on OS, which suggests that the ability to initiate and adopt radical change is facilitated (or hampered) by OS (e.g. Damanpour, 1987; Damanpour, 1988; Ettlie et al., 1984; Mintzberg, 1979; Nord and Tucker, 1987; Zaltman and Duncan, 1977; Zaltman et al., 1973). In summary they argued that as organizations move from industrial to post-industrial they require OS with: (1) less regulations and processes that encourage autonomous work and creativity (2) less number of layers in structural hierarchy (ensuring quicker responses and reactions), (3) greater levels of horizontal integration (to expand knowledge transfer), (4) a decentralized decision-making process (to deal with operating issues more efficiently and swiftly), and (5) a high degree of horizontal and vertical communication (enabling synchronization and better collaboration) (Koufteros and Vonderembse, 1998; Zammuto and O'Connor, 1992).

Germain et al. (2008) examined the mediating role of supply chain process variability on the relationship between OS (formal control and cross-functional integration) and performance. Furthermore the above relationship was also moderated by environmental uncertainty (high/low demand unpredictability). Results indicated that in predictable environments, formal controls affected supply chain process variability and led to better firm performance (financial outcomes). However in less predictable environments only cross-functional integration was found to have a significant impact on supply chain process variability and performance. The authors concluded that supply chain process variability had a negative association with financial performance, irrespective of the environment; and that OS provided managers with the instruments to reduce the negative effect of variability on financial performance. Similarly Willem and Buelens (2009) studied the impact of four dimensions of OS (coordination, centralization, formalization, and specialization) on knowledge sharing in inter-unit cooperative episodes. They examined how classical OS dimensions could be transformed to be more adapted to organizational knowledge sharing. Out of the four OS dimensions explored, only specialization had a significant impact on the association between coordination and knowledge sharing. Furthermore Zheng et al. (2010) investigated the possible mediating role of knowledge management on the relationship amongst organizational culture, OS (centralization), and strategy, on organizational performance (organizational effectiveness). They surveyed 301 organizations and found that knowledge management partially mediates the relationship between OS, strategy, culture and organizational effectiveness. The authors emphasized the significance of establishing a knowledge-friendly setting with a balance of OS, strategic and cultural features.

Huang et al. (2010) used 3 OS dimensions (flatness, decentralization, employee multi-functionality) in assessing the impact of OS on operational performance (mass customization capability). They modeled OS a second-tier factor based on a mechanistic-organic continuum, in which the mechanistic form was characterized as a tall, centralized, and employing few multifunctional staff. By testing the model on data collected from 167 manufacturing plants, the authors argued that firms with more organic structure had better mass customization capability. Liao et al. (2011) investigated the mediating role of knowledge management on the relationship between environmental uncertainty and OS (centralization, formalization, complexity and integration). The authors found supporting evidence that knowledge management and OS were significantly related and complement each other. Furthermore Daugherty et al. (2011) explored the impact of OS (formalization, centralization, and specialization) on performance (logistic service innovation). The authors argued that formalization negatively affected performance, while decentralization and specialization had a positive impact. Out of the three OS dimensions explored, only decentralization was found to have a positive impact on logistics service innovation capability. The authors argued gathering data from one country, could have influenced their outcomes and suggested future studies look at multiple contexts.

Claver-Cortés et al. (2012) examined the mediating impact of competitive strategy on the association between OS (formalization, centralization, and complexity) and organizational performance. Results indicated that formalization and complexity positively affect hybrid competitive strategy, however centralization was found to have a negative impact. The authors concluded that the OS did not have a direct impact on performance, but is mediated by the firm's strategy. Cosh et al. (2012) explored the association between OS (decentralization and formalization) and innovation, to determine whether certain OS would do better in specific environments. The authors argued that formalization accompanied by decentralized decision-making processes enabled, better performance (ability to innovate). However they noted that in certain environments (high technology industry), organic structures enabled firms to be more innovative. Marquis and Lee (2013) research on how OS impacts the role of corporate leaders, focused on two dimensions of OS (differentiation and formalization). The authors carried out a longitudinal study (1996 to 2006) and gathered data on Fortune 500 firms in the US. The authors found that the characteristics of corporate leaders and CEOs had an impact on their research outcome "corporate philanthropic contributions" and that OS constrained such an impact, but only affected board members rather than CEOs. More recently Yang et al. (2014) examined the relationship between OS (centralization) and innovation performance. The authors argued that the negative association between centralization and performance was positively moderated by more effective information flow.

**Strategy-Structure-Performance Paradigm**

As presented above, the more recent reviews indicate that researchers have now focused their attention on the association amongst OS, organization strategy, and performance. A rich stream of literature in the strategic management domain has focused on the strategy-structure-performance (SSP) paradigm. SSP predicts that an organization's strategy has been formed in relation to its external environment, and that it has an impact on an organization's structure and processes (Galunic and Eisenhardt, 1994; Mentzer, 2001; Miles and Snow, 1978).

Therefore some have argued that aligning organizational strategy to those of OS will enable higher organizational performance in comparison to those who lack such strategic fit (Bowersox et al., 1999; Cooper et al., 1997; Galbraith and Kazanjian, 1986).

Chandler (1962) was one of the first authors to describe the association between strategy and structure. The author argued that as organizations grew using product diversification (strategy), they would implement a divisional OS. Several authors empirical supported and extended Chandler's (1962) research outcome (Dyas and Thanheiser, 1976; Egelhoff, 1988; Lubatkin and Rogers, 1989; Rumelt, 1974). For instance, Rumelt (1974) research on Fortune 500 companies found that certain organizational strategies and structure arrangements were considerably better than other forms. The author suggested that organizations, which diversified, based on related businesses processes (product lines) consistently outperformed organizations that diversified into unrelated product lines or that were vertically integrated with restricted diversification choices. Therefore a number of authors in the domain of strategic management have highlighted the need for congruency between organization strategy and OS, and that a minimum fit or alignment is needed between the two for higher firm performance (Miller, 1988; Porter, 1985; Stimpert and Duhaime, 1997). For example, authors such as Clifford and Stank (2005), and Galunic and Eisenhardt (1994) have argued that internal and external contingency factors need to be taken into account in the process of developing and arranging efficient strategies. Similarly Chow et al. (1995) noted that organizations need appropriate structures matching their supply chain strategy (i.e. extending the organization boundary and across the entire supply chain). Accordingly the authors argued that the best structure-strategy was dependent on the context and situation. In another study Stock et al. (1999) created a framework of strategy (enterprise logistics) and structure in accordance to the contingent SSP theory. A number of other authors have similarly associated supply chain strategy and OS to higher level of performance in the context of supply chain environment (Bowersox et al., 1999; Rodrigues et al., 2004; Stank and Traichal, 1998). Therefore it has been argued that organization strategy-structure must be consistent amongst all supply chain partners (Chow et al., 1995). In other words strategy-structure needs to be complementary across organizations in order to support mutual and overall supply chain purpose.

Another important feature to consider in the SSP paradigm is the nature of the industry the organization competes in. Fisher (1997) classified an organization's product based on their demand pattern, into either primarily innovative or functional. Functional based products have high product life cycles, low product variety, and have predictable and stable demand. Such stability increases competition in the market and consequently lowers the profit margins. In order to overcome lower profit margins, some traditionally functional companies attempt to push themselves towards being more innovative (e.g. more advanced technologies and fashion). However, innovative products have lower life cycles (i.e. just a few months), unpredictable demand, higher product variety, and higher profit margins. As argued above an organization's external environment is what shapes its strategy, therefore it can be suggested that in more uncertain and unpredictable environments, organization strategies and structures are required, which enable a firm to be more innovative and achieve higher performance level.

Accordingly Rodrigues et al. (2004) argued that in post-industrial organizations (based on the relational strategy), firms would need to develop structures that align with their strategies, in order to improve inter-firm performance amongst supply chain members with common goals. Such cooperative view is vital to aligning the different operational processes of the parties involved, into an integrated system. For instance, an oil and gas company with a strategy focused on offering the highest quality and product variety (oil products) in the market, should align its strategy-structure with members that differentiate themselves from others (i.e. provide quality supply chain services, such as consistent and on-time delivery). Furthermore the Japanese keiretsu structure is also another example of different members in the supply chain that use strategies to attain a common goal (see Schonberger, 1982). For example, in keiretsu, suppliers of oil and gas equipment appreciate the close links with manufactures, usually transferring technology, information and personnel, which ties them to long-term contracts with important manufactures. Based on the framework introduced by fisher (1997), this study argues that from a Meso-level the oil and gas industry is highly technological and innovative based, therefore at a micro level an organization strategy is required that could enable the firm to be successfully innovative. Therefore it is important to view what type of supply chain strategy is ideal in relation to the environment, and consequently OS adopted by the firm. In simpler terms supply chain integration, as a strategy may be useful to improve performance in functional supply chains, however it is a necessary strategy for innovative supply chains.

### 3.1.2 A Critique on the Dimensions of Organization Structure

Pugh et al.'s (1968) earlier studies on OS, were critically assessed by McKelvey (1975) based on its practicality as the foundation for OS taxonomy. In this section of the research three of McKelvey's (1975) criticism towards OS dimensions are re-examined. These criticisms still apply to more recent studies (post 2000), since comparable conceptualization of the OS dimensions were utilized. In simpler terms, our current understanding of the different OS dimension has been largely influenced by the Aston studies. McKelvey (1975) argued that the initial Aston studies were incomplete because: (1) the research sample (organizations included), (2) Varying criteria and principles used in the multivariate analyses, and (3) The foundation for selecting the main six dimensions of OS dimensions. The research group at the Aston University chose the organizations using a random sample stratified by product and size (Pugh et al., 1968). However the sample was restricted to companies located in Birmingham, UK with 250 staff and above. It is suggested that such restrictions on the population under investigation in the Aston study, could have influenced the mixed (contradicting) findings in subsequent studies.

Furthermore Child (1974) noted that the configuration of the sample used by the Aston group (comprised of numerous subdivisions, contrasting to the main organization headquarter) could possibly be blamed for reducing the generalizability of the research findings. Interestingly in Child's (1972) study, the sample population did not included subdivisions (only parent organizations) and therefore the outcomes of such study were different in comparisons to the studies undertaken by the Aston group. Other studies that found similar contradictions (to original Aston studies) for example Reimann (1973) and Holdaway et al. (1975) also had differences in population sample. For example in Reimann's (1973) study the population contained independent organizations, subsidiaries and branch plants. On the other hand, Holdaway et al.'s (1975) targeted 23 educational institutes. The opposing outcomes presented in such studies provide credibility to Child's (1974) argument that; the hierarchical status of target respondents could be the reason for the mixed research findings on OS dimensions.

Following the Aston studies most researchers have inadvertently restricted the type and number of OS dimensions that could have be measured. Hence, it may be a serious theoretical worry that some fundamental OS dimensions, which were not captured in earlier research models, could remain unexplored. Further on a number of methodological deficiencies were also identified in the Aston studies. For instance Pugh et al. (1968) failed to indicate the criteria used to select the four factors they extracted. However in research carried out by Reimann (1973) the study selected and retrieved factors based on eigenvalues (eigenvalues > one) and Holdaway et al. (1975) picked a three factor solution in accordance to factor interpretability. Reviewing earlier research in the field of OS uncovers various conceptual and methodological issues that would prompt apprehensions amongst organizational researchers. By reviewing works of influential theorists and researchers in OS (e.g. Child, 1972; Dalton et al., 1980), this research suggests that the theoretical underpinnings in organizational studies are still Weberian in nature. However empirical justifications for recognizing and selecting different organizational features as dimensions of OS is still up for discussion and debate. Another issue would be how much of such mixed outcomes are disseminated by the dependence of organizational theory on research carried out at the University of Aston.

In an attempt to untangle and clarify the process of conceptualizing OS dimensions, this study builds on Roberts et al. (1978) analogy, revealing the essential issues in the conventional method of dimensionalizing OS. The authors argued that OS dimensions could be viewed as a web of tennis balls attached together using rubber bands. Each tennis ball represents a dimension of OS (e.g. formalization, centralization, and complexity/specialization). The authors argued that not much has been understood in relation to the regulations and rules controlling the interactions between the tennis balls. Also very little is understood regarding the configuration of the rubber bands. Therefore it is argued that the problem might not be the different ways OS dimensions have been conceptualized (tennis balls), but rather the way in which prior authors have brought together dimensions of OS, without appropriately acknowledging how they relate, or which category they belong to (i.e. physical aspect structural or process and structuring).

This study attempts to categorize OS dimensions by utilizing the tennis ball analogy, to observe if all the balls (dimensions) are situated in the network they belong to and if some of these balls need removing. In order to do so the term “structure” should be critically discussed. The term "structure" represents numerous concepts. In the current literature structure has been atomized into component parts, which are known as the structural dimensions. Different theorists argue upon the exact nature of such structural dimensions and if they are appropriate atomization or not. In order to overcome such confusion this research utilizes Campbell et al.'s (1974) distinction between "structural" and "structuring" characteristics of organizations. The structural elements are the organization's physical characteristics, such as size, span of control, and flat/tall hierarchy. Also known as the configuration aspect of OS, which is referred to the shape of an organization (Daft, 2006; Jablin and Krone, 1985). On the other hand "structuring" are the policies and actions that occur inside an organization, which recommend or limit the behavior of individuals. The OS dimensions under review in this research are arranged according to following table 3.2:

**Table 3. 2: Structural and Structuring Dimensions of Organization Structure**

| **Structural** | **Structuring** |
|---|---|
| Hierarchical relationship (Flat-tall/Levels of hierarchy, vertical complexity) | Formalization |
| Size | Centralization |
| Span of control | Horizontal relationship (complexity) |

An alternate understanding regarding the possible OS dimensions is embraced by other authors and theorists. Such theorists have highlighted Pugh et al.'s (1968) understanding that a variety of individual OS dimensions exist (even though Pugh only found four). Other authors have observed the range in the empirical research outcomes as an indication that the boundaries of OS dimensions have not yet been sufficiently recognized. For example, Holdaway et al. (1975) stressed that OS dimensions could differ in relation to the industrial sector. In another study James and Jones (1976) warned that prematurely closing OS domain would result in some important dimensions being excluded from the taxonomy. Reimann (1974) also provided a summary of such understanding, stressing that the conflicting outcomes from research in organizational studies illustrates, the notion that a universally acceptable form of OS dimensions is still up for debate

The above review shows that the debates on dimensions of OS have not substantially shifted, and still remain Weberian in nature. Connor (1980) argued that even though the jargon and language may differ slightly, the actual content (message) is the same. Additionally Child (1974) suggested researches generally agree that the 3 major dimensions of OS are namely centralization, complexity and formalization. Such interpretation was also supported by study carried out by Van de Ven (1976). The author suggested that a majority of studies agree that centralization, formalization and hierarchical and horizontal relationships (complexity) are amongst the main OS dimensions. The next section will provide backgrounds and features of the main OS dimension OS in literature.

### 3.1.3 Centralization: Background and Definition

Centralization refers to degree to which the locus of decision-making is located higher or lower in an organizational hierarchy, or in hand of few versus many individuals (Aiken and Hage, 1968; Claver-Cortés et al., 2012; Caruana et al., 1998; Daft, 2006; Daugherty et al., 2011; Fry and Slocum, 1984; Hall, 1996; Lee and Grover, 1999; Oldham and Hackman, 1981; Paswan et al., 1998; Pugh et al., 1968). In simpler terms Van de Ven and Ferry (1980) defined centralization as the:

> …"Locus of decision-making authority within an organization, when most decisions are made hierarchically, an organizational unit is considered to be centralized; a decentralized unit generally implies that the major source of decision making has been delegated by line managers to subordinate personnel"

Rapert and Wren (1998) argued that centralization has been the most studied dimension in the OS domain. The major feature of centralization is the determination of who has the right to make decisions (Dalton et al., 1980; Fredrickson, 1986; Paswan et al., 1998). As mentioned above the level of centralization indicates the degree to which decision-making autonomy is dispersed or concentrated (Csaszar, 2012; Daft, 2006; Germain et al., 1996; Nahm et al., 2003; Pfeffer, 1981; Thompson, 1965; Vickery et al., 1999a; Yang et al., 2014). Thus, it can be argued that participation of lower level (operational) employees in decision-making is minimized in organizations where autonomy is granted to few top-level managers (Jansen et al., 2012; Lee and Grover, 1999; Lin and Germain, 2003; Pierce and Delbecq, 1977).

In relation to this Andrews and Kacmar (2001) noted that high level of centralization specifies that decision-making occurs in upper echelons of the firm. On the other hand, decentralization indicates that decisions are more likely to be taken where the actual difficulties occur (operational). This is often at the lower levels and therefore providing more opportunity for employee input. Similarly Aiken and Hage (1966) defined "decentralization" as the extent to which individuals participate in decision-making. Others have also used different conceptualizations of decentralization, such as employee empowerment or autonomy ( e.g. Cosh et al., 2012; Huang et., 2010; Liu et al., 2006; Spreitzer et al., 1997). Therefore it is evident that some researchers have used centralization and decentralization interchangeably.

### Features of Centralization

In order to clearly explain centralization, the two aspects of such dimension should be introduced. The first aspect is the extent to which individuals are given tasks and are provided the freedom to carry them out without being interrupted by superiors. Some authors have defined such aspect as the level of hierarchal authority (Blau and Scott, 1962; Fry and Slocum, 1984). A second equally important aspect is the degree to which staff members participate in decision-making processes (Blau, 1994; Fry and Slocum, 1984; Paswan et al., 1998; Tannenbaum, 1961; Van de Ven and Walker, 1984).

Furthermore some have argued that centralized command structures are vertical in orientation. In highly centralized structures power to command/control is conferred on a small group of individuals, generally at top of the OS (e.g. Ferrel and Skinner 1988). Zey and Zey-Ferrell (1979) stressed that low centralization enables organization to distribute decision-making autonomy both laterally and vertically throughout the organization. Similarly Ferrel and Skinner (1988) argued that highly centralized organizations would have greater chance of controlling individual behavior. They proposed that authority should be located in the formal hierarchy and reporting relationships of the bureaucracy. Two features, that enabled them classify authority in their study, were: (a) staff position in the firm over focusing on individual characteristic (b) obedience of subordinates since they understand that higher ranked superiors have a legitimate right to exercise their authority.

### The Impact of Centralization on Operational Performance

Beside a small number of studies that illustrated a positive association between high centralization and organizational performance (e.g. Ettlie et al., 1984; Ruekert et al., 1985), the main body of literature in organizational theory suggests that lower centralization in OS is conducive to organizational performance at both subunit and organizational levels (Burns and

Stalker, 1961; Cosh et al., 2012; Daugherty et al., 2011; Dewar and Werbel, 1979; Floyd and Wooldridge, 1992; Foss et al., 2014; Huang et al., 2010; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Lin and Germain, 2003; Pierce and Delbecq, 1977; Rapert and Wren, 1998; Schminke et al., 2000).

At the subunit level of analysis, this research has identified that centralization has both negative (e.g. Harrison, 1974; Hirst et al., 2011; Jansen et al., 2012; Koufteros et al., 2007b; McMahon, 1976; Miller, 1967) and zero relationships with performance (e.g. McMahon and Ivancevich, 1976; McMahon and Perritt, 1971). Similarly at organizational level of analysis, negative (e.g. Beck and Betz, 1975; Claver-Cortés et al., 2012; Daugherty et al., 2011; Luke et al., 1973; Pennings, 1976; Sorensen Jr and Baum, 1975; Tannenbaum, 1961; Wong et al., 2011a) and zero (e.g. Bowers, 1964; Fiedler and Gillo, 1974; Hage and Dewar, 1973; Khandwalla, 1973; Reimann, 1975; Reimann and Negandhi, 1976) relationships have been suggested.

It has been established that low centralization encourages communication (Burns and Stalker, 1961; Csaszar, 2012; Daugherty et al., 2011; Hempel et al., 2012; Huang et al., 2010) and in turn improves individual satisfaction and motivation (Dewar and Werbel, 1979; Olson et al., 1995). Burns and Stalker (1961) argued that in lower centralized structures, streams of lateral and vertical communication are stimulated, and “expert opinion” has a greater impact on decision-making processes than “designated authority”. Therefore it is argued that staff working in such conditions would feel a greater sense of empowerment. Similarly Germain et al. (1996) suggested that in such organizations employees feel more responsible and willing to come up with innovative solutions (problem-solving). Schminke et al. (2000) additionally argued that with low centralization organizations responsiveness to market conditions is improved. A highly centralized organization therefore constrains the associations (i.e. inter and intra) amongst individuals in organizations (Gold and Arvind Malhotra, 2001; Olson et al., 1995; Willem and Buelens, 2009) and decreases the prospect of staff development (e.g. Claver-Cortés et al., 2012; Foss et al., 2014; Lin and Germain et al., 2003; Kennedy, 1983).

On the other hand, lower centralization enables more efficient internal communication (Bennett and Gabriel, 1999; Hage et al., 1971; Huang et al., 2010), and increases employee participation and creativity (Khandwalla, 1977; Koufteros et al., 2007b; Miller, 1971). Sivadas and Dwyer (2000) emphasized that higher centralization, may weaken efficiency, because it raises discernments of bureaucratic structuring. This in turn could reduce the willingness of employees to engage in teamwork and group projects. Some authors have also highlighted that lower centralization increases organizational flexibility, responsiveness, information distribution, knowledge gathering, and the organization's ability to cope with external uncertainties (e.g. Cosh et al., 2012; Jaworski and Kohli, 1993; Lin and Germain, 2003; Wilden et al., 2013). Additionally lower centralization improves organization lead-time (e.g. reducing the reporting line for decision making) (Damanpour, 1991; Germain, 1996; Moenaert et al., 1994).

Walton (1984) stressed that highly centralized organizations emphasize on management prerogatives and hierarchical authority by, assigning status symbols to enable to them to enforce hierarchy. Blauner, (1964) argued that highly centralized organizations were more likely to have higher rates of work alienation. The author noted that the feeling of autonomy is reduced, depending on the industry and line of their work (e.g. strong in textiles and automobiles industry, workers have little control over job scope). Other studies suggested that organizations characterized by a rigid hierarchy of authority have little cohesion amongst workers (Burns and Stalker, 1961; Crozier, 2009; Huang et al., 2010). This shortage of cohesion could be as a result of the high degree of alienation from fellow workers. The impact of individual alienation is greater in organizations with highly skilled employees (such as the oil and gas industry) (e.g. Claver-Cortés et al., 2012; Jansen et al., 2012; Wong et al., 2011a). Professionals normally have superior training and usually abide by codes of professional behavior. This fosters norms of autonomy and enables them to participate in decision-makings processes (Daugherty et al., 2011; Huang et al., 2010; Ji and Dimitratos, 2013). Hence if these individuals were to be denied autonomy in carrying out their duties, they would probably become dissatisfied with their task roles. Furthermore isolating such professionals may result in job alienation (less communication) and diminish overall performance (Csaszar, 2012; Hirst et al., 2011; Koufteros et al., 2007b; Wilden et al., 2013)

Based on this review, it is evident conflicting arguments and conceptualizations of centralization exist in the literature. However these discrepancies could be linked to the different aspects of centralization and how they have been measured. Centralization is most commonly measured as locus of authority, and participating in decision-making. Researchers have focused on measuring locus of authority, and participating in decision-making from strategic and operational levels. The focus of this study to examine the relationship amongst

OS, SCI, and operational performance in the oil and gas industry, therefore centralization is conceptualized from an operational perspective. The next section reviews the concepts of centralization from both strategic and operational perspectives.

**Strategic and Operational Centralization**

Baum and Wally (2003) suggested a very useful distinction between ‘front line’ decisions (operational decision-making) and those made by top-level managers (CEO) (strategic decision-making). They argued that previous studies had measured centralization as a feature of top-level management. Eisenhardt (1989) categorized autocratic CEO decision-making as high centralization, and decision procedures, involving management teams (and expert advisors) as low centralization. Hence, lower centralization of strategic decision-making, could imply greater participation of operational level (lower) staff in strategic decision making. In other words low centralization leads to the involvement of the executive team in strategic decisions. Similarly, lower centralization of operational decision-making included behaviors normally linked to self-managed teams (Huang et al., 2010; Jansen et al., 2012; Koufteros et al., 2007b). This conceptualization of centralization is consistent with Adler and Borys (1996) “enabling bureaucracy”. They argued that operational level (front-line) employees’ staff participate in operational decisions making (lower centralization), however strategic management was the purview of the executive level members (higher centralization). Several organizational theorists have acknowledged the positive outcomes of lower centralization on participation in operational decision-making processes (Adler and Borys, 1996; Hempel et al., 2012; Ji and Dimitratos, 2013; Jung and Avolio, 1999; Manz and Sims, 1990). For instance Sims (1996) proposed that lower centralization of operations level decision-makings using self-managed work teams encourages staff motivation, loyalty, and creativity. Low centralization of hiring, promotion, and control of production procedures (hierarchical level), also enhances financial performance and responsiveness to market conditions (Schminke et al., 2000).

While low centralization at operational level seems to enhance firm performance, studies have also indicated the advantages of strategic level centralization. Adler and Borys (1996) argued that staff members value strong level of strategic leadership in organization. An increase in firm performance can be witnessed when high level managers explicitly define the business strategy and determine power and communication hierarchies (Jacobides, 2007; Locke and Latham, 1990; Phan, 2000). Phan (2000) suggested that executive board members believe centralized strategic decision making by skillful and charismatic top management results in better levels of firm performance. Therefore firms that have centralized strategic decision-making could encourage quicker reaction times and fewer negotiation processes required to attain strategic level consensus (Baum and Wally 2003; Wong et al., 2011a; Yang et al., 2014).

When there is a low possibility of conflict occurring, top-level decision-makers are usually able to pass the 'attention,' 'option-generating,' and 'option-valuing' phases more swiftly than they would otherwise. Likewise, top-level managers are typically more eager to employ intuition and other fast-thinking approaches they have built based on their experience, than to justify personal thought procedures beyond executives (Baum and Wally, 2003; Isenberg, 1986; Wong et al., 2011a). Low centralization of operational decision-making provides an opportunity for strategic level management to better understand of operational and tactical issues. This is critical for prompt top-level decision-making, since lower (operational) centralization offers staff motivation and competence, which in turn enables speedy and effective execution of strategic decisions (Duhaime and Schwenk, 1985; Foss et al., 2014; Hempel et al., 2012; Wong et al., 2011a).

Since high levels of uncertainty is associated to the oil and gas industry, it is argued the operational performance of such firms are more likely to improve when operational decisions makings are decentralized (lower centralization). This is because the uncertain nature of the oil and gas industry, may require operational managers "to think on their feet" and be active in problem solving. The focus of this research is to explore the mediating role of SCI on the association between OS and operational performance, therefore this study conceptualizes centralization as the centralization of operational decision-making.

**The Role of Centralization in Uncertain Environments**

The existing literature proposes that organizations working in unreliable/uncertain environments ought to assign autonomy to contribute in decision-making processes, to lower level/operational staff (Aldrich, 2007; Alexander, 1991; Burns and Stalker, 1961; Cosh et al., 2012; Doll and Vonderembse, 1991; Germain et al., 2008; Liao et al., 2011; Lin and

Germain, 2003; Nahm et al., 2003).

This is because such operational experts are better able to cope with rapidly changing situations (have more experience) in their line of duty. It is well documented in literature that in situations where environment uncertainty is great (e.g. oil and gas), strategic decision-making authority is centralized (Paswan et al., 1998; Swamidass and Newell, 1987), but on the other hand firms should have lower centralization on operational decision-making (Daft, 2006; Ji and Dimitratos, 2013; Ruekert et al., 1985; Wong et al., 2011a). Koufteros et al. (2007b) argued that in today's business environment customers have grown to be more impatient. They expect faster response times from their suppliers (e.g. oil and gas contractors). Such could be achieved by adopting a decentralized (organic) structure to enable effective distribution and processing of information and further reduce decision-making lead-time. All of these become probable since many value-adding decisions are made locally (at operational level) (Koufteros et al., 2007b). Another consideration should be the extent of competition an organization faces from its rivals (i.e. environmental uncertainty). As a successful replication of Lawrence and Lorsch (1967) study, Negandhi and Reimann (1972) examined thirty firms in India, and proposed that competitive market situations places more significance on decentralization for organizational success in oppose to less competitive markets. Therefore many authors have argued that organic structures "decentralize" and mechanistic structures "centralize" decision-making processes (Lawrence and Lorsch, 1967; Foss et al., 2014; Huang et al., 2010; Koufteros et al., 2007b; Mollenkopf et al., 2000; Nemetz and Fry, 1988; Olson et al., 2005; Parthasarthy and Sethi, 1992; Snow and Miles, 1992; Zammuto and O'Connor, 1992).

Environmental uncertainty has long been viewed as an integral element in exploring structure-performance relationships (Cosh et al., 2012; Doll and Vonderembse, 1991; Duncan, 1972; Germain et al., 2008; Liao et al., 2011; Lin and Germain, 2003; Nahm et al., 2003). The dominant perspective is that environmental uncertainty tends to result in organic structures, which improves managerial flexibility and adaptability (Jauch and Kraft 1986; Mintzberg, 1979; Snow and Miles, 1992). Uncertain environments usually require complex administrative processes and non-repetitive responsibilities. It is argued that such environments impact the degree of *dynamism* of responsibilities in an organization, making decentralized structures more preferable since they improve managerial capability to maneuver and respond rapidly to challenges. Accordingly Duncan (1972) suggested that organizations that are more centralized (mechanic) tend to reinforce past actions of staff members. On the contrary the author argued that more decentralized structures (organic) tend to enable changes and adjustments in attitudes and beliefs. Therefore decentralized structures are able to reduce the cognitive workload on employees and enable the formation of more effective work groups/relationships (Daugherty et al., 2011; Fiol and Lyles, 1985; Galbraith, 1973; Jansen et al., 2012; Ji and Dimitratos, 2013; Wong et al., 2011a).

### 3.1.4 Formalization: Background and Definition

Formalization is an essential feature of Weber's bureaucratic ideal form and a comprehensively studied OS dimension (Mintzberg, 1979). Formalization can be defined as the level to which staff are given regulations, formal rules and processes that deny or inspire autonomous and creativity in work process (Blau, 1994; Claver-Cortés et al., 2012; Dewar and Werbel, 1979; Fry and Slocum, 1984; Germain et al., 2008; Hage, 1980; Miller et al., 1991; Oldham and Hackman, 1981; Pugh et al., 1968). In other words, formalization represents the degree to which the roles, activities of members of an organization are clearly documented, coded and reported by way of written rules and procedures (Daugherty, 2011; Ferrel and Skinner, 1988; Hall, 1996; Lin and Germain 2003; Pierce and Delbecq, 1977; Ruekert et al., 1985). Accordingly, rules and regulations are structural mechanisms, which guarantee the uniformity of business activities. Hence, formalization directs business procedure for the standard execution of job assignments (Germain et al., 1994; Liao et al., 2011; Lee and Grover, 1999; Ruekert et al., 1985). Hall (1996) argued that formalization is an organizational device for prescribing how, when, and by whom tasks are to be performed. Formalization is not an abstract concept, meaning that the extent to which an organization is formalized reflects the perception of decisions makers in relation to individual staff. Thus if individuals are able to demonstrate excellent judgment and self-control, formalization would be low; however if they are incompetent in carrying out their tasks and demand a large set of rules and procedures to monitor their behavior, formalization would be higher (Clercq et al., 2013; Hempel et al., 2012; Koufteros et al. 2007b; Olson et al., 2005; Thompson, 2011).

In the organizational theory literature standardization and formalization are closely associated to each other. Dalton et al. (1980) argued that standardization prescribes or restricts the behavior and conducts of individuals in an organization. Based on this logic, the mechanisms of formalization include job descriptions, which outline the expectations for each job classification. While job descriptions define the job expectations of individuals in each classification, they do not prescribe or restricts processes. Accordingly the role of standardization is to explicitly outline the processes for each job classifications. In simpler terms, formalization relates to what one is asked to do, on the other hand standardization relates to how carries out such tasks (Pugh et al., 1968). Another term closely associated to formalization is professionalism. If formalization is the process of organizations setting regulations and ensuring that they are followed, professionalization attempts to do the same thing with non-organizational based means. Hall (1996) noted that formalized organizations with more professionalized workforce were subject to more conflicts and alienation amongst their employees. In an earlier study, Miller (1967) argued that the length of professional training (i.e. individual with a PhD) was directly related to the degree of alienation felt in highly formalized organizations. The author concluded that professional employees bring a set of externally (professionally) derived standards, which affects their behaviors. Thus, in such context it could be argued that the presence of highly formalized guidelines is a repetition of norms, which are possibly viewed as less valid in comparison to the norms of the professionals involved.

**Features of Formalization**

Literature on formalization has produced inconsistent conceptualizations. This research argues that such inconsistency could be associated to authors focusing on different aspect of this OS dimension. However the earliest divergence can be traced back to the late 1940s. Parsons (1949), criticized Weber's classification of the two causes of authority in bureaucracies: (1) incumbency in a legally defined office and (2) the exercise of control on the basis of knowledge. It was argued that Weber’s view of bureaucracy was two-sided (Janus-faced organization), organization were administrated based on discipline and that staff followed strict supervision and rules, since order was viewed as the best approach to achieving company objective (Gouldner, 1954; Hage and Aiken, 1967a; Parsons, 1949). Consequently, two streams of studies on the functions and consequences of bureaucracy emerged. The first stream focused on the power to enforce compliance from employees, while the second stream focused on technical codification and standardization (see Adler and Borys 1996). Thus, formalization is also described as the *degree of job codification* and *the degree of rule observation*.

Blau and Scott (1962) defined formalization as the degree of work standardization and the amount of deviation that is allowed from job standards. They described bureaucratic formalization as:

“ . . . Official procedures . . . which prescribe the appropriate reactions to recurrent situations and furnish established guides for decision-making."

Similarly Nemetz and Fry (1988) noted that “standardization” was used to control variability in human behavior. They argued rules and regulations in highly standardized organizations are tools used to reduce the impact of individualism on the organization. Additionally Vickery et al. (1999a) and Germain et al. (2008) defined formalization as “formal control”. They noted that formal control is a device used to monitor systems on a written, codified, and rational basis (also see Khandwalla, 1974; Workman et al., 1998). Adler and Borys (1996) further argued that formalization can be divided into (1) formalization of routine company policies and procedures (e.g. in predictable environments) (2) formalization of non-routine policies and procedures (e.g. in uncertain /turbulent environments).

**The Impact of Formalization on Operational Performance**

The organizational literature splits formalization into high versus low. Burns and Stalker (1961) argued that low degrees of formalization were associated to organic structures, and high degrees of formalization were associated to mechanistic structures. There are conflicting arguments on the different levels of formalization and its impact on performance. Some authors argued that if a minimum level of formalization and standardization does not exist, there is a possibility that role ambiguity may occur (e.g. Cosh et al., 2012; Germain et al., 2008; Hempel et al., 2012; Hirst et al., 2011; Kahn et al., 1964; Nahm et al., 2003; Rizzo et al., 1970). For example, Thompson (2011) suggested that formalization could reduce organizational conflicts, because individual roles are clearly defined. Schwenk and Shrader's (1993) research on small sized organizations found that formalized planning improved performance. Accordingly John and Martin (1984) argued that formalization could have a positive impact on performance when it aids in the collection of valued information and conveys priorities and values. In a meta-analytic review by Damanpour (1991) high formalization was found to have a negative impact on operational performance (innovation). Nevertheless the author argued that a number of researchers have highlighted the importance of well-established rules and regulations for performance (innovation, assimilation of new employees).

The consequences of formalization can be complex. Depending on the context used to test such variable, mixed outcomes have been reported. For example, studies on health-and-welfare organizations (Hage and Dewar, 1973), manufacturing (Schuler, 1975), county administrators (Rogers and Molnar, 1976), and banks (Vredenburgh and Alutto, 1977) did not find any direct relationship between formalization and performance. However, Harrison (1974), Baum and Youngblood, (1975), Vinson and Holloway (1977), and Ferrel and Skinner (1988) reported a positive relationship between formalization and performance. Unfortunately, none of the earlier researchers utilized "hard" performance measures for formalization. For instance, different measures such as perceived role performance (Harrison, 1974), peer and supervisory ratings (Schuler, 1975; Vinson and Holloway, 1977), laboratory simulation (Baum and Youngblood, 1975), and role ambiguity (Hackman and Lawler, 1971; Hulin and Blood, 1968; Rogers and Molnar, 1976) were utilized.

Equally, another big stream of literature suggests that formalization and standardization limit the job scope of an employee causing, boredom, alienation, job dissatisfaction, absenteeism, turnover, and low output (Daugherty, 2011; Koufteros and Vonderembse, 1998; Liao et al., 2011; Vickery et al., 1999a). Fredrickson (1986) argued that highly formalized processes and policies could diminish assertiveness, resulting in a reactive problem-solving environment. On the other hand, in organizations where employees are empowered to take initiatives, a proactive problem-solving behavior is encouraged. Therefore based on these arguments, highly formalized structures have a negative impact on staff motivation, autonomy, innovation and performance (Aiken and Hage, 1971; Daugherty, 2011; Clercq et al., 2013; Damanpour, 1991; Pierce and Delbecq, 1977). This is because in such organizations members are discouraged from actively generating new ideas, when faced with non-routine processes. Some have argued that higher work supervision resulted in the drop of staff morale (e.g. Gross, 1953; Hempel et al., 2012; Liao et al., 2011; Schminke et al., 2000; Worthy, 1950). Furthermore others have suggested that formalization rigorously limits the level of individual freedom and discretion in carrying out their tasks (Forehand and Von Haller, 1964; Koufteros et al., 2007b; Hall et al., 1967; Wilden et al., 2013). Khandwalla (1977) suggested that formalization diminishes organizational performance, because it constrains flexibility, open communication, and quick competitive response. Likewise Zaltman (1979) argued that, formalized structures are less flexible, thus making it difficult to use and share knowledge across organizations.

Further literature review revealed that subject to its degree, formalization could limit or support autonomous (independent) work, flexibility, rigidity, and communication (Clercq et al., 2013; Dewar and Werbel, 1979; Dwyer et al., 1987; Liao et al., 2011; Miner, 1982), and also inhibits trust and collaboration (Moorman et al., 1993). Willem and Buelens (2009) reported that formalized structures were negatively associated to information sharing and communication within the organization. The authors suggested that formalized structures (plans, procedures, standards and goals) control how much information exchange is possible within organizations (also see Egelhoff, 1991; Galbraith, 1973; Nidumolu, 1996). Thus, it could be argued that formalization limits information flow across different consecutively layers of hierarchy (roles) in an organization (Grant, 1996).

Sivadas and Dwyer (2000) indicated that the use of explicit rules and regulations were barriers to organizational flexibility. Similarly Baum and Wally (2003) noted that formalization inhibits resource flexibility (e.g. resource allocation, and initiative taking in non-routine processes). Lin and Germain (2003) further highlighted that formalization could be viewed negative when it results to insufficient communication, and unanticipated conformity in planning and implementation (see also Mintzberg, 1979). Therefore, it can be argued that formalization weakens creativity and employee's capability to adjust to non-standardized/non-routine job environments (Daugherty et al., 2011; Hirst et al., 2011; Koufteros et al., 2007b). In such case formalization can be used as a tool to cope with external uncertainties, rather than a mechanism for enforcing rigid rules and regulations (Kelley et al., 1996; Koufteros and Vonderembse, 1998; Wilden et al., 2013).

Earlier researchers like Burns and Stalker (1961) argued that the focus should be on the degree and nature of formalization (e.g. viewing formalization in continuum, from high to low). Therefore the rigid regulations and procedures in highly formalized organizations reduce staff autonomy, innovation and timely reactions (e.g. operational problems that can happen on a daily basis). Such organizations are described as mechanistic. On the other hand organic organizations are those that have structures, which enable and motivate staff to be creative and have work autonomy (e.g. problem-solving and making timely decisions) (Blau, 1994; Burns and Stalker, 1961; Huang et al., 2010; Mintzberg, 1979; Olson et al., 2005; Koufteros and Vonderembse, 1998).

Theorists such as Herbert (1976) also noted the negative consequences of extensive formalization on the speed of strategic level decision-making. The number of hierarchical levels of reporting and approval in highly formalized organizations, tends to reduce the flow of information across different levels of the organization. Therefore, higher formalization alongside inflexible restrictions on freedom of action slows down the 'option-generating' and 'option-valuing' stages of top-level decision-making. Additionally some organizational theorists have proposed that staff participation in determining their work routines motivates them share information and collaborate more effectively (Fiske, 1992; Fredrickson and Iaquinto, 1989). Flexibility in the top-level decision-making procedure improves creativity and the opportunity for decision-makers to employ fast and intuitive thinking processes for tactical knowledge sharing (Berman et al., 2002; Fiske, 1992; Isenberg, 1986; Liao et al., 2011).

As highlighted in the previous section, this study adopts the definition of formalization proposed by Adler and Borys (1996). Formalization is conceptualized as a multifaceted construct comprising of two distinct qualities: (1) formalization of *routine* company policies and procedures (typically in predictable environments) (2) formalization of *non-routine* policies and procedures (typically in uncertain and turbulent environments). Some researchers have noted that formalization of routines increases the speed of strategic level decision-making, and preserving informal non-routine policies and procedures improves the use of fast a-rational methods (e.g. Baum and Wally, 2003; Daugherty, 2011; Fiske, 1992; Hempel et al., 2012).

Based on the literature review, this research acknowledges the conflicting arguments and research outcomes on the different levels of formalization and its impact on performance. However, such variations could be attributed to the way formalization has been conceptualized and measured in previous studies (e.g. different features, soft or hard factors, context). Most studies conceptualized formalization as a single construct without clarifying the exact feature of formalization measured (routine, non-routine). In this study the focus is on examining the mediating role of SCI on the relationship between OS and operational performance of oil and gas supply chains. Due to the high levels of uncertainty in the oil and gas industry, it is an essential capability for employees to make quick and speedy decisions. However because of the high levels of risk, companies are forced to implement rigid routine processes. So the focus of this study is to explore the impact of formalization of non-routine processes (e.g. oil rig failures and material selection).

**The Role of Formalization in Uncertain Environments**

Environmental uncertainty has long been viewed as an integral element in defining OS (Cosh et al., 2012; Duncan, 1972; Wilden et al., 2013). Uncertain and dynamic environments would usually lead to less formalize, more complex, and non-routine administrative organizational processes (Burns and Stalker, 1961). Therefore, the conventional perception is that uncertainty in an industry could increase the organicity of operating firms (Germain et al., 2008; Jauch and Kraft, 1986; Liao et al., 2011; Mintzberg, 1979; Mollenkopf et al., 2000; Snow and Miles, 1992). Accordingly it is understood that organic structures tend to be less formalized than bureaucratic ones (Bums and Stalker, 1961; Galbraith, 1973; Lawrence and Lorsch, 1967), and encourage more flexible tasks or roles, and enable better vertical and horizontal communication (Olson et al., 2005). In relation to this Meyer (1982) suggested that in formalized organizations learning amongst individuals is hindered. Thus, if firms want to inspire learning and reflective action-taking in more uncertain environments, a good strategy would be to adopt less formalized non-routine processes (Fiol and Lyles, 1985; Germain et al., 1994; Koufteros et al., 2007b; Lee and Grover, 1999; Morgan and Ramirez, 1984). In uncertain business environments the external conditions are prone to quick and successive changes, making it difficult to predict frequency and the direction of such change. However, in more predictable and stable environments, it is quite easier to forecast the future based on what has happened in the past (see Mintzberg, 1979; Tung, 1979). Uncertain environments may therefore require individuals to have more cooperation, communication, and capability to maneuver and respond rapidly to unexpected challenges.

Consequently Snow and Miles (1992) argued that, organic structures would enable firms operating in uncertain environments to respond appropriately to changes in market (competitors), improve internal, customer, and supplier, communication and cooperation, and reduce the time needed to make decisions. This is also reflected in Liao et al. (2011), who found that higher environmental uncertainty makes it more difficult for organizations to react promptly. They argued that formalization creates a certain degrees of bureaucracy (e.g. dismaying creative and autonomous work).

Such alternative outcomes of formalization on performance proposes a curvilinear association in which an optimal degree of formalization would exist by decreasing role ambiguity yet preserving a reasonable level of job scope. However this study views that a reasonable level of job scope would be very difficult to define in more uncertain environments (e.g. operational changes happening that job codification do not cover). In determining the optimal level of formalization (if any) the organizational context and environment should be considered. In other words the more uncertain the environment, the better organizations area able to perform if their structure was less formalized and vice-versa.

### 3.1.5 Hierarchical Relationship

Unlike the two structuring dimensions reviewed (centralization and formalization), hierarchical relationship forms a part of the structural elements of OS. These are the organization's physical characteristics, such as size, span of control, and flatness or tallness (hierarchical relationship). Some have also referred to it as the configurational aspect of OS, or the shape of an organization (see Jablin and Krone, 1985). Structural dimensions must be given significant attention and reviewed accordingly, since they affect the way organization-structuring processes are carried out (Campbell et al., 1974; Dalton et al.1980). Hierarchical relationship forms a part (feature) of a well-known OS dimension, referred to in literature as complexity. Organizational complexity represents the level to which different departments (functions) and subunits are defined with relation to goals, targets, job orientation, time horizon and level of work autonomy. Organization complexity has been divided into, horizontal and vertical complexity (Daft, 2006; Hage and Aiken, 1967a; Hage and Dewar, 1973; Hall, 1996; Huang et al., 2010; Koufteros et al., 2007b; Lawrence and Lorsch, 1967; Nahm et al., 2003; Walton, 1984). Accordingly Bedeian (1984) defined complexity as the number of distinct functions within an organization as characterized by hierarchical levels (vertical complexity) and functional division of labor (horizontal complexity). Thus, it is generally agreed that complexity defines the procedure by which organizational units advance vertically and horizontally (e.g. Hage and Aiken, 1967a; Hall, 1996; Lawrence and Lorsch, 1967).

### Interchangeable Terms Used

In the organizational theory, although there are slight differences in the definitions, theorists have been using complexity, specialization, and differentiation interchangeably. For example, specialization has been described as the number of different occupational titles or different functional activities, pursued within an organization (Payne and Mansfield, 1973; Pugh et al., 1968). Mintzberg (1983) defined specialization as the extent to which organizational responsibilities are divided into subtasks, and the allocation of staff to specific subtasks. Thus, specialization creates a unique organizational resource capability (e.g. knowledge) in sub units and organizations (Grant, 1996). Similarly Germain et al. (1994) described specialization as the degree to which tasks in the organization required narrowly defined skills or expertise.

Galbraith (1973) referred to complexity as interdepartmental relations and defined it as lateral information processing capability. The author argued complexity could be achieved through strategies such as direct contact, liaison roles, and integrators. However, Daft and Lengel (1986) referred to complexity as differentiation, in which every department created its own functional specialization, time horizon and targets. Likewise Pierce and Delbecq (1977) described differentiation as heterogeneity in occupational types. They argued that concentrating on the significance of constructive conflict (Lawrence and Lorsch, 1967; Thompson, 1965), lack of a distinct professional ideology (Mohr, 1971), and cross-fertilization of opinions (Aiken and Hage, 1971) are illustrative of phenomenon inherent in organizational differentiation. For the purpose of clarity, this study will refer to the vertical aspect of complexity as *hierarchical relationship* and the horizontal aspect as *Horizontal relationship*. This is done in order to capture literature on both aspects of vertical and horizontal complexity (Hage and Aiken, 1967a; Hall, 1996; Lawrence and Lorsch, 1967).

### Background and Definition

Hierarchical relationship or the number of layers in a hierarchy is the extent to which a firm has a few, or many levels of reporting hierarchies (flat vs. tall) (Burns and Stalker, 1961; Huang et al., 2010; Jacobides, 2007; Koufteros et al., 2007b; Nahm et al., 2003; Nemetz and

Fry, 1988; Walton, 1984). In other words, flatness of OS refers to the number of management levels in an organization's chain of command (Hall, 1996). It could also be referred to an individual's position in a scalar chain, that ranges from non-supervisory staff at the lower end of the scale, to CEOs at the upper end (Berger and Cummings, 1979). As mentioned earlier, this OS dimension has been given a variety of different labels in the literature. For example, it has been labeled as hierarchical level (Berger and Cummings, 1979), flat/tall (Dalton et al., 1980), vertical differentiation (Damanpour, 1991), flatness (Huang et al., 2010), number of layers in hierarchy (Jacobides, 2007; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Nahm et al., 2003; Oldham and Hackman, 1981). Regardless of the differences in terminology, researchers and theorists agree that it is important to capture hierarchical relationship (structural complexity) as a dimension of OS.

Studies carried out in relation to hierarchical relationship have used direct indicators of the depth of organizational hierarchy. For instance, in examining the hierarchical depth of an organization, Meyer (1968a) measured the "proliferation of supervisory levels". Pugh et al. (1968) on the other hand suggested that vertical dimensions could be measured by a "count of the number of job positions between the chief executive and the employees working on the output". Likewise, Hall et al. (1967) utilized the extent of layers in the deepest single division and average level for the company as a total (total number of levels in all divisions/number of divisions). Such direct indicators of hierarchical relationship assume that authority is dispersed in relation to the level in the hierarchy. Thus the higher the level in a hierarchy, the grater the authority assumed. However, it is important to note that distribution of authority is not the only reason for the levels of hierarchy in an organization. For example Hall (1996) noted the idea of the "dual leader", where an employee (highly skilled professionals) is promoted to a position of authority without a change in job description.

**The Impact of Hierarchical Relationship on Operational Performance**

A conventional (bureaucratic) command and control structure is distinguished by an extended hierarchy that is developed to monitor and control staff behavior. The commitment model on the other hand, is distinguished by a management system, which has a flat or low level hierarchical relationship, relying on mutual goals for control, coordination, and data processing, rather than rank or position (Walton, 1984). Doll and Vonderembse (1991) argued that self-directed work teams are established amongst employees in an organization based on the above commitment model. Employees are better able to collaborate and learn from each other, thus increasing organizational efficiency, flexibility, and providing end customer value. Furthermore others have argued that flatter organizations enable more efficient communication to take place between organizations and their partners (e.g. supplier and customers) (Csaszar, 2012; Huang et al., 2010; Jacobides, 2007; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Nahm et al., 2003; Tushman and Scanlan, 1981; Wong et al., 2011a). Accordingly Koufteros et al. (2007b) suggested that in order to meet customer expectations (e.g. fast deliveries of products and services), firms would find it valuable to restrict the number of layers of hierarchy. This is because flatter structures enable organizations operating in uncertain environment to overcome potential challenges such as, delayed transmission of information; alteration and corruption of transmitted information; or complete obstruction of information flow; by hierarchical layers within the organization.

In the organizational literature hierarchical relationship has also been closely associated with span of control. Vickery et al. (1999a) suggested that "higher number of layers" in an organization would consequently result in "wider spans of control". The authors concluded that decisions that need to pass through excessive hierarchical layers take a lot of time and are usually made by individuals that are not directly in the 'trenches'. Thus, decreasing the number of hierarchical levels, and empowering lower level staff to execute decisions traditionally made by hierarchies, could be carried out simultaneously. Therefore, it has been argued that hierarchical relationship affects communication, control, and coordination, amongst organizational members (e.g. Huang et al., 2010; Jacobides, 2007; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Stevenson, 1990). Sub-functions within a hierarchical relationship are differentiated from adjacent functions and the total organization according to vertical relationships (Hall, 1996). Accordingly authors have suggested that, the number of layers in the hierarchy enhances the relations and makes communication channels more complex, which could obstruct the flow of information and data (Damanpour, 1991; Huang et al., 2010; Hull and Hage, 1982; Jacobides, 2007; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Nahm et al., 2003; Tushman and Scanlan, 1981).

In earlier studies, Blau (1968) noted that organization with many levels of hierarchy usually have more precise promotion principles, emphasizing merit rather than seniority. On the other hand, Carzo and Yanouzas (1969) investigated such relationship in a laboratory format. They found that the amount of time needed to complete decisions did not vary considerably between organizations with many levels of hierarchy compared to those with low levels. However, organizations with more levels of hierarchy were shown to have fewer issues in relation to conflict resolution and coordination efforts. The authors argued that such results were contextual since they were laboratory constructs rather than organizationally derived. Ivancevich and Donnelly (1975) suggested that salespersons were more efficient in organizations with lower levels of hierarchy. More recent studies have also argued that taller hierarchical relationships decreased the quality of feedback received from supervisors and co-workers (e.g. Foss et al., 2014; Huang et al., 2010; Ji and Dimitratos, 2013; Rousseau, 1978). Some have also illustrated difference in communication behavior in relation to hierarchical level. For example MacLeod et al. (1992) suggested that more oral and informal communication took place between bank managers in hierarchical firms.

Based on the review, hierarchical relationship is a significant structural element of OS dimensions. Hierarchical relationship forms the organizational skeleton, or structural layout; therefore it is an essential dimension in the conceptualization of OS. Studies have shown that hierarchical relationship has an impact on operational performance. Although there have been varying outcomes on the relationship between hierarchical relationship and operational performance, it is generally understood that flatter OS, has a positive impact on innovation and operational performance (more efficient information sharing and faster decision-making) (e.g. Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Vickery et al., 1999a).

### 3.1.6 Other Dimensions of Organization Structure

Based on the literature review conducted in this study, three other extensively examined dimensions of OS were identified. These dimensions include, span of control, horizontal relationship and organizational size. Although the three represent significant features of OS, authors have reported a high degree of overlap between these dimensions and the dimensions conceptualized under this study (centralization, formalization, and hierarchical relationship). For example, span of control has been shown to overlap significantly with levels of hierarchy (hierarchical relationship). Furthermore in the operations management field horizontal relationships has been commonly referred to as internal or cross-functional integration (Allred et al., 2011; Flynn et al., 2010; Gimenez and Ventura, 2005; Huo, 2012; Koufteros et al., 2010; Sanders, 2007) and for the purpose of this study, this aspect of OS (as it overlaps with the internal or cross-functional integration under SCI) has not been conceptualized as an OS dimension, but rather as a SCI dimension. Additionally most of the studies in the organizational theory domain, have conceptualized organizational size as a control variable, moderator, or a mediating variable in the relationship between OS and performance. In line with previous studies, this research also conceptualizes size as a control variable. Consequently span of control, horizontal relationship, and organizational size and are not included in the conceptualization of OS under this study, however this section provides an overview of these dimensions.

**Span of Control**

In the organizational theory hierarchical relationship or levels of hierarchy is closely associated to span of control. Porter and Lawler (1965) proposed that

> … "The degree to which a structure is tall or flat is determined by the average span of control within an organization and vice versa".

In simpler terms Dalton et al. (1980) noted that an organization with a tall OS would result in a narrower span of control. Congruently, a rather flat structure (few hierarchical levels) would essentially have a wider average span of control. Therefore span of control could be defined as the number of subordinates reporting directly to a superior/supervisor (Bedeian, 1984; Dalton et al., 1980; Hage 1980; Mintzberg, 1983; Jablin and Krone, 1985). In other words, it is the way relationships are structured between superiors and subordinates in a firm. Thus, a large span of control occurs when a manager administers many subordinates; a small span of control occurs when a manager administers few subordinates (Georgiou, 2013; Meier and Bohte, 2000). For this reason, previous studies have in some cases used such dimensions interchangeably and in other cases have directly or indirectly address span of control as hierarchical relationship. Therefore it can be argued that larger spans provided better prospect for individual creativity and improved communication that have also been associated to flatter organizations (Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Worthy, 1950).

Theorists such as Meyer (1968a) found that in taller organizations where span of control is low, superiors and subordinates would have better contacts with each other compared to situations in which span of control was high. Under this study it was suggested that in situations where working conditions enable two-way exchange between subordinates and superiors, the organization would not need a wide or large span of control. Similarly Blau (1970) noted that large homogeneous staff components in tall OS affect administration process and the supervisory responsibilities, due to the narrow span of control of superiors. Accordingly, Dalton et al. (1980) and Bedeian (1984) suggested that the efficiency of work teams could differ depending on the number of staff controlled by a single supervisor (i.e. small amount of staff = narrow span, and greater number of staff = wider span of control).

Additionally Nemetz and Fry (1988) suggested that firms, which are flexible enough to respond rapidly to alterations, have better capability in processing data from different sources (see also Galbraith, 1977; Mintzberg, 1983). They defined such organizations as "adhocracies" characterizing them by different OS dimensions one of which was wider spans of control associated to flatter organizations. Meier and Bohte (2003) extended the foundational studies by Gulick (1937) and Woodward et al. (1965). Their results indicated that Gulick (1937) was correct in asserting that diversity of function, time, and space played a direct role in how span of control was structured. However, such variables had different meanings depending on hierarchical relationship. Simon (1946) in a critique of Gulick (1937), tried to find an optimal point along the continuum ranging from taller to flatter OS. Nevertheless, Hammond (1990) argued that the rationale behind Gulick (1937) study was not to find an optimal OS, but to explain the effect of the number of layers in the organization on the span of control. Based on the above review it is evident that span of control is an integral aspect of hierarchical relationship, and therefore by capturing hierarchical relationship, one can also develop a better understanding on the impact of organizational span of control (wide or narrow).

**Horizontal Relationship**

Horizontal relationship can be described as the extent to which organizational departments are functionally specialized versus high level of cross-functional integration (e.g. integrated in their job, skills, and training) (Davenport and Nohria, 2012; Doll and Vonderembse, 1991;

Gerwin and Kolodny, 1992; Koufteros et al., 2007b; Nahm et al., 2003; Vonderembse et al., 1997). In post-industrial organizations employees are more frequently grouped together in autonomous work teams, cross-functional/multifunctional teams, and task forces (Davenport and Nohria, 2012; Doll and Vonderembse, 1991; Gerwin and Kolodny, 1992; Walton, 1984). This creates multifunctional and cross-trained employees, who better understand the entire business process, and cope more effectively with external uncertainties (Koufteros et al., 2007b; Nahm et al., 2003; Vonderembse et al., 1997).

One of the main features of horizontal relationship is employee multi-functionality. Employee multi-functionality represents the level that an organization offers cross training to staff members to enable them to carry out multiple tasks (Huang et al., 2010). Thus, cross-functional relationships could be defined as the lateral communication within the organization, and indicates the degree of coordination between various work units (Galbraith, 1994; Lawrence and Lorsch, 1967; Walker and Ruekert, 1987). This concept embodies a significant feature of human resource management, which comprises the method an organization divides tasks and labor (e.g. Cua et al., 2001; Davenport and Nohria, 2012; Linderman et al., 2004; MacDuffie, 1995; Sakakibara et al., 1997). Another important feature of horizontal relationship that has been commonly discussed is co-worker cooperation, which specifies the quality of the association amongst staff, and their co-workers. A number of researchers have suggested that co-worker cooperation results in better level of firm performance (e.g. reducing role conflict, more effective cross-functional interaction) (Ferris and Kacmar, 1992; Ferris et al., 1989; Kacmar et al., 1999; Parker et al., 1995). For instance, Howes et al. (1995) argued that successful cooperation normally occurs between individuals at similar hierarchical level or job scope. The authors stressed that the success of co-worker cooperation could not be achieved without sufficient support from top management (organizational leaders).

As a result, a number of studies have associated multi-functionality and co-worker cooperation to more organic structures, in which higher levels of horizontal relationship exist (Daft, 2006; Davenport and Nohria, 2012; Gerwin and Kolodny, 1992; Huang et al., 2010). It was argued that interdepartmental relationships could be complex, ambiguous and difficult to interpret (Allen and Cohen, 1969; Csaszar, 2012; Huang et al., 2010; Lee and Grover, 1999; Parthasarthy and Sethi, 1992). For example, an individual trained as an engineer may find it quite difficult to understand the perspective of a lawyer, since a common perspective on any subject matter does not exist. Thus, it is argued that equivocality is great when the levels of horizontal relationships are high. OS should therefore allow staff members to encounter and resolve disagreements (or misunderstanding) resulting from interdepartmental interactions (see Davenport and Nohria, 2012). The opposite of horizontal relationships, is functional departmentalization (the strength of departmental or functional interdependence). Functional interdependence refers to the degree that departments/units rely on one another in order to complete their tasks (Thompson, 2011). Some units may be able to carry out a job independently while others must continuously adapt to one another. Functional interdependence can therefore raise uncertainty since actions taken by one unit can cause unexpected adjustment to other units in the organization. Van de Ven et al. (1976) suggested that regular alterations in organization process would be needed in cases that interdependence was high (more information is to be processed). Conversely when interdependence between units is low, much greater autonomy, stability and certainty would be felt.

In exploring the association between horizontal relationship and organizational performance, Corwin (1970) and Reimann (1975) did not find any significant association between the two constructs, in studies of high schools and manufacturing organizations. However a number of other researches did find a significant and positive association. For example Beck and Betz (1975) argued that inter stratum conflict is reduced by higher horizontal relationship in elementary and secondary schools. Inter stratum conflict also occurs between different functional units that have dissimilar authority over allocation of control inside a firm (Beck and Betz, 1975; Pondy, 1969). Likewise Hage and Dewar (1973), and Baldridge and Burnham (1975) reported a positive relationship amongst horizontal relationships and innovation in school and health-and-welfare organizations respectively. A higher level of horizontal relationships has also been shown to positively impact co-worker cooperation (Ferris and Kacmar, 1992; Kacmar et al., 1999) and employee multi-functionality (Huang et al., 2010). Therefore, the more cross-functional integration amongst functional units, the higher chances of a company endorsing diversity in staff skills and also adopting multi-functional approach to different organizational operations. For example, multi-functional individuals can better identify cross-functional problems and risks (that may be invisible to each department individually), and are capable of managing them more effectively. Such members are also able to communicate with other departments, since they have an expanded domain of technical vocabulary and skills (e.g. a person from finance talks and understands an individual from the law department).

A number of authors have suggested that cross-functional responsiveness enable higher communication, information/data sharing, and innovation (Adler and Kwon, 2002; Baldridge and Burnham, 1975; Grant, 1996; Gulati, 1998; Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003). For example, Adler and Kwon (2002) noted that rotating managers enables them to gain experience from different units and improves their effectiveness in dealing with subordinates (e.g. built relational associations). Nahm et al. (2003) also empirically found a strong, positive and indirect association between horizontal relationships and performance (attaining time-based manufacturing practices). In a similar study, Koufteros et al. (2007b) found that high levels of horizontal relationships increased knowledge transfer capabilities. These capabilities are fundamental in firms shifting from an industrial to a post-industrial mode of operations (e.g. using pull production strategies). Likewise Huang et al. (2010) empirically found a positive association amongst employee multi-functionality (as a part of organic structure) and Mass Customization capability.

As argued throughout this chapter uncertain environment may require staff to be more cooperative with members in other functional units (in identifying potential risks). This is because each unit individually, may not be able to fully understand the variety of the risks an organization may experience (cross-functional risks). Furthermore the lateral communication associated to organization with more horizontal relationship enable a higher degree of coordination between various work units (Galbraith, 1994; Lawrence and Lorsch, 1967; Walker and Ruekert, 1987), which is much needed in volatile industries (Huang et al., 2010; Koufteros et al. 2007b). Overall in domain of organic vs. mechanistic structures, authors have argued that organic structures with higher horizontal relationship could be distinguished by having more efficient decision-making processes. Nevertheless as argued at the beginning of this section, in SCM horizontal relationships are commonly referred to as “internal” or “cross-functional” integration (Allred et al., 2011; Flynn et al., 2010; Gimenez and Ventura, 2005; Huo, 2012; Koufteros et al., 2010; Sanders, 2007). Since the purpose of this study is to examine the impact of SCI (internal, customer and supplier) on the relationship between OS and operational performance, this research captures the horizontal relationship aspect of OS, as a dimension of SCI (internal integration).

**Organizational Size**

Organizational size sounds like a simple construct, but in reality it is one of the broadest and most contextual dimensions of OS. Arguments in the area of organizational size indicate that it is sometimes difficult to represent who is exactly inside or outside an organization (Hall, 1996). Different studies have conceptualized organizational size, either as structural component on its own (Meyer, 1972), a dimension of an organizational context (Pugh et al., 1963; Schminke et al., 2000) or a substitute for organizational complexity (Wally and Baum, 1994). In an influential study, Kimberly (1976) suggested that size could essentially be measured using four components: (1) physical capacity, (2) personnel available, (3) inputs or outputs, and (4) discretionary resources available. Physical capacity refers to a company's fixed production capacity, such as the number of assembly lines, amount of lecture halls in universities, and so on. The second component is the staff/personnel available to an organization. This component is the most frequently utilized measurement and conceptualization of size, employed in over 80 percent of studies. The main problem with this component is that the number of staff could be interpreted differently. For example, for some universities, size could be viewed as a goal. Bigger size could refer to increased budget. For other organization the goal could be to keep size as smallest possible to decrease cost. The third component of organizational size is the firm's process inputs or outputs. Inputs could refer to factors such as, the number of an organization's customers/suppliers, and sales volumes. The last component suggested was the discretionary resources available to a firm in the shape of wealth, knowledge (expertise), or net profit/assets. Other studies such as Hrebiniak and Alutto (1973) used the number of beds suggestion of organization size, while Bidwell and Kasarda (1975) used average student turnout as an indication of school size. Kimberly (1976) argued that the four components of size could be highly inter-correlated (in some cases they are), but since the conceptual distinctions between them are so huge, each should be treated individually. This research concluded that, studies measuring organizational size as a dimension of OS have been affected with conceptual and empirical challenges.

Some studies have found a significant association between organizational size and performance. However these associations have shown mixed outcomes. For example, Pondy (1969) and Williamson (1967) found that with the increase of size the control costs suffered by top-level executives and managers also increased. Pondy (1969) suggested that it was more effective to delegate some control responsibilities to operational level managers.

Additionally a meta-analysis research carried out by Damanpour (1991) reported that, where innovation was standardized in relation to size, the impact of determinants such as concentration of specialists also increased when size decreased. Germain et al. (1994) also found direct effects of organizational size on integration, performance control, specialization, and decentralization. Germain, (1996) also proved that organizational size has direct and significant association on specialization, decentralization of innovation adoption and manufacturing operations and integration. Furthermore Cropanzano et al. (1997) found that as organizations increased in size, more interests were likely to play a role in the structuring the organization, thus more subgroups would be created and organized. Daft (2006) also stated that as organization became larger they rely more heavily on hierarchical authority. In a similar approach to the Aston studies Hall et al. (1976) could not find a direct association between size and structure. By gathering data from seventy-five organizations of highly varied types, the authors argued that their findings in relation to size were comparable to those of previous research that utilized size as a major variable. They highlighted that; the association amongst size and other OS components were unpredictable. The authors noted a slight tendency for bigger firms to be more complex and formalized, but only in few cases. They implied that while size may have an impact structure, other OS dimensions played a more significant role in such association. Likewise, Argyris (1972) argued that size could be correlated with, but not cause, differentiation.

It has been reported that increase of organizational size reduces interactions between superiors and subordinates (e.g. Ettlie et al., 1984). However, some authors have empirically questioned this relationship (e.g. Green et al., 1983; Jablin and Krone, 1985; Klauss, 1982). Furthermore Indik (1963), Katzell et al. (1961) and Thomas (1959) found an inverse association amongst subunit size and performance. In contrast, Argyle et al. (1958) reported a minor tendency for bigger organizations to be more effective than smaller ones. By employing a formula of cost per patient a day, as a measure of performance, Hrebiniak and Alutto (1973) discovered a negative relationship in investigating hospital departments. They argued as the size of the departments increased so did the cost per patient a day. Schminke et al. (2000) reported a negative association between size and organizational interactional fairness. Consequently, they argued that individual members from larger organizations were more likely to relate to the power structure based on impersonal rules and policies and were less likely to have associations through interpersonal contact. Baum and Wally (2003) found a significant negative correlation between firm size and speed of decision-making. Nahm et al. (2003) also argued that the strength of the association amongst OS variables could have been moderated by firm size.

From an organization level perspective, Herbst (1957) and Revans (1958) in three different studies (two of which compared size with retail sales, and the other was based on output per coal miner) also found curvilinear associations. Other research utilizing reading and mathematics achievement scores, dropout, and college attendance rates as performance measures, reported no relationship between the size of academic institutes and student performance (Bidwell and Kasarda, 1975; Corwin, 1970). Furthermore research carried out in schools, colleges and industrial companies also hinted at no relationship between size and performance, using more soft performance criteria. Such research employed moderately soft performance measures, for example Reimann (1975) asked executives to compare their own operations performance to competitors using self-assessments, Fiedler and Gillo (1974) used college deans and presidents to rate the performances of their teachers, and Mahoney et al. (1972) utilized degree of effective operations that was undefined.

These are just a few examples from the literature to show that each approach was reasonable in their context. However comparing these different studies to each other is a difficult and complicated task, since such measurements of size are neither identical nor interchangeable. Studies show that at the subunit and operational level there is no significant indication of a direct relationship between size and performance. Since the aim of this research is to investigate the relationship between OS and operational performance of oil and gas supply chains and the mediating role of supplier chain integration in such process, size is defined in accordance to Kimberly's (1976) classification of operational size (high input/output or low input/output). Therefore, this study controls for organizational size, in order to examine its impact on the relationship amongst conceptualized dimensions of OS (centralization, formalization, and hierarchical relationship) and performance.

### 3.1.7 Summary on Organization Structure Dimensions

The chapter 3.1 on OS started with backgrounds and definitions on the research construct. After providing a background to this field of research, a systematic review was carried out in order to identify and establish the most common dimensions associated to OS. There are several different conceptualizations existing in the literature on OS and its dimensions.

Despite differences in terminologies, this research identified the most relevant dimensions of OS (formalization, centralization and hierarchical relationship) in examining the structure-performance relationship. Predominantly organizational theorists have focused on the broad OS classifications of organic vs. mechanistic.

In the seminal book by Burns and Stalker (1961) two extreme sides of OS were proposed as the organic and the mechanistic. The two polar extremes of OS present different levels of formalization, centralization, number of layers (flatness) and horizontal complexity (employee multi-functionality or cross functional teams). Mechanistic structures normally have high levels of centralized authority (control), are more formalized (task standardization) and have taller structures (higher number of hierarchical layers). In mechanic structures staff would operate based on the function or unit they belong to with less cross-functional activities taking place. The channel of communication in such OS usually follows the vertical reporting path. Mechanistic structures typically result in tight supervision from higher-level managers and members basically work in the established system with rigid regulations and procedures. On the other hand, organic structures operate based on lower levels of centralization, formalization and have fewer layers in the organizational hierarchy. In these structures multifunctional teams are used, enabled through higher degrees of horizontal integration (e.g. Aiken and Hage, 1971; Burns and Stalker, 1961). Pierce and Delbecq (1977) further added that organic structures have a great impact on innovation, through more effective information sharing. In other words, a structure is considered bureaucratic or mechanistic to the degree, which its behavior is standardized, and is adhocratic or organic when, standardization is lacking (Mintzberg, 1983; Parthasarthy and Sethi, 1992). Snow and Miles (1992) suggested that organic structures enable staff members to react faster to environmental uncertainty (e.g. alterations in supply and demand). The authors also suggested more efficient information and data sharing (e.g. lateral communications), and faster decision-making processes, are closely tied to organic structures. Therefore, the overwhelming view in the OS domain is that organic structures place less importance on formalization, have less hierarchical layers, and have lower centralized decision-making (Burns and Stalker, 1961; Droge and Calantone, 1996; Olson et al., 2005).

Another equally important classification of OS dimensions identified from the systematic literature review, is the structural and structuring classification. Roberts et al. (1978) argued that there are essential issues in the conventional method of dimensionalizing OS. They used a tennis ball analogy, to distinguish between OS dimensions (balls) and their position within the network (rubber bands holding tennis balls). The idea was to determine the position of the tennis balls in the network, and to see if some needed removing. In order to check whether the dimensions were situated appropriately to each classification, this study utilized Campbell et al.'s (1974) distinction between "structural" and "structuring" characteristics of organizations. It was argued that structural elements were the organization's physical characteristics, such as size, span of control, and flat/tall hierarchy. Also known as the configuration aspect of OS (shape of an organization). On the other hand, structuring refers to the processes and actions that occur inside an organization (e.g. centralization, formalization). Since the majority of studies have focused on the organic vs. mechanistic classification of OS, this study also focuses on the structural (hierarchical relationship) and structuring dimensions (centralization and formalization) and their effect on performance.

Finally the review of the studies on the structure-performance relationship showed that organization strategy plays a critical role (e.g. mediating) between OS and operational performance. Strategies from different fields of management have been used as such mediators (e.g. strategic management, operations management). SCI has been heralded as a competitive strategy for operations and SCM. The next section provides a systematic literature review on SCI and its impact on operational performance. This is in line with the aim and objectives of this research.

## 3.2 Supply Chain Integration: Introduction Background

A supply chain is commonly referred to as a system of organizations, individuals, processes, information (or material), and resources that are required to move a product from suppliers to customers. SCM was developed in the 1980s enabling companies to more effectively integrate their business processes (i.e. from end user to suppliers). During the past four decades it has received substantial attention from academics and practitioners. It is described as the flow of materials, goods, information, and resources within a company, as well as across organization from suppliers to manufacturers and manufactures to customers in order to increase the long-term performance of the companies and the supply chain as a whole (Mentzer et al., 2001). SCI has turned into one of the most significant features of SCM and its enablers and outcomes have been researched quite extensively (e.g. Das et al., 2006; Droge et al., 2004; Droge et al., 2012; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002; Swink et al., 2007; Vickery et al., 2003; Zhao et al., 2011).

Due to the increasing level of competition and the continuous requirement to improve innovation (i.e. new technologies and know-how) in product and processes in uncertain industries (e.g. the oil and gas), it has become important for focal firms to share capabilities and strategic resources enabled through SCI (Cousins and Menguc, 2006; Flynn et al., 2010; Koh et al., 2006; Lau et al., 2010; Thun, 2010; Zhao et al., 2008). Thus, it has been argued that competition should be viewed as both between different firms, and more importantly amongst supply chains (e.g. Alfalla-Luque et al., 2013). Furthermore, in order for companies to better manage (focus more on) their core competencies, an increase in outsourcing and fragmentation of their supply chain could be helpful. This is prominent in complex and uncertain industries such as the oil and gas, where a focal company may not be individually capable in handling the diverse products, procedures, or technologies, on its own. This may lead to the company becoming too “unfocused” and ultimately ceding market share to rivals with better focused capabilities (Stonebraker and Liao, 2006). The oil and gas industry is global; therefore the focal company’s location, the actual location of the oil and gas project, and the location of its key suppliers and customers could all differ. Thus, such companies would require a closer coordination and a better relationship with their key supply chain members’ in order to receive essential data and know-how for their operational activities (Alfalla-Luque et al., 2013; Frohlich and Westbrook, 2001; Koufteros et al., 2007a; Swink et al., 2007).

For this reason SCI has been transformed into a very useful practice because it promotes joint planning, value creation, and the development of cross-firm problem-solving processes (Cao and Zhang, 2011; Cao et al., 2015; Wong et al., 2011b; Wu et al., 2010). Hence, during the past decade different scholars have been emphasizing on the strategic significance of close integrative associations between supply chain partners (Bernon et al., 2013; Childerhouse and Towill, 2011; Fawcett and Magnan, 2002; Harland et al., 2007; Lambert and Cooper, 2000; Palomero and Chalmeta, 2014; Zhao et al., 2011). For instance, Frohlich and Westbrook (2002) argued that firms that link their suppliers and customers in decisively integrated networks could turn into the most competitive and valued companies in the industry. Majority of the authors empirically agree that SCI improves performance (e.g. Das et al., 2006; Flynn et al., 2010; Koufteros et al., 2007a; Lee et al., 2007; Petersen et al., 2005; Schoenherr and Swink, 2012; Swink et al., 2007; Zhao et al., 2013) others have however not reported such a relationships (Chen et al., 2007; Cousins and Menguc, 2006; Sezen, 2008). In some cases investigation on this issue reported a negative relationship between SCI and performance (Rosenzweig et al., 2003; Vickery et al., 2003).

Furthermore some studies focused on developing definitions and dimensions of SCI. While some authors have viewed SCI as a single construct (e.g. Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006), few researchers have examined the effects of internal, customer, and supplier integration on performance outcomes (Flynn et al., 2010; Koufteros et al., 2005; Wong et al., 2011b). Additionally a small number of studies have employed the same SCI dimensions and variables for specific region, country or industry (Alfalla-Luque et al., 2013). However it is argued that most of such empirical research overlook the role of internal integration, and emphasize supplier and customer integration. Therefore, some researchers argue that the unclear definition and understanding of the dimensions of SCI has resulted in mixed outcomes on the impact of SCI on operational performance (Das et al., 2006; Devaraj et al., 2007; Fabbe-Costes and Jahre, 2008; Germain and Iyer, 2006; Pagell, 2004). Even though SCI has been a field of both academic and managerial interest for a while (Cousins and Menguc, 2006; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002), there has been a number of recent calls from scholars for a systematic review of SCI (Alfalla-Luque et al., 2013; Flynn et al., 2010; Kim, 2013; Palomero and Chalmeta, 2014; Shub and Stonebraker, 2009; van der Vaart and van Donk, 2008). Thus it is essential to periodically review SCI taxonomy and empirical measures used in previous studies, in order to improve and provide better advice for future practitioner and researchers.

SCI still remains a fairly new and developing concept. As argued above there are numerous and sometimes different opinions on SCI (Bernon et al., 2013; Terjesen et al., 2012; van der Vaart and van Donk, 2008). Nevertheless, the prevalent perspective is that SCI involves synchronizing physical or materials flow (Childerhouse and Towill, 2011; Frohlich and Westbrook, 2001; Schoenherr and Swink, 2012), information and resource flow (Cai et al., 2010) and strategic and relational flow (Flynn et al., 2010; Jayaram et al., 2010; Zhao et al., 2011). In their research Vallet-Bellmunt and Rivera-Torres, (2013) stressed that even though each of these flows investigates a distinctive feature of integration; they are all positively associated to one another. For this reason this study argues that SCI must have robust definition that incorporates all different perceptions. Accordingly, SCI could be defined as, the level of strategic collaboration between supply chain partners for the effective management of intra- and inter- organizational processes and relationships with the aim of improving efficiency in the flow of tangible and intangible resources, for optimal productivity and maximum supply chain performance (Flynn et al., 2010; Frohlich and Westbrook, 2001; Schoenherr and Swink, 2012; Vallet-Bellmunt and Rivera-Torres, 2013).

### 3.2.1 Interchange Terms in Supply Chain Integration

Authors have commonly classified SCI into, "supply chain collaboration" and "supply chain coordination" (e.g. Carr et al., 2008; Fawcett et al., 2008; Leuschner et al., 2013; Stank et al., 2001b). Most concepts of SCI clearly distinguish the existence of flow of goods (material) or data (know-how), between the focal company and its customer/supplier (Droge et al., 2004; Fawcett and Magnan, 2002; Huang et al., 2014; Lau et al., 2010; Power, 2005; Vickery et al., 2003). Therefore, researchers have primarily categorized SCI as, internal integration (inside a company), customer integration (downstream integration), and supplier integration (upstream integration) (e.g. Danese and Romano, 2011; Flynn et al., 2010; Kim, 2006; Koufteros et al., 2005; Swink et al., 2007). Based on this categorization SCI activities are managed in two directions, backwards from the customer to the focal company, and forward from the supplier to the focal company (Cousins and Menguc, 2006). The flow of good (material) has also been referred to as logistics integration. Stock et al. (2000) defined this type of integration as:

> …. "Specific operational activities and logistics practices that synchronize the flow of goods from suppliers to customers throughout the value stream".

The authors argued that logistic integration offers organizations essential data on time and quantity of materials. On the other hand, data/information integration is defined as sharing of key data along the supply chain through information technology (IT). Real-time transmissions and processing of data (needed for supply chain decision-makings) are the main advantages of information integration (e.g. Huang et al., 2014; Villena et al., 2009; Prajogo and Olhager, 2012). Therefore as argued above logistics and information integration have also been represent in two interconnected methods of integration. Forward integration refers to the physical movement of goods from suppliers to manufactures, whereas backward integration is the coordination of IT and the flows of data from manufacturers to suppliers. The two methods of integrating are dissimilar in nature. The first necessitates a better collaboration (of production systems) amongst customers, suppliers, and co-location of plants. Thus, forward integration is closely associated to purchasing practices. However backward integration aims at leveraging data (better coordination) from counterparts to enhance internal processes and activities (e.g. Cagliano et al., 2006; Cousins and Menguc, 2006; Villena et al., 2009). Thus, it can be argued that organizations integrate their infrastructure, processes and strategies based on two distinctive dimensions, internally between functional/ units; and externally with customer/supplier. Fawcett and Magnan (2002) additionally noted that the above two distinctive dimensions of SCI have developed into the: internal/cross-functional process integration; backward integration with valued suppliers (most common type of SCI); forward integration with valued first-tier customers; complete forward and backward integration. Thus, SCI is a company strategy that enables firms to integrate their internal departments and also links firm's processes and activities to outside supply chain members. In other words, SCI examines how supply chain members integrate their inimitable capabilities to leverage expertise (or core competencies) (Allred et al., 2011; He and Lai, 2012; Zhao et al., 2011). Swink et al. (2007) noted that SCI should not be considered an outcome, but rather a process to obtain and combine strategic information and know-hows. Similarly Cao and Zhang (2011) suggested that, SCI is a process of mutual partnership in which companies, plan and carryout out supply chain operations, to achieve shared goals and common advantages. Thus, authors in the field of operation management have commonly suggested that SCI embodies the exchange mechanism of resources and know-hows in a supply chain.

Furthermore SCI could also be viewed as routine practices (strategies) that enable effective share (and exchange) of know-how/resources, within an organization and across its supply chain (Lockstrom et al., 2010; Swink et al., 2007). Lockstrom et al. (2010) suggested that such practices link firm's internal processes (combined, integrated) to its external activities. Similarly authors have argued that SCI success is related to a company's ability (and will) to effectively share their data (know-how) and resources with key supply chain partners (Flynn et al., 2010; Schoenherr and Swink, 2012; Vallet-Bellmunt and Rivera-Torres, 2013). Since the success of this strategy has been associated to firm's internal capabilities, some authors have used resource-based view in exploring its outcome and consequences (e.g. Allred et al., 2011; Cousins and Menguc, 2006; Devaraj et al., 2007). Nevertheless as argued above, an organization's internal process (capabilities) is required to be aligned with its external surrounding (e.g. suppliers and customers), highlights the need for external integration. An influential research on external integration by Frohlich and Westbrook (2001), suggested that the degree of external integration has a significant impact on operational performance. The authors used a framework of five "arcs of integration", to describe the intensity level of external integration (customer and supplier). Numerous empirical studies support the relationship between integration intensity and operational performance (e.g. Flynn et al., 2010; Danese et al., 2013; Droge et al., 2012; He et al., 2014; Koufteros et al., 2010; Zhao et al., 2013).

SCI has also been viewed as a performance-oriented effort to generate tangible or intangible values (i.e. efficient flows of products). Under this characteristic, researchers have defined SCI as the extent to which a company strategically cooperates with others, in order to obtain effective flow of data, information, and goods (Flynn et al., 2010; Zhao et al., 2011). Therefore, the level of SCI has been used illustrate the success and potential of a supply chain partnership. However, empirical studies examining the impact of SCI intensity on operational performance, have generally examined SCI as either a one-dimensional (Cao et al., 2010; Danese and Romano, 2013; Gimenez et al., 2012; Kim, 2009; Li et al., 2009; Liu et al., 2012) or multiple dimension construct (e.g. Cao et al., 2015; Schoenherr and Swink, 2012; Thun, 2010; Villena et al., 2009; Wong et al., 2013). In doing so, some studies have broken down external integration into customer and supplier (He et al., 2014; Koufteros et al., 2010; Moyano-Fuentes et al., 2012; Swink et al., 2007; Vallet-Bellmunt and Rivera-Torres, 2013) others have just used the term external integration (Bernon et al., 2013; Danese et al., 2013; Das et al., 2006; Gimenez and Ventura, 2005; Saeed et al., 2005). Based on the review it was also argued that empirical research on the effect of SCI intensity and operational performance has also overlooked the role of internal integration (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Droge et al., 2012; Frohlich and Westbrook, 2001). Furthermore, authors have reported mixed outcomes on the relationship between SCI and operational performance. These could be as a result of the limited number of studies exploring both internal and external integration under one conceptual framework (Danese and Romano, 2012; Liu et al., 2012; Moyano-Fuentes et al., 2012; Prajogo et al., 2012; Swink et al., 2007), and also the several terminologies used to conceptualize SCI dimensions. For example Narasimhan and Kim (2002) referred to it as levels, Kim (2006) described them as stages and Swink et al. (2007) called them SCI types. Likewise, the strength of integration has been referred to both as degree and intensity (Frohlich and Westbrook, 2002) or arc (Frohlich and Westbrook, 2001) of integration.

As argued previously SCI is a developing concept. There are numerous and sometimes different opinions on SCI (Bernon et al., 2013; Terjesen et al., 2012; van der Vaart and van Donk, 2008). Some authors have focused on individual dimensions of SCI (Lockstrom et al., 2010; Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006; Williams et al., 2013), while others have examined the effects of multiple dimensions of SCI on performance outcomes (Cousins and Menguc, 2006; Flynn et al., 2010; Koufteros et al., 2007a; Saeed et al., 2011). This could lead to poor application of SCI policies by organization managers and business owners (Bagchi et al., 2005; Fawcett and Magnan, 2002; Jin et al., 2013; Vallet-Bellmunt and Rivera-Torres, 2013). In order to explain some of the inconsistent on SCI outcomes, Van der Vaart and Van Donk (2008) conducted a systematic review of SCI. The authors classified SCI into three general groups of *practices, patterns* and *attitudes*. From the 46 papers reviewed, the majority of the studies examined the *practices* or the tangible SCI activities in SCs. A small number of research measured integration in terms of *patterns* in SCs, and similarly a few study explored the *attitudes* of supply chain partners in relation to SCI initiatives. Therefore each categorization would need a different form of measurement. In other words, while certain features of SCI can be measured using hard and quantifiable items, other features might need softer relational items to measure SCI (Jayaram et al., 2010; Shub and Stonebraker, 2009). For this reason, this research argues that a more vigorous conceptualization of SCI should include both softer relational drivers and hard measures of integration to enhance the quality of empirical findings. Accordingly this research will attempt to extend the review by Van der Vaart and Van Donk (2008) by providing a more up-to-date and systematic investigation on the dimensions and intensity of SCI. This is because SCI is a developing field of research that has resulted in several different conceptualizations of SCI, resulting in mixed research outcomes.

### 3.2.2 Systematic Review

By taking a systematic approach, this study attempts to methodically collect and compare findings from a number of key SCI studies ( Briner et al., 2009; Tranfield et al., 2003). As argued above, SCI is a developing concept, with numerous and sometimes different opinions on its impact on operational performance. However, a few systematic reviews if any, have been carried out in the field of SCI (e.g. Fabbe-Costes and Jahre, 2007; Leuschner et al., 2013; Van der Vaart and Van Donk, 2008). Denyer and Tranfield (2009) demonstrated that systematic reviews aim to locate, select and appraise, as much as possible, of literature relevant to particular research questions. Therefore, systematic literature reviews offers a brief and cumulative overview of research outcomes. This is done through consecutive steps to clarify the general understanding, and also relevant gaps in the literature (Pittaway et al., 2004; Tranfield et al., 2003).

As a first step, key words and databases were identified. By using the search string of “supply chain AND integration” to screen article titles, 4,145 articles were identified from the Scopus database. The following inclusion and exclusion criteria were used:

1. **Exclude journals before 2000 (include works from 2000-2014)**
   Since SCI is a developing concept, more recent research and arguments must be included (see Briner et al., 2009). Therefore this study excluded SCI research prior to 2000. This reduced the number of articles to 4,037.

2. **Only include peer-reviewed research**
   Reay et al. (2009) noted that it is essential to utilize a standard selection method in conducting systematic reviews. This study only included SCI articles, which were peer-reviewed (e.g. empirical, analytical, and conceptual). This is because peer feedbacks inspire standard reporting, and contributions are based on number of revisions. Using this inclusion criteria the number of studies reduced to 2,115.

3. **Excluding research based on fields of study**
   Integration could have different applications and meanings across other management fields. In order to focus the scope of the study, only SCI in operation management were considered. This step of exclusion reduced the number of articles to 1,298.
4. **Citation analysis**
   By exporting a citation data file from the researchers Endnote, this research conducted a bibliometric citation analyses. The remaining articles were filtered and graded using a computed h-index values from the Harzing’s publish/perish software (Harzing, 2007). H-index is a measure of productivity and impact of published work in a given field (Hirsch, 2005). This research used citation analysis to assess the journal impact. This computation helps to ensure that selection is based on the most influential work

in the field and is compared to the ranking of publish journals (Rousseau and Leuven, 2008). Thus, this research only included articles with levels of H-index that were under the high journal categories of Association of Business Schools (ABS): Operations and management and SCM, production operations. This narrowed down the number of articles to 689.

5. **Dealing with non-relevant journals**

   This study also excluded research that focused on other features of SCM not directly relevant to SCI. SCM research frequently contain “supply chain” and “integration” in the title, abstract and keywords, this is because such field often defines SCM as integration of structure and procedures that allow mutual ability improvement. By reviewing the abstracts and key sections of the articles, the number of articles reduced to 238.

The remaining 238 articles were analyzed in relation to relevancy, and evaluated based on a number of quality criteria such as theory robustness, implication for practice, methodology, generalizability, and contribution (see Pittaway et al., 2004). Therefore the articles were categorized as:

a. SCI studies that had clarity and methodological rigidity, in relation to SCI dimensions and measures. Since this research uses findings from other studies, it is important to have conceptual and methodological accuracy.

b. Clear defined measures of SCI and performance. Since this research uses findings from previous studies, it is important to understand the measures and the context. The majority of studies carried out were in areas of manufacturing/production and retail supply chains, which to some extent enabled generalizability.

c. SCI studies that examined different dimensions of SCI (supplier, customer and internal integration) in terms of intensity.

**Table 3. 3: Criteria for Selecting Studies**

| Criteria a, b, c | Number of study | Relevant to study |
|---|---|---|
| Studies meeting all three criteria | 37 | Included |
| Studies meeting at least two criteria | 58 | Included |
| Studies meeting at least one criteria | 163 | Not included |

As illustrated in table 3.3 a total 95 articles were identified as relevant studies. It is important to also present the difficulties of using the above systematic approach. By restricting the inclusion of articles based on the H-index (in accordance ABS journals), books and other journal findings may be overlooked. Nevertheless, this study has attempted to reduce such risk, by including empirical, analytical, conceptual, and systematically reviewed studies. Furthermore the papers selected in this research were reviewed on the basis of journal publication, date of publication, research methodology utilized, and also the theoretical foundation. This step was carried out in order to assess whether or not sample size or location had any implication on the review findings under this research, and therefore provides a balanced view on the research findings.

The oldest journal publications dates back to 2001. Furthermore 63 out of the 95 journals are published between 2008 and 2015, demonstrating that more recent academic opinions have been considered. From the 95 articles, 7 are case studies, 4 literature reviews, 4 systematic literature reviews, 1 Meta-analysis, 3 multi methods (survey and interviews), and the remaining 76 are survey-based studies (quantitative empirical research). By categorizing the selected studies based on methodological approach, the majority of selected studies are survey-based. This is in line with other systematic literature reviews in the area of SCI (e.g. Fabbe-Costes and Jahre, 2007; Van Der Vaart and Van Donk, 2008). It has been argued that, reviewing articles with different mixture of methodologies will provide a better understanding on the different conceptualization of SCI (Alfalla-Luque et al., 2013). Finally the breakdowns of the journal publications of the selected 95 studies were as follow:

23 studies from the *Journal of Operation Management,* 8 from the *International Journal of Physical Distribution & Logistics Management*, 11 from the *International Journal of Operations & Production Management,* 8 from the *Decision Sciences Journal,* 7 from the *International Journal of Production Research,* 1 from the *Operations Management Research,* 14 from the *Supply Chain Management: An International Journal,* 2 from *Production*

*Planning & Control*, 10 from the *International Journal of Production Economics*, 5 from the *Journal of Supply Chain Management*, 1 from the *Journal of Manufacturing Technology Management*, 2 from the *International Journal of Logistics Management,* 2 from *OMEGA*, 1 from the *Management Research Review* and 1 from the *Transportation Research Part E.*

Thematic synthesis was used to retain the categorical associations between the key arguments and the outcomes of the selected studies. This process includes identifying and aggregating major conceptions from a variety of studies, and improving the understanding of concepts beyond the content of the original study (see Thomas and Harden, 2008). The following section reports on the descriptive and conceptual (analytical) themes, as derived from the selected SCI studies. As the first step in conceptualizing SCI, this research attempts to identify the definitional discrepancies. By analyzing the descriptive themes, three key definitional discrepancies were found (Table 3.4):

- 56 articles operationalized SCI as containing internal, supplier and customer dimensions
- 28 articles operationalized SCI as a single dimension, with majority focusing on external integration
- The remaining 11 articles considered other distinct dimensions of SCI, such as information integration, cross-functional process integration, and forward/backward integration.

**Table 3. 4: Supply Chain Integration Studies Reviewed**

| | **Studies** |
|---|---|
| **Multiple dimension, Internal/External (supplier/ customer)** | Alfalla-Luque et al. (2013), Allred et al. (2011), Aryee et al. (2008), Bernon et al. (2013), Boon-itt and Wong (2011b), Cao et al., (2015) Chen et al. (2007), Childerhouse and Towill (2011), Cousins and Menguc (2006), Danese et al. (2013), Danese and Romano (2011), Das et al. (2006), Devaraj et al. (2007), Droge et al. (2004), Droge et al. (2012), Fabbe-Costes and Jahre (2007), Fawcett and Magnan (2002), Flynn et al. (2010), Gimenez and Ventura (2005), Handfield et al. (2009), He and Lai (2012), He et al. (2014), Huo (2012), Kannan and Tan, (2010), Kim (2006), Koufteros et al. (2005), Koufteros et al. (2010), Koufteros et al. (2012), Lee et al. (2007), Leuschner et al., (2013), Moyano-Fuentes et al. (2012), Narasimhan et al. (2010), Olhager and Prajogo (2012), Peng et al. (2013), Prajogo and Olhager (2012), Prajogo et al. |

| | |
|---|---|
| | (2012), Richey et al. (2009), Saeed et al. (2005), Sahin and Robinson (2005), Sanders (2007), Schoenherr and Swink (2012), Swink et al. (2007), Terjesen et al. (2012), Thun (2010), Vachon and Klassen (2006), Vachon and Klassen (2007), Vallet-Bellmunt and Rivera-Torres (2013), Van de Vaart and van Donk (2008), Vereecke and Muylle (2006),Villena et al. (2009), Wong (2013), Wong et al. (2013), Wong et al. (2011b), Zailani and Rajagopal (2005), Zhao et al. (2013), Zhao et al. (2011) |
| **One dimensional SCI** | Basnet (2013), Cao and Zhang (2011), Cao et al. (2010), Danese and Romano (2013), Danese (2013), Danese and Romano (2012), Frohlich and Westbrook (2001), Frohlich and Westbrook (2002), Gimenez et al. (2012), Harland et al. (2007), Huang et al. (2014), Kim (2009), Koufteros et al. (2007a), Lai et al. (2014), Lau et al. (2010), Li et al. (2009), Liu et al. (2012), Lockström et al. (2010), Narasimhan and Kim (2002), Pagell (2004), Palomero and Chalmeta (2014), Petersen et al. (2005), Rosenzweig et al. (2003), Sezen (2008), Shub and Stonebraker (2009), Stonebraker and Liao (2006), Vickery et al. (2003), Williams et al. (2013) |
| **Backward/forward/information integration (other)** | Bagchi et al. (2005), Cai et al. (2010), Cagliano et al., (2006), Jayaram et al. (2010), Jin et al. (2013), Koh et al. (2006), Liu et al. (2013), McCarthy-Byrne and Mentzer (2011), Power (2005), Saeed et al. (2011), Sanders (2008) |

Before categorizing the SCI dimensions, it is important to note that past researchers have used different definitions and measurement scales (Alfalla-Luque et al., 2013; Fabbe-Costes and Jahre, 2007; Kannan and Tan, 2010; Terjesen et al., 2012; van der). Vaart and van Donk (2008) argued that researchers have commonly used three types of empirical measures namely, *attitudes*, *practices* and *patterns* in examining SCI.  For example, Gimenez et al. (2012) measured the attitudes (attitude of buyer and supplier towards each other, relational aspects and trust) of companies towards integration. They did so by examining company's willingness to collaborate with supply chain partners, in order to enhance long-term operational activities. Furthermore studies have measured patterns of SCI amongst firms, or inside specific industries. Gimenez et al. (2012) described patterns, as the interaction and communication patterns amongst companies and their suppliers/customers (e.g. regular visits to the supplier's facility, frequent face-to-face communication and high, corporate-level communication on important issues). In measuring the patterns of integration Frohlich and Westbrook (2001), asked questions such as whether companies had direct computer links to each other (internet or electronic data interchange-EDI). Lastly measures have also been used to assess the SCI practices. These are the tangible activities or technologies that impact a firm's ability to effectively collaborate with suppliers/customers (e.g. integrated production planning, vendor-managed inventories and delivery synchronization) (Van der Vaart and Van Donk, 2008). For instance, "*We share our demand forecasts with our major suppliers*" (Flynn et al., 2010).

Vallet-Bellmunt and Rivera-Torres (2013) argued that each of the above measures of SCI had a different purpose. The authors suggested that measures of attitude captured strategic-level data, scales used for patterns provided tactical-level implications, and measures of practices offered operational-level data. Approximately 71% of studies identified under this research used both scales of pattern and practices to measure SCI. However, 22% of the studies used combined measures of practices and attitudes/attitudes and patterns. Lastly only 7% of the studies measured SCI using all of the three types (attitudes, patterns, and practices) (Das et al., 2006; Gimenez et al., 2012; Jin et al., 2013; Palomero and Chalmeta, 2014; Vallet-Bellmunt and Rivera-Torres, 2013; Van der Vaart and Van Donk, 2008; Williams et al., 2013).

### 3.2.3 Supplier Chain Integration Conceptualization: Internal, Supplier, and Customer Integration

SCI has been receiving substantial consideration as a vital strategy in generating flows of data and material, and leveraging core competencies (Narasimhan et al., 2010; Swink et al., 2007). Different authors have highlighted the potential benefits of SCI, facilitated through efficient internal operations and solid supply chain networks (Allred et al., 2011; Flynn et al., 2010; Huo, 2012; Koufteros et al., 2010; Olhager and Prajogo, 2012; Saeed et al., 2005; Wong et al., 2011b; Zhao et al., 2011). For instance, Narasimhan and Kim (2002) were the first to operationalize SCI as both internal and external integration. The authors provided key definitions and measurement of SCI, and extended Frohlich and Westbrook (2001) concept of SCI (only external integration). Therefore starting from this research, several authors developed their frameworks on SCI (Flynn et al., 2010; Kim, 2006; Zailani and Rajagopal, 2005). A number of authors offered empirical evidences in relation to the different impact SCI has on performance. These include activities such as, developing reactions to complex and uncertain business environments (e.g. Frohlich and Westbrook, 2002), and also pooling resources and capabilities across supply chain members (Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002; Swink et al., 2007). However, unclear definitions and understandings of SCI (Fabbe-Costes and Jahre, 2008; Pagell, 2004) and the developing conceptualizations have resulted in mixed outcomes concerning the relationship between SCI and operational performance (Das et al., 2006; Devaraj et al., 2007; Germain and Iyer, 2006). While several authors empirically agree that SCI improves operational performance (Das et al., 2006; Flynn et al., 2010; Frohlich & Westbrook, 2001; Koufteros et al., 2007a; Lee et al., 2007; Petersen et al., 2005; Swink et al., 2007), others do not report such relationship (Chen et al., 2007; Cousins and Menguc, 2006; Sezen, 2008). Additionally, in some cases investigation authors have reported a negative relationship (e.g. Narasimhan et al., 2010; Rosenzweig et al., 2003; Swink et al., 2007; Vickery et al., 2003). Although a number of studies have highlighted the importance of SCI and its advantages, through the systematic review it has been identified that inadequacies still exist (refer to Appendix B).

For example, Van der Vaart and Van Donk (2008) ignored the role of internal integration, and focused on the external factors of integration. Similarly Lee et al. (2007) also investigated external integration (customer and supplier) as the main source of innovative concepts, and disregarded the impact of the company's ability to internally integrate. The authors argued that companies must create and effectively maintain routines for sharing data and information with their customers and suppliers, if they want to be competitive. In a separate systematic review Fabbe-Costes and Jahre (2008) presented definitions and measurement items of SCI. They argued that ambiguous definitions and measures in relation to SCI resulted in inconsistent research outcomes. Alfalla-Luque et al. (2013) stated that a lack of uniformity could be seen in the measures utilized to assess SCI. They suggested a framework, which includes measurements for resource sharing and coordination, in both inter and intra organizational relationships. Although it was argued that higher level of SCI positively affects the performance of the focal firm (e.g. Liu et al., 2013; Bagchi et al., 2005; Prajogo et al., 2012; Zhao et al., 2013), the outcome of such topic was not so clear in other cases (Gimenez and Ventura, 2005; Sahin and Robinson, 2005; Swink et al., 2007). Alfalla-Luque et al. (2013) concluded that both internal and external integration should receive the same level of importance. Additionally Basnet (2013) noted that internal integration was mostly affected by the level of coordination, communication, and affective relationship between different links in the SC. The authors argued that although collaboration and communication have been widely examined in external integration, its role and affective relationship in internal integration remains unexplored.

Additionally Williams et al. (2013) proposed that, although supply chain visibility was enhanced by merging information and data with external supply chain partners, however not all data sharing was beneficial in real practice. Based on such perspective, it could be argued that the data processing abilities required to enhance SC, must be initially built through internal integration (cross-functional units). Accordingly Huo (2012) argued that examining the mediating influence of internal integration on both customer and supplier integration could be used to clarify the discrepancy in the SCI findings. Moreover, Wong et al. (2013) investigated the direct and interaction effects of internal and external integration on product innovation. The authors examined this through "*complementary integration*" which develops enough external integration to support and encourage internal integration and consequently meet the demands of new product development, and also "*balanced integration*" which achieves similar degrees of internal and external integration. The results of this study indicated that complementary integration was positively associated with product innovation, however the same relationship was insignificant for balanced integration. This further highlights the role of internal integration in achieving successful SCI, and also the impact of internal integration (e.g. cross-functional knowledge sharing) on the ability of companies to benefit from external integration. It is argued that most research has focused on external integration, and that a few have considered the impact of internal integration. Furthermore those studies, which have included internal integration in their study generally, do not break down external integration to customer and supplier integration. Therefore based on evidence from a number of reviewed studies, this research proposes that internal and customer, supplier integration is complementary and must be examined together (in separate constructs) in order to completely appreciate the impact of each dimensions of SCI on performance and provide a more robust conceptualization of SCI as a whole.

Another reason for the discrepancies in the relationship amongst SCI dimensions and operational performance is that, different methodological approaches have been adopted. For example, authors have been using mathematical simulations, case studies, and literature reviews (see Fabbe-Costes and Jahre, 2008; Pagell, 2004). Similarly different degrees of measurement, such as financial, or multiple measures, and sample sizes (e.g. from 38 to 980), have been used to examine SCI (Chen et al., 2007; Flynn et al., 2010; Handfield et al., 2009). Many recent studies have been using structural equation modeling (SEM) as their analysis technique (e.g., Cao and Zhang, 2011; Koufteros et al., 2010) whereas correlation or regression analysis has also been commonly utilized (e.g. Das et al., 2006; Olhager and Prajogo, 2012). In some studies data was obtained from multiple sources like CEOs, directors, or managers (e.g. Devaraj et al., 2007; Flynn et al., 2010; Koufteros et al., 2005; Sanders, 2008) while in others only one respondent was targeted (e.g., Danese and Romano, 2012; He and Lai, 2012). This research argues that such discrepancies amongst SCI studies have resulted in unclear and in some cases confusing association between SCI dimensions and operational performance. Therefore by reviewing articles with different mixtures of methodologies (e.g. survey, case study, and meta-analysis) this study hopes to shed some clarity (i.e. revealing qualitative and quantitative perspectives) on the mixed research findings.

Lastly, some of the existing systematic reviews were based publications between 2000 and 2007 (e.g. Fabbe-Costes and Jahre, 2008; Van der Vaart and Van Donk, 2008), and a more updated review was needed. Therefore, under this study the oldest journal article was dated back to 2001, around 63 out of the 95 journals were published between 2008 and 2015, demonstrating that more recent academic debates on SCI have been considered. Researchers have also used their own criteria in selecting journals. For example Fabbe-Costes and Jahre (2008) only considered journal ranking (which changes over years), and Van der Vaart and Van Donk (2008) did not include SCI-oriented articles (e.g. Journal of Supply Chain Management). As argued previously, in order to ensure studies under review were of the highest quality and academic standard, this research only included articles with high levels of H-index. This section provided some overlaps and limitations for existing studies, which examined the relationship between SCI dimension and operational performance. It is argued that the unclear conceptualization and understanding of the dimensions of SCI has resulted in mixed outcomes on the impact of SCI on operational performance. The focus of this research is to explore the mediating role of SCI on the association between OS and operational performance of oil and gas supply chains. Therefore in the next section, each dimension of SCI (internal, supplier and customer integration) is defined, and its relationship with operational performance reviewed.

### 3.2.4 Internal Integration and Operational Performance

Internal integration is defined as the company practices of combining and developing internal information/resources for the purpose of generating know-hows and knowledge beyond borders of single department/function, in order to support external integration activities, and ultimately achieve goal alignment and improved performance (Alfalla-Luque et al., 2013; Fabbe-Costes and Jahre, 2007; Huo, 2012; Koufteros et al., 2010; Leuschner et al., 2013; Sanders, 2007; Zailani and Rajagopal, 2005; Zhao et al., 2011, Zhao et al., 2013). In simpler terms, it is the degree a firm set its structural strategies and practices into mutual, joined, and synchronized activities, in order to meet customer demands and effectively cooperate with suppliers (Boon-itt and Wong, 2011; Zhao et al., 2011). Therefore, internal integration is the chain of activities or functions within a firm that results in goods delivered to customers. Integration of such functions involves the holistic performance of organizational processes across departmental boundaries, and thus integrating from materials management to production, sales, and distribution is vital to meet customer needs at lower cost (Basnet, 2013; Morash and Clinton, 1998). Numerous researchers have argued that internal integration encourages greater intra-firm collaboration and coordination between different functions. This is achieved mainly sharing through higher integration of data/information system sharing and cross-functional collaboration (Schoenherr and Swink, 2012; Williams et al., 2013). For example, Pagell (2004) stressed that internal integration enables better usage of each of the individual function/department's competencies. The author concluded that internal integration enables firms to better explain functional interdependencies. Thus better functional coordination and cross-functional teams, enable staff to manage disagreements and conflicts arising across individual functions (Vickery et al., 2003).

Droge et al. (2004) further argued that using organizational capabilities in isolation does not support the creation of a unified value chain. This is because individual abilities are interrelated and must be synchronized in order for firms to achieve better levels of operational performance (Flynn et al., 2010; Huo, 2012). Some authors argued that the systematic coordination between departmental functions and mutual problem-solving initiatives could also diminish the barriers caused by traditional departmentalization and functional borders (Aryee et al., 2008; Germain and Iyer, 2006; Zhao et al., 2011). In other words, internal integration breaks down traditionally departmental barriers and stimulates cooperation, which shapes the foundation for the coordination of data flow across different functional departments (Flynn et al., 2010). Therefore some have argued that not focusing on the role of internal integration, would result in various departments becoming cross-purpose and strictly functional. For example, Pagell (2004) found that in companies with lower internal integration, resources were more frequently wasted. The author concluded that such waste of resource had detrimental effect on cost and quality performance. Similarly Rosenzweig et al. (2003) suggested that internal integration enables cross-functional teams to concurrently improve product and process design. The authors argued this assist companies with decreasing their production cost and increasing production quality. By further investigating the production literature, it was also found that internal integration enables the share of knowledge throughout different departments and manufacturing plants (Narasimhan and Kim, 2002), and thus allows better coordination of production capacity, enhanced production flexibility, and better delivery performance (Droge et al., 2004).

It has also been argued that internal integration influence external integration. For example authors such as, Flynn et al. (2010) and Zhao et al. (2011) suggested that internal integration acts as the foundation to which a company can more effectively obtain, interpret and apply external information/resources. Thus, external integration could be considered an extension of internal integration across company borders (Huo, 2012). Some theorists have gone the extra mile and have suggested that internal integration is a precondition for external integration (e.g. Morash and Clinton, 1998; Narasimhan and Kim, 2002). This implies that internal integration could aid organizations in understanding the needs of their customers, work with them in mutual product design initiatives, exchange data more effectively, and ultimately strategic alliance success. Therefore without the cooperation of numerous internal departments, it would be difficult for focal companies to meet the needs of their customers, especially in more uncertain business environment (Huo, 2012; Zhao et al., 2011; Wong et al., 2011b). Furthermore internal integration also improves the ability of companies to better understand their suppliers (e.g. quality standards of raw materials and components). For example, Huo (2012) argued that internal integration could enhance information exchange, partnerships, joint planning, and product design with suppliers. Additionally in a number of studies it was found that idea/knowledge sharing and value creation using internal integration had a positive effect on the degree of external cooperation and organizational competitive performance (Allred et al., 2011; Childerhouse and Towill, 2011; Droge et al., 2004; Flynn et al., 2010; Gimenez and Ventura, 2005; Koufteros et al., 2005; Prajogo and Olhager, 2012; Wong and Boon-itt, 2011; Zhao et al., 2011). However, in other studies results were mixed (Devaraj et al., 2007; Flynn et al., 2010; Germain and Iyer, 2006).

Not all information received from the external sources is useful and in some cases they may be overlapping (Lau et al., 2010; Liu et al., 2013; Olhager and Prajogo, 2012). For example, Danese and Romano (2012) found that closer coordination with customers (downstream integration) did not significantly impact operational efficiency. Therefore, this research argues that form a strategic perspective, it is the company's responsibility to internally assess and alter the external data into an economically valuable source (e.g. utilizing data management systems and learning mechanisms). Moreover in order to design an internally integrated firm that can appropriately interact with firm external uncertainties, managers use variety of techniques, such as concurrent engineering, cross-functional teams, enterprise resource planning (Droge et al., 2004; Koufteros et al., 2005; Vickery et al., 2003). Regardless of the differences, managers typically use such techniques in order to initiate the strategic modification of individual goals, inspire knowledge and idea sharing, and to establish collaborative cultures (Flynn et al., 2010).

Based on the systematic review on the current SCI studies, two significant outcomes on the dimension of internal integration are presented. Firstly, a stream of literature indicates that knowledge sharing and values obtained using internal integration, aid companies in strengthening their collaboration with customers and suppliers. A number of authors have highlighted the importance of close cooperation between different functional units, for effectively managing relationships with the partners outside the company boundaries (e.g. Flynn et al., 2010; Schoenherr and Swink, 2012; Vickery et al., 2003; Zhao et al., 2011). For example, Vickery et al. (2003) reported a direct and significant association between SCI (including cross functional team integration) and customer service. Swink et al. (2007) also reported that internal integration (product-process technology) enhances manufacturing abilities, and consequently customer satisfaction.

Secondly, studies have also found that internal integration has either a direct or indirect effect on operational performance (Danese and Romano, 2011; Danese et al., 2013; Frohlich and Westbrook, 2001; Lau et al., 2010; Rosenzweig et al., 2003; Stank et al., 2001a; Stank et al., 2001b) and financial performance (e.g. Droge et al., 2004; Flynn et al., 2010; Frohlich and Westbrook, 2001; Kim, 2009; Koufteros et al., 2005; Narasimhan and Kim, 2002; Petersen et al., 2005; Rosenzweig et al., 2003; Swink et al., 2007). For example, Gimenez and Ventura (2005) reported that internal integration positively impacts external integration, and that external integration plays a mediating role on the association between internal integration and operational performance. Likewise Koufteros et al. (2005) investigated the inter-relationships amongst internal and external integration the context of new product development. By assessing 244 US manufacturing firms the authors found that a high degree of internal integration (e.g. concurrent workflow and early involvement) were important enablers and assisted timely trade of key data (know-hows) amongst customers and suppliers. Although in some research a direct association was not found amongst internal integration and operational performance (Koufteros et al., 2005; Gimenez and Ventura, 2005), Other researchers managed to find direct positive associations including, enhancing customer satisfaction, productivity, financial performance and development time (Allred et al., 2011; Chen et al., 2007); developing competitive capabilities and process efficiency (Rosenzweig et al., 2003; Saeed et al., 2005); improving quality, cost, delivery, and flexibility (Boon-itt and Wong, 2011; Swink et al., 2007; Wong et al., 2011b); improving responsiveness and time-based performance (Danese et al., 2013; Droge et al., 2004); enhancing logistics and service performance (Germain and Iyer, 2006; Stank et al., 2001a; Stank et al., 2001b); and improving schedule attainment and competitive performance (Zhao et al., 2013).

It is important to note some of these different findings could be as a result of viewing internal integration without the effects of external integration. Furthermore a few researchers that have included internal integration did not split external integration into supplier and customer. Furthermore the differences in sample size and industry could have also affected the outcomes. Since the objective of this research is to examine the relationship (direct and mediating) amongst OS, SCI, and operational performance, this study classifies all three OS dimensions (internal, supplier and customer) under the same conceptual framework. This is done in order to provide a more comprehensive conceptualization, and to illustrate which of the three OS dimensions has the highest significance in relation to operational performance of the uncertain oil and gas supply chains.

### 3.2.5 Supplier Integration and Operational Performance

Supplier integration refers to the practices amongst companies and their suppliers, that enables the efficient transfer of knowledge and resources, required for generating mutual benefits (Childerhouse and Towill, 2011; Danese and Romano, 2011; Danese, 2013; Das et al., 2006; Droge et al., 2012; Huo, 2012; Leuschner et al., 2013; Lockström et al., 2010; Narasimhan et al., 2010; Petersen et al., 2005; Swink et al., 2007; Vereecke and Muylle, 2006). In simpler terms, supplier integration involves closer collaboration and coordination with key suppliers in order to achieve, mutual benefits such as a reduction of inventory, and supplier lead-time (Thun, 2010). This entails long-term interactions with suppliers, enhancing the process of joint problem identification and real-time process/product solutions (Flynn et al., 2010). Some have argued that supplier integration is the most common type of SCI (Fawcett and Magnan, 2002). Therefore, as much as internal integration is vital to an organization success, in the post-industrial era organizations can no longer rely on themselves for continual development (i.e. globalized business processes). For example, Petersen et al. (2005) argued that in uncertain and turbulent business environments, companies required higher level of accuracy on real-time information, in order to leverage supplier network (resources) and improve customer satisfaction.

Furthermore successful supplier integration necessitates cooperative rather than adversarial attitude. Boon-itt and Wong (2011) suggested joint efforts in developing products, exchanging technology, mutual problem solving initiatives, and design supports, as important features cooperative attitudes. Thus, it is vital for a focal company to communicate effectively with its major suppliers, and to frequently upgrade data gathered in the intentional integration processes. This should happen since the focal company may have outdated data that do not expose new or ongoing problems in the real business environment (Das et al., 2006; Handfield et al., 2009; Narasimhan et al., 2010). As argued earlier supplier integration is obtained through data sharing, and collaborations amongst companies and their suppliers (Ragatz et al., 2002). When this occurs, there is more of a chance to facilitate regular deliveries in smaller sizes, utilize more than one source of supply, assess substitute supply sources in relation to quality and delivery instead of cost, and create long-term relationships with suppliers to enhance performance (Handfield et al., 2009). Such mutual and timely exchanging of operational and market data, enables the focal firm to better predict and respond to alterations in customer demands (Zailani and Rajagopal, 2005). A supplier cooperates with the foal company as either a seller offering equipment parts/components or as a strategic collaborator sharing expertise and know-hows (data and information) (Bernon et al., 2013). Accordingly from the point of view of the company acting as the seller, a supplier is basically included in the focal company's purchasing procedure and has the one and only obligation to produce the goods (Koufteros et al., 2010). Thus, it is essential for the focal company to pay close attention in selecting an appropriate supplier, checking delivered goods, and controlling related procedures. In a separate study Koufteros et al. (2007a) named such type of integration as the black box approach. It has also been referred to in literature as the supplier product integration. Some authors argue that the supplier is mostly considered as the main provider of the goods, and they affect the focal company in terms of process/product quality, cost, and flexibility (Kim, 2009; Koufteros et al., 2007a; Prajogo et al., 2012).

On the other hand, suppliers also play an essential role as strategic collaborators permitting focal companies to access their operational and technological resources (Alfalla-Luque et al., 2013; Droge et al., 2004; Narasimhan et al., 2010). Because suppliers tend to collaborate with the focal company in different processes, authors have also term it as supplier process integration. However, Koufteros et al. (2007a) termed such type of integration as the gray-box approach. They argued that the supplier integration generates communication, leverages supplier competencies, and accomplish shared goals. Accordingly Droge et al. (2004) noted that by utilizing the critical technological ability and competency of suppliers, the focal company could then diminish any alteration in design, avoid delays, and give itself a good chance of carrying out parallel processing. The authors further suggested that qualified and competitive supplier are more beneficial to focal companies since they tend to have technical capabilities, innovative capacity, and a dynamic business network, which they have established through supplier development programs (e.g. certification program, site visit by buying firm, feedback loop in relation to performance evaluation). The view of suppliers acting as strategic collaborators has also been reflected in Petersen et al. (2005), where the authors suggested that suppliers could also support the focal company in a number of product development steps, such as generating ideas, initial technological appraisal, developing concepts and carrying out tests.

Based on the transaction cost perspective, supplier integration is capable of decreasing transactional costs (Flynn et al., 2010; Zhao et al., 2008; Zhao et al., 2011). The shared vision and cooperative goals achieved through supplier integration reduces opportunistic behavior. Additionally supplier integration helps decrease uncertainties, which in itself reduces costs. For example, Das et al. (2006) argued that reduction in environment uncertainties were hugely successful by investing in definite assets (e.g. information systems and committed staff), which enable data sharing and mutual processes. It has been suggested that supplier integration facilitates the reduction of production and operational costs. Some have argued that the increased level of supplier integration is typically associated with smaller number of suppliers. This enables suppliers to achieve economies of scale and consequently a reduction in material and product costs (Cao and Zhang, 2011; Wong et al., 2011b; Zhao et al., 2013). Furthermore Zhao et al. (2013) suggested that by creating trust and collaboration with suppliers, the focal company would be motivated to invest more in fixed assets and R&D processes to enhance the suppliers and their own product and process quality and reduce cost. The authors concluded that supplier integration (sharing data) enables companies to decrease their inventory and increase delivery speed, quality, and customer service.

A closer investigation on the current empirical studies specified two significant outcomes. Firstly, most studies agree that higher supplier integration (more cooperation) improves operational performance. For instance Frohlich and Westbrook (2001) found that higher degrees of supplier integration was positively associated with operational performance (e.g. Marketplace, productivity, and non-productivity). In another study, Frohlich and Westbrook (2002) reported that greater level of SCI improved delivery time, transaction costs, and inventory turnover. Similarly Saeed et al. (2005) argued that more effective external integration (information exchange) improved process and sourcing efficiency. The authors reported that the degree of shared data with supplier was a significant determinant of operational performance. Cousins and Menguc (2006) also suggested that higher degrees of supplier integration had a significant positive impact on supplier communication performance. Koufteros et al. (2007a) reported a significant and direct relationship between gray-box supplier integration and product innovation. In another empirical study Handfield et al. (2009) argued that more effective supplier integration improves sourcing enterprise performance. Wong et al. (2011b) also found a significant association between supplier integration and operational performance (e.g. delivery and flexibility). More recently studies have shown that higher supplier integration improves delivery performance (Droge et al., 2012). For example, Prajogo et al. (2012) found a positive relationship amongst strategic long-term supplier integration and delivery, flexibility and, cost performance. Furthermore studies have also found that more effective supplier integration improves buyer performance (e.g. efficiency and flexibility) (Danese, 2013) schedule attainment (Zhao et al., 2013) and new product performance (manufacturing flexibility) (He et al., 2014).

Secondly, it is suggested to take a contingency view, when examining supplier integration and its impact on operational performance. It is argued that contextual elements could play a major role in the implementation of supplier integration (i.e. suitability of strategy to environment). Factors such as the degree of environment uncertainty, the size of the company and the extent of collaboration may all affect the benefits of effectively integrating with suppliers (e.g. Flynn et al., 2010; Stonebraker and Afifi, 2004). For example, Koufteros et al. (2007a) suggested that the positive association between supplier integration and product innovation differed in relation to the size of the company. The authors argued that as organization became bigger in size, supplier integration led to higher degrees of innovation. It was suggested that this could be as a result of smaller sized companies having lower resources and expertise. Furthermore strategic targets or operational goals may also have a role in the decision of organizations including their suppliers. This implies that, a supplier with high levels of unique technology may need to collaborate with the focal company in earlier stages of developing a product (e.g. suppliers in the oil and gas industry). Other suppliers with standardized technology could therefore aid the focal company in decreasing costs and enhancing quality in different development stages.

Additionally supplier integration also involves organizational routines, which are created amongst companies. Some argue that such associations are unique set of competencies, which are built upon tacit, heterogeneous, and context-specific knowledge (Schoenherr and Swink, 2012). For example, Swink et al. (2007) argued that greater levels of supplier integration is often reflected by mutual commitments, dedicated associations, and co-developed systems (e.g. company competences, knowledge assets, and other features of SCI). Furthermore such integration practices can create mixtures of unique skills, knowledge, and mutual abilities. It was argued that better supplier integration is likely to produce product quality improvements. This idea generation and assessment conducted mutually with suppliers could result in superior product design and launch quality (He et al., 2014). Therefore supplier integration assists delivery and flexibility performance, by providing more accurate and up-to-date demand and supply information, more detailed production plans and forecasts, and clearer future trends and directions (e.g. Lee et al., 2007). Through such efforts, supply chain members better understand and predict each other's requirements, decrease uncertainties (Swink et al., 2007) and enable higher performance abilities inherent in quality, delivery, flexibility, and cost (Schoenherr and Swink, 2012). It is important to note some of the above mixed findings could be as a result of viewing supplier without the effects of customer integration, or customer and internal integration combined. The differences in sample size and industry could have also affected the outcomes. By viewing all the three important SCI dimensions in one research framework, this study hopes to remove some of the ambiguity in the relationship between supplier integration and operational performance.

### 3.2.6 Customer Integration and Operational Performance

Customer integration could be defined as the organizational practices of identifying, understanding, and utilizing customer requirements with the objective of producing customer-defined goods/products and increasing customer satisfaction (Boon-itt and Wong, 2011; Childerhouse and Towill, 2011; Droge et al., 2012; Flynn et al., 2010; Huo, 2012; Kannan and Tan, 2010; Lai et al., 2014; Lau et al., 2010; Schoenherr and Swink, 2012; Wong et al., 2011b). In other words, it is the mutual participation of customers with the focal company, strategically distributing data, information and know-how's about their demands and performance levels (e.g. such as quality, delivery time, and cost) (Devaraj et al., 2007; Fabbe-Costes and Jahre, 2007; Koufteros et al., 2010; Zhao et al., 2011). Customer integration is therefore an important feature in better understanding the requirements of key customers, and the logical counterpart of supplier integration (Thun, 2010). It does so by enabling focal company to penetrate deep into the customer firm, in order to understand the customer's product, culture, market, and organization, in order to efficiently react to customer needs (Boon-itt and Wong, 2011). Authors such as Frohlich and Westbrook (2001), Kim (2006), Rosenzweig et al. (2003), and Vickery et al. (2003) have also conceptualized customer integration as a part of the external (vertical) connection of the firm.

By taking a marketing perspective customers could be viewed as decision-makers who attain potential purchasing power and assess the features of the products (Boon-itt and Wong, 2011). Customer integration hugely depends on sharing data, know-hows and information between the focal company and the customer (He et al., 2014). Therefore the lack of information sharing from both ends of the supply chain could result in tremendous inefficiencies in relation to customer service (Lee et al., 2007). Customers typically provide their insight and judgment on a product through surveys or in person (to selling company), however the focal company offers operational data to customers, such as schedules of their production, level of inventory, and sales forecast (Danese and Romano, 2013; Lau et al., 2010; Moyano-Fuentes et al., 2012). Accordingly customer-driven companies are in more regular contacts with their customers, in order to inspire customers to get involved in the product development stages and also to create feedback tools (Koufteros et al., 2010; Swink et al., 2007; Zhao et al., 2011). Such companies typically embrace a variety of information technology tools to exchange data with their customers. Subsequently, these customer-driven companies will be capable of implementing collaborative initiatives such as automatic replenishment programs including vendor managed inventory, efficient consumer response, quick response used to capture the exact customer demand, and comprehend the changes in customer needs (see Daugherty et al., 1999).

Additionally in a study carried out by Flynn et al. (2010) it was suggested that communicating with customers largely depended on the company's technological ability and infrastructure. They also gave examples such as points of sales (POS) system, inventory management system, and customer ordering system. By using such systems the focal company can take advantage of the increased accuracy in their demand forecast and also increase their speed in identifying demand variations (Droge et al., 2012; Flynn et al., 2010; Huo, 2012; Vickery et al., 2003). This can also increase the supplier's order quantity decisions in multi-stage serial systems, since information about customer's inventory levels decreases the demand uncertainty faced by the supplier (Danese and Romano, 2012). Therefore companies that have demand-oriented activities are also enabled to reduce business environment uncertainty, avoid costly errors, and possible delays (Danese and Romano, 2012; Koufteros et al., 2005). Different authors have suggested that data and information sharing is an important aspect of coordination in SCI which affects performance. For example, Sahin and Robinson (2005) suggested that integration at various layers in the supply chain, contributes to performance by improving data and information exchange, and fostering coordination amongst supplier and customer (e.g. joint improvement efforts, close contact and partnership). Accordingly, Swink et al. (2007) argued that SCI involves more efficient information sharing in aligning operational activities (e.g. ordering and payment systems, production planning) amongst supplier-customer, and an enhanced co-ordination of strategic activities (e.g. relationship building, joint improvement activities) that enable customer-supplier intimacy. As reported in studies (e.g. Frohlich and Westbrook 2001), coordination enables an attitude of problem sharing, collaboration, open communication, and inter-company decision making practices, which assure more effective problem solving methods are attained (Danese and Romano, 2012).

A closer investigation of the current empirical studies on customer integration and operational performance indicates mixed outcomes. In particular, authors have retained that customer integration has a complex nature, and more studies are needed to examine its impact on operational performance. Some authors have reported that integrating closely with customers improves product innovation and performance (e.g. productivity and marketplace) (Droge et al., 2004; Frohlich and Westbrook, 2001; Koufteros et al., 2005). Furthermore authors have argued that customer integration enables companies to better understand customer requirements, decrease uncertainties (Swink et al., 2007) and achieve higher performance abilities (e.g. quality, delivery, flexibility, and cost) (Schoenherr and Swink, 2012). For example Droge et al. (2004) reported that customer integration directly increases time-to- market, time-to-product, and responsiveness. Koufteros et al. (2005) also argued that higher levels of customer integration, improves quality and innovation performance. Additionally Zhao et al. (2013) suggested that customer integration positively impacts schedule attainment, competitive performance, and customer satisfaction. Similarly He et al. (2014) found customer integration positively affected new product performance.

On the other hand, some have argued that paying too much attention to customer requirements could have a negative impact on operational performance (Devaraj et al., 2007; Flynn et al., 2010; Koufteros et al., 2010; Swink et al., 2007). In a research carried out by Swink et al. (2007), the authors reported that strategically integrating with customers had a positive impact on customer satisfaction, and a negative effect on market performance. The authors concluded that paying too much attention to customer requirements could lead to a decline in market share and profit. Sezen (2008) reported that integrating with customers did not have a significant impact on operational performance (e.g. flexibility, efficiency, customer satisfaction or profit.

Some have argued that that customer integration could lead to higher operational costs and affect overall firm performance (e.g. Cousins and Menguc, 2006; Das et al., 2006 Devaraj et al., 2007). For example, Flynn et al. (2010) found higher customer integration was not positively related with business performance; however they did report a direct and positive relationship between customer integration and operational performance. The authors concluded the relationship operational performance mediated the relationship between customer integration and business performance. Likewise Koufteros et al. (2010) reported that customer integration did not impact product development (e.g. capability to diminish glitches and to swiftly alter the engineering processes). Lau et al. (2010) suggested that customers could hinder the focal company’s ability to innovative. The authors argued that in some cases customers would request their suppliers to continue using the same processes and manufacture familiar product. It is important to note some of the mixed findings could be as a result of viewing customer integration without the effects of supplier integration, or supplier and internal integration combined. The differences in sample size and industry could have also affected the outcomes. By viewing all the three important SCI dimensions (internal, customer, supplier) in one research framework, this study hopes to remove some of the ambiguity in the relationship between customer integration and operational performance. This is done in order to provide a more comprehensive conceptualization, and to illustrate which of the three OS dimensions has the highest significance in relation to operational performance of the uncertain oil and gas supply chains.

### 3.2.7 Summary on Supply Chain Integration Dimensions

The chapter 3.2 on SCI started with backgrounds and definitions on the research construct. Accordingly, a systematic review was carried out in order to identify and establish the most common dimensions associated to SCI. It was argued that most concepts of SCI clearly distinguish the existence of either flow of goods or equally significant flow of data. Therefore researchers had primarily categorized SCI as, internal integration inside a company, down-stream integration with customers, and upstream integration with suppliers. Nevertheless, the majority of existing research on SCI was characterized by developing explanations and dimensions (Flynn et al., 2010). While some authors focused on individual dimensions of SCI (i.e. Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006) few authors had examined the effects of both internal and external (customer and supplier) integration on operational performance outcomes (Flynn et al., 2010; Koufteros et al., 2005; Wong et al., 2011b). Additionally a small number of studies have employed the same SCI dimensions and variables for a specific region, country or industry.

Based on the review it was argued that developing conceptualizations resulted in unreliable outcomes, on the relationship between SCI dimensions and operational performance. Therefore this study conceptualized SCI as a multiple construct consisting of internal, customer and supplier integration and reviewed literature on how each individually affect operational performance. Although some studies reported mixed findings on the relationship between the dimensions of SCI and operational performance, majority of authors reported positive associations. The next chapter presents a systematic literature review on operational performance. This is in line with the aim and objective of the research.

### 3.3 Operational Performance: Introduction and Background

Market globalization, increasing competition amongst different companies, and cumulative emphasis on customer orientation, are frequently regarded as the catalyst surging interest in SCM (Beamon, 1999; Gunasekaran et al., 2001). During early 1990s, outsourcing in a number of industries in the United States, added up to approximately 60 per cent of total product cost (Ballou, 1999). Such an example highlights the importance of inter-firm associations. Therefore, company performance can no longer be singularly associated to the focal firm's activities, and should be viewed in accordance to the performance of the supply chain (SC). Such developments clearly illustrate the importance of SCM (i.e. purchasing, logistics), more evidently in uncertain and complex industries (e.g. the oil and gas industry).

Although measurements related to organizational performance continue to be exhaustively used in research (e.g. quantitative and qualitative), it may not provide a holistic view of performance in more uncertain and inter-dependent industries, such as the oil and gas (i.e. goals of companies typically overlap one another). In such SCs, with numerous suppliers, manufactures, distributors and retailers, distributed regionally or globally, using operational performance measurements that only characterize performance outcomes related to a single firm will not provide a clear illustration of performance (Bhagwat and Sharma, 2007; Gunasekaran et al., 2004; Shepherd and Gunter, 2011). Authors have argued that SC issues such as lack of standardized data, poor technological integration, cultural and regional differences, different organizational policies, poor standardized performance metric, and numerous tiers within the SC, are amongst important factors that make it difficult to measure or even understand inter-firm performance (Bhagwat and Sharma, 2007; Gunasekaran et al., 2005; Hervani et al., 2005).

When measuring SC performance, unlike intra-firm performance that typically focuses on financial measures (e.g. cost, return on investment, profitability, and revenue), non-financial measures such as, process quality and flexibility should also be taken into consideration. Some have argued that problems in generating measurement standards for SC performance are traced to the numerous measurement taxonomies such as: level of measurement (e.g. strategic, tactical, or operational); tangible and intangible measures; differences in gathering and reporting; and the location of the firm within the SC (e.g. marketing vs. operations) (Gunasekaran et al., 2004). Therefore a number of studies have attempted to examine the universal principles of performance measurement system (PMS) (Adams, 1999; Beamon, 1999; Gunasekaran et al., 2001; Kocaoğlu et al., 2013; Sink and Tuttle, 1990), and have reported the following:

- PMSs could have tangible or intangible measures - balance of the two in a single study is most preferable
- Measures should be targeted at multiple levels (strategic, tactical, or operational)
- A more balanced approach between quantitative and qualitative approaches to measuring performance.
- When evaluating SC performance, qualitative assessments such as “above” or “below average”, “good” or “excellent”, and “poor” are ambiguous, and are challenging to use in a meaningful. Therefore researchers in the operations management have often preferred quantitative performance (easier to understand) ( Chen et al., 2007; Kim, 2009; Sanders, 2007; Prajogo et al., 2012). In other words researchers typically prefer numerical performance measures, since the information is readily available and ease to interpret. Nevertheless numerical performance measure may not be able to sufficiently describe the SC performance, and could consequently be as ambiguous and challenging to apply as the qualitative evaluation. As mentioned above the problems of creating suitable performance measures are more than just contextual issues and could also be associated to scope, such as such as deciding on whether the PMS should involve a single or a number of companies (Beamon, 1998; Gunasekaran et al., 2004). Additionally factors related to the complexity of SCs (e.g. number of echelons in the chain), make selecting the suitable performance measures even more problematic (Neely et al., 1995). A number of conceptual frameworks and discussions exist on different SC performance measurements. By reviewing such discipline, this research will adapt and develop a framework that is able to measure oil and gas supply chains.

### 3.3.1 Performance Measures in Supply Chain Management

Performance measurement could be described as the procedure of quantifying the effectiveness and efficiency of an action (Neely et al., 1995). Accordingly effectiveness is the levels to which customer’s needs are met, whereby efficiency relates to how economically a company’s resources are utilized (i.e. offering a pre-specified degree of customer satisfaction) (Beamon and Chen, 2001; Gunasekaran et al., 2004). Therefore performance measurement system (PMS) could be defined as the complete set of metric utilized to quantify the efficiency and effectiveness of actions. Additionally Chan and Qi (2003) argued that performance measurement also described the feedback on processes in relation to meeting customer demand, and the strategic objectives of the company. Different types of measures have been utilized to describe performance systems (i.e. such as production, distribution, and inventory systems), making the selection of performance measures a difficult task.

Traditional approaches have focused on established and quantitative financial measures, such as the return on investment (ROI), net present value (NPV), the internal rate of return (IRR), and the payback period. These approaches are best suitable to evaluate simple and basic SCM applications. Nevertheless, this research argues that assessment approaches that depend solely on financial measures may not be able to provide a comprehensive assessment of the more complex SCM applications (e.g. such as the ones in the oil and gas industry) (Kocaoğlu et al., 2013). Accordingly Neely et al. (1995) reported that prior researchers have used numerous methods of performance measurement, for example: the balanced scorecard (Kaplan and Norton, 1995), the performance measurement matrix (Keegan et al., 1989); performance measurement questionnaires (Dixon, 1990), and criteria for measurement system design (Globerson, 1985). Furthermore, the authors also underlined the some of the limitations of the existing PMSs. For example, they argued that such systems did not encourage long-term performance optimization, and also lacked strategic focus.

Although substantial research has been carried out in relation to performance measurement and individual firm operations, some have argued more focus is needed on SC performance measurement, in both practices and research (Bhagwat and Sharma, 2007; Gunasekaran et al., 2004; Shepherd and Gunter, 2011). SC performance measurements, have usually focused on attention on financial (e.g. cost) (Cohen and Lee, 1989; Lee and Feitzinger, 1995) and a combination of financial and non-finical measures (Altiok and Ranjan, 1995; Arntzen et al., 1995; Beamon, 1998; Davis, 1993; Lee and Billington, 1993). Additionally some of the existing literature also offers insights into the wider SC performance measurement, such as supplier performance evaluation, and research on suitable performance measures (Carr and Smeltzer, 1997; Davis, 1993; Nicoll, 1994). Most of these studies have focused on developing and evaluating supplier performance measurements. For example Beamon and Chen (2001) suggested that inventory system stock-out risk, the probability distribution of demand and transportation time, were amongst the most significant factors in establishing the efficiency of the SC. In a systematic review Gunasekaran et al. (2001) offered a summary of performance metric within SCs. Using an integrative framework, the authors viewed the different functions inside a firm's SC, and offered a metric related to managing the SC (e.g. plan, source, make, and delivery). In another study Gunasekaran et al. (2004) argued that for effective implementation of performance metric, organization-wide coordination was needed. Thus, in monitoring performance every single metric must take a SC perspective, and each unit in the supply chain must be measured and enhanced in accordance to the common goals. It has been suggested that non-financial metric are gaining more consideration than the financial ones and that additional effort is needed to create and design new qualitative measures (e.g. Bhagwat and Sharma, 2007; Gunasekaran et al., 2004; Shepherd and Gunter, 2011).

Therefore it is argued that a systematic approach to organizing and collecting measures for assessing SC performance is needed. Further on as presented above, debates exist over the most applicable method to classify such measures. Some have classified them as, qualitative or quantitative measures (e.g. Beamon, 1999; Chan, 2003); others focused on strategic, operational or tactical (e.g. Gunasekaran et al., 2001); and a few have classified the measures based on SC process (Chan and Qi, 2003; Huang et al., 2004; Li et al., 2005). Furthermore authors have used performance indicators such as cost and non-cost (De Toni and Tonchia, 2001; Gunasekaran, 2001); quality, cost, delivery, and flexibility (Schönsleben, 2003); cost, quality, resource utilization, flexibility, visibility, trust, and innovativeness (Chan, 2003); resources, outputs, and flexibility (Beamon, 1999); supply chain collaboration efficiency, coordination efficiency, and configuration (Hieber, 2002); and, input, output and composite measures (Chan and Qi, 2003). As presented above performance indicators have been used differently by a number of authors. For example, Chan and Qi (2003) used inputs, outputs and composite measures. This is very different to what Schönsleben (2004) used to measure SC performance (i.e. in terms of quality, cost, delivery and flexibility). Likewise, advocates of the supply chain operations reference (SCOR) (Huang et al., 2004; Li et al., 2005; Lockamy and McCormack, 2004; Stephens, 2001) reported that SC performance should be measured at several stages and allocated five classifications of metric in the framework (e.g. reliability, responsiveness, flexibility, cost and efficiency). Nevertheless the complexity associated to supply chain makes the tasks of difficult to define and categorize performance metric.

In an attempt to overcome such challenges, Shepherd and Günter (2006) measured SC performance using cost, time, quality, and flexibility to assess the four SC processes prescribed in the Supply Chain Operations Reference (SCOR) model (i.e. plan, source, make, and deliver). The authors reported that the overall proportion of measures illustrated an inconsistent focus on the cost factor. Out of 132 measures, 55 focused on cost, 38 on quality, 25 on time, and only 14 on flexibility (see Appendix C). This highlights that the majority of studies have been using cost measures in PMS. Furthermore it was found that from the 132 measures, 108 were quantitative metric and only 24 of were qualitative. This also suggests that majority of the researchers focus on extending quantitative based performance measurements, and few have attempted to create qualitative measurements that may be needed to better understand SC performance. As argued above the significance of performance measurement in SC is increasing. Therefore effective company performance can no longer be associated to the focal firm's activities alone, but should be viewed in accordance to the performance of the supply chain. Accordingly, organizations need to pay more attention to methods that could enhance their operational performance (i.e. improved integration of operations across subsequent echelons and dissimilar functions in the SC). As argued above a number of authors have criticized PMS used to assess SC performance. For example, its association with strategy (Beamon, 1999; Chan and Qi, 2003; Gunasekaran et al., 2004); focusing on cost measures (Beamon, 1999; De Toni and Tonchia, 2001); not applying a balanced approach (Beamon, 1999; Chan, 2003); not much focus on supplier, customers, and competitors in the environment (Beamon, 1999); lack of supply chain context and system thinking (Chan, 2003; Chan and Qi, 2003).

However, it is promising to witness researchers responding to these limitations, and attempts have been made to develop balanced measures to evaluate the supply chain performance (e.g. Chen and Paulraj, 2004; Ellinger, 2000; Windischer and Grote, 2003). The creation of the SCOR model is a good example. The Supply-Chain Council was organized in 1996 by Pittigilio Rabin Todd and McGrath (PRTM), and AMR research, and created the SCOR model a year later. It can be described as the systematic approach to identify, assess and monitor SC performance (Stephens, 2001). Its fundamental principle is that a balanced approach is critical and that single measures (e.g. cost) cannot sufficiently measure the multiple levels of supply chain. While some researchers question whether SCOR actually provides a systematic method for prioritizing measures (e.g. Huang et al., 2004; Li et al., 2005), advocates of SCOR argue that it does so, by including business process and technology, and offering five groups of metric (reliability, responsiveness, flexibility, cost and efficiency). Summarizing the literature review on performance measurement, this study argues that the importance of implementing a systemic and balanced approach in relation to developing PMS for SCs has been extensively recognized. However more studies are needed which create measures for SCs, rather than just focusing on inter-firms performance (Lambert et al., 2005). Thus, in developing the balanced approach to measure performance of oil and gas supply chains, the following list of minimum requirements for Supply Chain Performance Metric is achieved (Kocaoğlu et al., 2013):

1. Metric that is process based

Utilizing functional based metric could result in each function or department enhancing its own performance, which rarely results in an improved inter-organizational performance. Under this research four process based measurements, namely process quality, process cost, process lead-time and process flexibility are utilized in order to measure the oil and gas supply chains.

2. Metric at strategic, operational and tactical level

By measuring process flexibility captures strategic level data. Measuring process quality and cost will provide this research with operational level inputs, and lastly by measuring process lead-time tactical level data is captured.

3. Metric should be aligned to overall organization aim and objectives

The metric used to measure supply chain performance must be related to the overall organizational targets such as revenue, return on assets (ROA), and market share. More specifically in the uncertain and dynamic oil and gas industry it is essential that performance metric account cost, and also non-cost measures such as, process flexibility, lead-time and quality and not just focus on cost measures. This is because in an oil and gas project, a measure of cost would not illustrate a complete of operational performance. Therefore all the four processes of quality, cost, lead-time and flexibility must be aligned for an oil and gas project to be a success.

4. Metric should cover the performance of all SC activities in an organization

The performance metric adopted under this study covers three main areas of internal operation (e.g. purchasing, production) supplier's operation (e.g. inbound logistics), and the customer side (e.g. outbound logistics).

5. Metric utilized at inter firm associations

Nowadays more companies are practicing SCM-initiatives (e.g. collaborating and coordinating with supplier/customer). This is evident in the oil and gas industry, with numerous transition points for products (processes) across a large number of players, all vital in providing end consumers with the goods/services. The oil and gas industry is one of the few industries where a large number of mid-chain customers exist, thus it becomes essential to measure activities, outside the company boundary. By examining the relationship amongst OS, SCI and operational performance, this study can offer insights on how supplier/customer integration affects operational performance.

### 3.3.2 Systematic Review: Developing Qualitative Measures

Operational performance is the final construct reviewed under this. Four items are adopted to understand operational performance of oil and gas supply chains, all of which are measured from a process perspective. Cost, time, quality, and flexibility have frequently come up in the literature as key operational performance indicators (e.g. Beamon, 1999; Neely et al., 1995; Shepard and Günter, 2006). However, researchers have commonly used the above dimensions in the form of simpler quantitative performance measures. Nevertheless as argued in the previous chapter, company performance can no longer be singularly associated to the focal firm's activities, and should be viewed in accordance to the performance of the supply chain. Therefore, just relying on numerical (quantitative) performance measure may not be able to sufficiently describe a firms SC performance. Since operational performance and their measurements could have a different interpretation from one industry to another, consultation between the researcher and industry experts (oil and gas) was needed. Thus, it was agreed that the performance indicators needed to be customized to suit the business practices in the oil and gas supply chains. In order to create a PMS that can overcome the limitations presented, this research has taken the following into consideration:

1. Focused on qualitative measures to understand the inter and intra SC process more transparently

2. Adopted a balanced approach by focusing both on cost and non-cost measures (flexibility, quality and time)
3. Measured the operational performance from the three levels of decision making, flexibility (strategic), quality and cost (operational) and time (tactical)
4. Consulted with industrial experts to determine the number of metric to be utilized (i.e. having a few number vs. many metric, in order to better address performance measurement).

The subsequent sections present a literature review for each of the operational performance measures selected under this study.

### 3.3.3 Flexibility

Many organizations that in the past relied on gaining market share through lower cost and standardized productions, have been forced to become more flexible (Vickery et al., 1999b). The significance of flexibility in meeting consumer demands has been extensively acknowledged in the literature (Fisher et al., 1994; Flynn et al., 2010; Lin and Germain, 2003; Olhager and West, 2002; Rosenzweig et al., 2003; Sanchez and Perez, 2005), to a point that it is now considered as a strategic capability (De Toni and Tonchia, 2001; Krajewski et al., 2005; Lau, 1996; Schoenherr and Swink, 2012). In the 1980s and early 1990s, flexibility was generally linked to the manufacturing flexibility literature (Gerwin, 1993; Slack, 1987; Upton, 1995). Although such studies should be appreciated, they restricted the focus of flexibility on manufacturing cells and plants (i.e. intra-firm flexibility) (Croom et al., 2000; Fisher, 1997; Jack and Raturi, 2002; Lambert et al., 2005). As discussed earlier, organizations nowadays are becoming more dependent on external sources, and acknowledge the need to manage and view their SC from a more holistic perspective. For this reason, flexibility has received a lot of attention in the SC domain (Flynn et al., 2010; Krajewski et al., 2005; Kumar et al., 2006; Lummus et al., 2003; Schmenner and Tatikonda, 2005; Prajogo et al. 2012; Rosenzweig et al., 2003; Schoenherr and Swink, 2012; Stevenson and Spring, 2007; Vickery et al., 1999b). In earlier research flexibility was described in terms of scope, range, mobility, and uniformity (i.e. the variety of situation the system can adopt, the capability of an organization to move from producing a certain product with specified range to producing another). For example, Slack (1983) suggested that flexibility was partially measuring potential behavior. The author defined five elements of flexibility, namely new product, product mix, quality, volume and delivery. Furthermore some have measured flexibility in seven (Gerwin, 1987), eight (Narasimhan and Das, 2000) and fifteen (Vokurka and O'Leary-Kelly, 2000) dimensions. It is worth mentioning that the majority of these researches focused on organization level flexibility (intra-firm flexibility). It wasn't until early 2000s that focus shifted to supply chain flexibility. For example, Duclos et al. (2003) proposed a conceptual model of supply chain flexibility consisting of six components. Accordingly Lummus et al. (2003) used five components namely, operational systems, logistics processes, supply network, organizational design and information systems flexibility. Kumar et al. (2006) further contributed to this field by incorporating more explicit inter-firm element in relation to the flexibility types (i.e. logistics or process flexibility, related to receiving and delivering products as the sources of supply and customers change).

It has been argued that the process of designing the supply chain, aids managers to determine the flexibility of the existing structure and how easily it can be reconfigured (Vickery et al. 1999b). A number of authors have added to this field of research by enhancing single-stage models to multi-stage SCs (Bertrand, 2003; Graves and Tomlin, 2003). For example, Garavelli (2003) investigated the effect of process and logistics flexibility on SC performance. The author suggested the focus should be on the appropriate levels of flexibility. Additionally different features of flexibility in the focal company-supplier association have also been investigated in the literature. For example, authors have focused on procurement flexibility, which could offer constancy for the supplier and help the focal firm react to the demand variations (Milner and Kouvelis, 2005; Sethi et al., 2004; Tsay, 1999; Tsay and Lovejoy, 1999). However, the majority of the above empirical studies have investigated the softer features of SC relationships. Suarez et al. (1996) evaluated the effect of relationships with suppliers on manufacturing flexibility. They reported that close associations resulted in positive impact on mix, volume and new product flexibility. Similarly Pérez and Sánchez, (2001) examined the flexibility of buyer-seller relationships, emphasizing the significance of JIT delivery, trust, data sharing, supplier participation in designing the product and commitment.

A large body of literature suggests that information sharing improves flexibility of SCs (Flynn et al., 2010; Fredericks, 2005; Golden and Powell, 1999; Rosenzweig et al., 2003; Prajogo et al. 2012; Rosenzweig et al., 2003; Schoenherr and Swink, 2012; Stevenson and Spring, 2007; Vickery et al., 1999b; Wong et al., 2011b). It has been argued that flexibility could enhance transparency, reduce lost sales, increase payment cycles, develop trust, and reduce over-production and inventories (e.g. Rosenzweig et al., 2003; Vickery et al., 1999b). Furthermore using information technology (IT) systems organizations are now capable of effectively coordinating their supply networks. For example, Golden and Powell (1999) suggested that SC flexibility relied on the degree to which information were shared through inter-organizational systems. Additionally White et al. (2005) evaluated the role of web services in offering flexibility, and argued that data from such systems could improve deeper associations and enhance flexibility. In another study examining the Volvo car manufacturing, Fredriksson and Gadde (2005) emphasized the significance of data sharing and illustrated that industrial features affect SC flexibility.

Furthermore another rich stream of literature in this area has been directed towards the relationship between organization flexibility and wider supply chain. For example, Narasimhan and Das (2000) reported that sourcing and SCM practices impact organization flexibility. Likewise, Vickery et al. (1999b) also reported a positive association amongst supply chain flexibility (volume and launch flexibility) and operational performance. Olhager and West (2002) examined the impact of manufacturing flexibility and market requirements. Similarly Sanchez and Perez (2005) investigated the association between supply chain flexibility and firm performance. They placed importance on volume flexibility, and also highlighted the need for tailoring flexibility strategies to features of the supplier. The authors reviewed flexibility by using a hierarchical framework with three levels: basic, system and aggregate. By doing so they enabled a simpler understanding of the different levels of flexibility. Figure 3.1 presents the bottom-up model of flexibility adopted from Sanchez and Perez (2005). This identifies the different dimensions of flexibility in the form of:

- Shop floor level (product, volume, Routing flexibility)
- Company level (delivery, transshipment, postponement flexibility)
- Chain level (launch, sourcing, response and access flexibility).

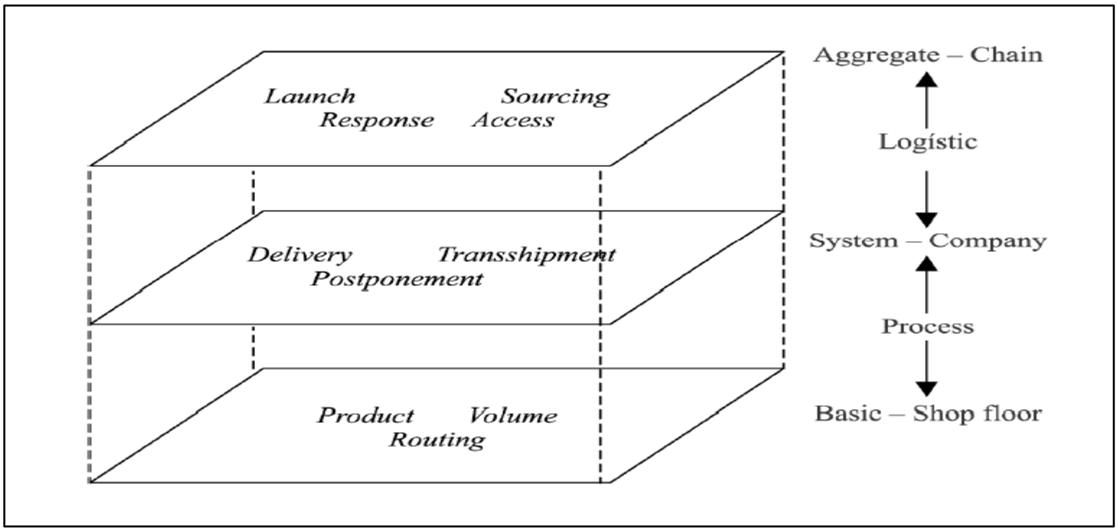



**Figure 3. 1: Bottom-up Classification Model of Flexibility (source: Sanchez and Perez 2005).**

While many studies have examined the relationship between supply chain and firm flexibility, these have been carried out at company or plant (shop floor) level, and emphasize was on operational performance of the focal firm. However more attention needs to be focused on the flexibility at supply chain level (Gosain et al., 2004; Harland et al., 1999; Krajewski et al., 2005; Stevenson and Spring, 2007; van Hoek et al., 2001). Thus, to date the majority of the literature has extended only as far as the first-tier associations.

### 3.3.4 Quality

Quality is one of the most researched upon features of operational performance. Quality gurus argue that quality management is a vital processes needed to enhance organizational performance (Dean and Bowen, 1994; Deming, 1982; Deming, 1986; Evans and Lindsay, 2005; Juran, 1988). Accordingly numerous empirical researchers have found a positive association between quality management and operational performance (Chung et al., 2008; Flynn et al., 2010; Flynn et al., 1995; Kaynak, 2003; Koufteros et al., 2005; Powell, 1995; Prajogo et al., 2012; Rosenzweig et al., 2003; Samson and Terziovski, 1999; Sila, 2007; Wong et al., 2011b). For example, studies have focused on total quality management (TQM) (Powell, 1995; York and Miree, 2004; Zakuan et al., 2010), ISO 9001 standard (Dick et al., 2008; Heras-Saizarbitoria and Boiral, 2013), and also on quality awards (Easton and Jarrell, 1998; Hendricks and Singhal, 1997).

Additionally a clear distinction can be viewed between studies that have conceptualized TQM as a single construct, and those that have defined TQM as a set of process or practices. Such practices have been split into soft and hard practices (e.g. Gadenne and Sharma, 2009; Rahman, 2004; Rahman and Bullock, 2005). Soft quality practices are usually related to managing people, relationships and leadership actions. On the other hand, hard quality practices are the tools and techniques utilized in quality management. Accordingly empirical studies have investigated the direct (Corbett et al., 2005; Powell, 1995; Terziovski et al., 2003) and indirect (Nair, 2006; Sila, 2007) impact of quality management on operational performance and have found mixed results for soft and hard quality measures (Flynn et al., 1995; Gadenne and Sharma, 2009; Ho et al., 2001; José Tarí, 2005; Rahman, 2004). Therefore, there is a need to review the literature on both soft and hard quality management practices. As argued above one of the most common mechanisms for managing quality is TQM.

TQM is considered an integrated method, involving principles and practices that aim to increase the quality of firm's goods and services (e.g. continuously monitoring supplier quality and meeting customer needs) (Gunasekaran and McGaughey, 2003; Vanichchinchai and Igel, 2009, 2011). Such objective is closely aligned with SCM, thus TQM is seen as a method that enhances operational performance through more efficient integration of internal functions with external supply chain operations (i.e. supplier and customer). It has been argued that SCM focuses on synchronization and configuration of the processes, needed to enable higher quality productions (i.e. quality assurance and control). Additionally TQM is considered a total systems approach, which is applied horizontally throughout departments and functions (including all staff members) and is extended forward and backward to suppliers and customers in the process (Flynn* and Flynn, 2005; Gadenne and Sharma, 2009). This makes such quality management technique ideal to measure performances across SCs. Therefore both upstream and downstream members in the supply chain need to be effectively managed, interacted, and aligned with, in order to achieve supply chain performance. Flynn et al. (1995) argued that TQM practices could help companies decrease process variations, and performance cycles and delivery times. In an extended study, Flynn* and Flynn (2005) also reported that TQM practices allow for set-up time reduction. Author have also suggested that TQM enables enhanced schedule attainment and consequently quicker reaction time to market demands, therefore improving the overall supply chain performance (e.g. Ferdows et al., 2004; Foster, 2008; Liker and Choi, 2004). Based on the above review, it is argued that that TQM and SCM go hand in hand facilitating managers to monitor and improve performance. For this reason table 3.5 lists the most successful TQM practices.

**Table 3. 5: Total Quality Management Practices**

| TQM practices | Study |
|---|---|
| Continuous improvement | Al-Marri et al. (2007), Antony et al. (2002), Chin et al. (2002), Demirbag et al. (2006), Flynn et al. (1995), Fotopoulos and Psomas (2009), Gadenne and Sharma (2009), Hellsten and Klefsjö (2000), Jung and Wang (2006), Khamalah and Lingaraj (2007), Koh et al. (2007), Lakhal et al. (2006), Lewis et al. (2006), Rahman and Bullock (2005), Samat et al. (2006), Sila and Ebrahimpour (2002), Talib and Rahman (2010), Ueno (2008), Zhang et al. (2000) |
| Supplier quality management (i.e. quality, relationship, collaboration, partnership) | Ahire et al. (1996), Antony et al. (2002), Black and Porter (1996), Brah et al. (2000), Chin et al. (2002), Flynn et al. (1995), Fotopoulos and Psomas (2009), Gadenne and Sharma (2009), Hellsten and Klefsjö (2000), Ho et al. (2001), Kaynak (2003), Khamalah and Lingaraj (2007), Kim et al. (2012), Lakhal et al. (2006), Lewis et al. (2006), Quazi et al. (1998), Powell (1995) Rahman and Bullock (2005), Saraph et al. (1989), Sila and Ebrahimpour (2002), Singh et al. (2006), Talib and Rahman (2010) |
| Benchmarking | Al-Marri et al. (2007), Antony et al. (2002), Fotopoulos and Psomas (2009), Gadenne and Sharma (2009), Khamalah and Lingaraj (2007), Koh et al. (2007), Kuei et al. (2001), Lakhal et al. (2006), Lewis et al. (2006), Quazi et al. (1998), Rahman (2004), Sila and Ebrahimpour (2002), Singh et al. (2006), Talib and Rahman (2010), Zhang et al. (2000) |
| Top-management commitment (i.e. leadership, management support and management commitment, communication, quality data and reporting) | Ahire et al. (1996), Antony et al. (2002), Brah et al. (2000), Fotopoulos and Psomas (2009), Hellsten and Klefsjö (2000), Ho et al. (2001), Huq and Stolen (1998), Kanji and Wallace (2000), Kaynak (2003), Khamalah and Lingaraj (2007), Kim et al. (2012), Lakhal et al. (2006), Lewis (2006), Quazi et al. (1998), Rahman (2004), Rahman and Bullock (2005), Samat et al. (2006), Saraph et al. (1989), Sila and Ebrahimpour (2002), Singh et al. (2006) , Talib and Rahman (2010), Woon (2000), Zhang et al. (2000) |
| Employee involvement | Ahire et al.(1996), Antony et al. (2002), Brah et al. (2000), Fotopoulos and Psomas (2009), Kanji and Wallace (2000), Lakhal et al. (2006), Sila and Ebrahimpour (2002), Singh et al. (2006), Talib and Rahman (2010), Zhang et al. (2000) |
| Training and education | Ahire et al. (1996), Antony et al. (2002) , Brah et al. (2000), Fotopoulos and Psomas (2009), Khamalah and Lingaraj (2007), Lakhal et al. (2006), Quazi et al. (1998), Samat et al. (2006), Saraph et al. (1989), Sila and Ebrahimpour (2002), Talib and Rahman (2010), Zhang et al. (2000) |
| Customer focus (i.e. customer satisfaction and orientation) | Ahire et al. (1996), Antony et al. (2002), Brah et al. (2000), Kanji and Wallace (2000), Lakhal et al. (2006), Samat et al. (2006), Sila and Ebrahimpour (2002), Singh et al. (2006), Talib and Rahman (2010), Woon (2000), Zhang et al. (2000) |

TQM practices can be categorized into two groups (Evans and Lindsay, 2005; Wilkinson et al., 2008):

a. Management and technical systems
b. Soft/hard elements

The technical systems comprise of a set of tools and processes (e.g. run, flow and control charts), while the hard parts are referred to the production and process control techniques that enable the correct operations of such processes (e.g. process design and JIT) (see Evans and Lindsay, 2005; Wilkinson et al., 2008). On the other hand, the management system or soft elements are the social or human features of management (i.e. planning and leadership). While differences exist in relation to what represents soft and hard measures, it is typically understood that soft TQM practices are associated to people and individual members. However, hard TQM aspects are associated to practices such as quality tools, techniques, and design processes, amongst other important factors. Some authors have referred to such soft measures as leadership, strategic planning, people management (Chin et al., 2002); work attitudes, customer/supplier relationship, top management support (Flynn et al., 1995); continuous improvement, human resource development, supplier management, strategic quality planning (Fotopoulos and Psomas, 2009); employee involvement and training, supplier support (Gadenne and Sharma, 2009) employee training, top management role (Ho et al., 2001) supplier relationships, customer focus, managing people (e.g. team training) (Rahman and Bullock (2005). On the other hand, hard measures have been referred to in literature as: process analysis/measurement, SCM practices, quality system (Chin et al., 2002); statistical control and evaluation, process flow management (Flynn et al., 1995); control and run charts, process diagram (Fotopoulos and Psomas, 2009); efficiency and continuous improvement, benchmarking (Gadenne and Sharma, 2009); JIT, technology, and computer improvements (Rahman and Bullock, 2005).

Based on the above studies, it is summarized that soft aspects of TQM tend to measure practices in relation to management commitment, customer and supply focus, and people management. Accordingly hard measures have been focused upon continuous improvement program, benchmarking, quality tools and techniques, supplier quality management. Nevertheless there is no universal agreement in relation to what is a soft or hard measure. For example measures such as supplier quality management, and quality data and reporting were considered as hard measures by Ho et al. (2001), However in Rahman and Bullock (2005) and Lewis et al. (2006), supplier relations and management were classified as a soft measure. Similarly Rahman (2004) also categorized quality data and reporting as soft measures as well. Nevertheless studies that have analyzed the impact of quality practices generally reported a positive association between such management practices and performance (Chung et al., 2008; Flynn et al., 1995; Kaynak, 2003; Powell, 1995; Sila, 2007).

From the literature review carried out under this study, a set of four TQM practices was selected. These four practices were chosen based on the higher frequencies they appeared in different TQM studies, and are treated as major quality practices. The four practices are namely continuous improvement, data quality and reporting, benchmarking and supplier quality management. The relevancy of the selected practices the oil and gas industry was also considered (i.e. discussions with industrial experts). This was done in order to create a better understanding of how such quality measures are viewed and implemented in actual practice.

### 3.3.5 Lead-Time

Lead-time plays a significant role in modern logistics and SCM (e.g. Droge et al., 2004; Flynn* and Flynn, 2005; Frohlich and Westbrook, 2002; Koufteros et al., 2010; Thun, 2010). Lead-time is defined as the time that elapses between placing an order, and receiving the goods in the inventory (Silver et al., 1998). In more recent years companies have devoted considerable attention to lead-time, because of its impact on customer service and inventory costs (Ben-Daya and Raouf, 1994; Droge et al., 2004; Koufteros et al., 2010; Lee and Billington, 1993; Liao and Shyu, 1991). For example, JIT production system has shown that by decreasing lead-time an increase in productivity, closer association with suppliers, and competitive positioning may be witnessed (Jayaram et al., 1999; Koufteros et al., 2010; Nahm et al., 2003 Pan and Yang, 2002; Tersine and Hummingbird, 1995). Thus, controlling for lead-time could be considered a key element of the SCM success. Lead-time has been typically categorized into the following components: (1) order preparation, (2) order transit, (3) supplier lead-time, and (4) delivery time (see Tersine, 1994). Order preparation consists of in-house order preparation time, in simpler words, it is the time required for a focal firm to prepare and place orders to suppliers. Order transit, is the process of order time to the supplier. It is the time needed to send a completed order, and for the supplier to receive such order in timely fashion. Issues in order transit could arise when suppliers and focal company use systems with different operating platforms. Supplier lead-time is the time needed for the supplier to process and transport the requested goods to the focal firm. Delivery time is the time associated to in-house goods preparation, and also the delivery time to the customer.

By observing the four categorize of lead-time, it is argued that components 1 and 4 are governed by decision and practices related to the focal company (e.g. made inside the ordering firm). However components 2 and 3 are governed by elements outside the boundary of the focal firm, and are therefore more difficult to control. Thus, the above components could be classified into factors governed inside, and factors governed outside the focal company. In the inventory management literature, lead-time has frequently been viewed as a decision variable, which could vary in a given boundary (e.g. Ben-Daya and Raouf, 1994). By dividing lead-time into four processes (Tersine, 1994), it is assumed that each individual process time could be decreased. For example, a firm may reorganize the production process or utilize a complex plant information systems, in order to decrease its setup time or increase setup accuracy (McIntosh et al., 2000; Trovinger and Bohn, 2005); it may adjust the production equipment to increase the speed of the production process; or apply a batch transfer policy to take advantage from overlapping production cycles (Muffatto, 1999). In the uncertain oil and gas industry, companies are facing supply and demand uncertainty on a daily basis (e.g. demand for specific drilling equipment or parts in remote location). Therefore, decreasing lead-time becomes an essential part of the oil and gas operations or supply chains. Tersine (1994) noted that demand uncertainty increases lead-times and place companies at the risk of running out of materials before orders arrive. Furthermore reducing lead-time in oil and gas supply chains is necessary. This is because of the numerous transition points for the products and processes, across a large number of players, all of which are vital in providing end customers with products/services. In simpler terms the oil and gas industry is one of the few industries, where a large number of mid-chain customers exist. Thus it can be argued for successful oil and gas supply chains, each of the mid-level customers must meet their individual lead-times. Accordingly some studies have found that decreasing replenishment lead-time (i.e. time between the decision to replenish a part/material and the time it is actually in the inventory) could reduce safety stock and stock-out loss (e.g. Silver et al., 1998). It could further enhance the degree of customer satisfaction, resulting in a reduction in total cost, underscoring the significance of managing lead-time (Germain et al., 1994; Koufteros et al., 2007b; Moenaert et al., 1994; Ramanathan, 2007; Thun, 2010).

Liao and Shyu (1991) were one of the first studies that investigated variable lead-time in inventory systems. In this study, the authors viewed lead-time as a construct consisting of several components. Each component had a different linear crashing cost function, in reducing lead-time and could be lowered to a given minimum duration. By assuming that lot size was predetermined, and a normal distribution of demand existed, the authors estimated an ideal lead-time, and illustrated that decreasing such factor resulted in lower total costs. Similarly Ben-Daya and Raouf (1994) suggested a framework that viewed lead-time and order quantity as decision variables. Furthermore Ouyang et al. (1996) anticipated that a portion of the demand (throughout the stock out period) was back ordered, the authors referred to such outstanding portion as lost sales. However studies have also suggested a model with lead-time reliant on procurement costs. These authors have argued that decreasing lead-time results in more procurement costs (e.g. Kim and Benton, 1995; Ouyang et al., 1999; Pan and Yang, 2002). The association between lead-time and costs was enabled through linear and a nonlinear procurement cost function. Other research allowed further parameters. For example, studies examined models in which setup costs and lead-time could have been reduced at crashing cost (e.g. Hariga, 2000; Ouyang et al., 1999). However, literature also highlights that lead-time crashing cost, differs in relation to the lot size. Ouyang and Chang (2002) suggested a model with lead-time and setup cost reduction, and examined the impact of inadequate production process on ideal lead-time. Furthermore authors have also investigated the effect of lead-time stock-out costs on lead-time reduction (Chuang et al., 2004), and also the impact of lead time reduction on setup time (Pan et al., 2004).

Based on the above review, the majority of studies argue that lead-time is a significant aspect of inventory management system. It is has been suggested that by reducing lead-time, a reduction in safety stock and loss caused by stock-out could be attained. Lower lead-time was also related to improving the ability of firms to compete (Ouyang and Wu, 1997). Another important finding was that, even though lead-time relates to inter-firm processes, the majority of studies in the literature have been using financial measures such as ROI or average profit, directed at firm level. It has been argued that lead-time concerns all levels of supply chain and impacts the scheduling of activates amongst a number of players (e.g. supplier, customer and focal firm) (Mason-Jones and Towill, 1999; Ramanathan, 2007). Thus, reducing or increasing lead-time should be measured in accordance to SC chain response time (Gunasekaran et al., 2001). This study attempts to measure oil and gas operational lead-time, internally and externally across the supply chain (upstream suppliers and downstream customers).

### 3.3.6 Cost

The progress of the field of management accounting has been finely reviewed in the literature (Johnson, 1972, 1981, 1983; Johnson, 1978). Amongst many scholars Johnson's studies illustrated that, the majority of the current accounting systems were based upon estimations made over 60 years ago. In a number of earlier literature reviews in the field of accounting (e.g. Garner, 1976) it was reported that most complicated cost accounting theories were developed by 1925. The Return on Investment (ROI) is a perfect example. DuPont created ROI measurement so that they could evaluate both the effectiveness of each business function, and the organizational success as a whole (Chandler, 1977; Johnson, 1972; Neely et al., 1995). In modern accounting ROI is still used for the same reasons, however it generally accepted that such a technique of measuring cost encourages short-termism (see Banks and Wheelwright, 1979). However, since organizations have gone through dramatic changes during the past 60 years, the original assumptions that built the foundations of management accounting may need revisiting. For example, Johnson (1991) criticized the allocation of indirect labour and overhead costs in accordance to direct labour costs. This is because back in 1900s, direct labour was associated to most of the full product cost. Therefore, it made sense to assign overheads to finished goods (in relation to the direct labour content). But nowadays as a result of advancement in production technologies, the direct labour cost is normally 10 to 20 %, whereas overhead makes up 30 to 40 % of the full product cost (Murphy and Braund, 2000). Therefore, even a comparatively small alteration in product's direct labour content could hugely affect the cost structure, leading to overheads of 400 to 1000 % (see Neely et al., 1995).

Furthermore assigning overheard to direct labor hours, could result in managers attempting to lower the number of such hours in their cost centers. Such issue could turn more severe in time, as the life cycle of products decreases. Therefore, it is argued that a continuously enhancing proportion of the costs (related to full product) will take the form of research and development overhead (see Johnson, 1991). Nevertheless it should be reported that a universal agreement does not exist amongst the accounting fraternity on the view held by Johnson (1991). For example, the UK's Chartered Institute of Management Accountants (CIMA) attempted to investigate the level of disagreements associated to management accounting in the US in 1988. Some authors have argued that management accounting systems were short-term oriented, lacked strategic focus, depended too much on unnecessary assumptions in relation to production process, and managers frequently used them as a means for external financial reporting (and not to manage their business) (see Bromwich and Bhimani, 1989). The criticisms directed to traditional management accounting approaches led to development of a more comprehensive method called the activity-based costing (ABC) (see Cooper, 1987, 1989a). Similar to traditional management accounting, ABC measures both direct (labour and material) and indirect costs. Indirect costs are the overhead costs which cannot be allocated directly for exact product units (e.g. costs assigned to explicit production runs, batches, or time periods, such as materials purchase order, machine set up, the cost of transporting equipment and materials, and machine maintenance, and cleaning costs). Since ABC and traditional accounting have different estimates for measuring indirect costs, this could lead to different profitability estimations on the same product. In other words, ABC is a method that assigns costs to services, products, or tasks. These are based on the activities that go into, and the resources that are used by such processes. It is understood that the cost of a product is the sum of all processes needed produce and deliver the product (Cooper, 1989). Thus, it is argued that ABC is able to provide a more accurate cost by transforming many of cost factors that are considered indirect (e.g. traditional method) to direct costs. Accordingly it has been argued that ABC overcomes traditional management accounting limitations, such as (Jeans and Morrow, 1989):

- In most firms the percentage of direct labour has reduced from total cost; however it still remains the most regular basis for loading overheads on goods.
- Traditional management accounting became biased in relation to external financial reporting. For example, such cost systems were focused on valuing stock rather than offering information on product cost.
- Overhead costs could no longer be disregarded and minimized. Because of increased competition amongst firms, overhead functions such as quality control techniques, customer service, and order processing have become more significant (e.g. keeping customers satisfied).
- Increase in complexity has led to more sophisticated production and manufacturing processes. This has resulted in the range of products increasing, product life cycles decreasing, and quality improving.

Therefore it is argued that, although managers tend to put their entire focus on visible cost (direct labor and material), overheads are mainly caused by invisible cost (transaction)(Cooper and Kaplan, 1988; Miller and Vollmann, 1985). Cooper's early work in ABC emerged from research by Miller and Vollmann (1985); with the central assumption being that, it is not products but activities and processes that are the main sources of cost. Furthermore some have suggested that there must be a detachment among the external financial reporting and the systems utilized to collect data for strategic decision making (Cooper, 1989b; Kaplan, 1988). During its introduction ABC was perceived by many US companies as a small payoff activity or process, nevertheless it has been subject to little criticism (Kim and Miller, 1992). Reviewing the literature also revealed that ABC was not a newly formed theory. Troxel and Weber (1990) argued that this model had undertaken three phases to develop. During the first stage ABC was not officially recognized. It was simply viewed as a form of advanced traditional cost accounting and companies were known to utilize it from back in 1960s. It was not until the second stage, when ABC was officially recognized as a costing system (led by scholars such as Cooper). Nevertheless a lot of practitioners were discouraged by the idea that they would probably have to get rid of their accounting system in order to use ABC. In the final stage of development it was recognized that ABC was not an alternative to conventional accounting systems, but a costing model that could be utilized as part of the strategic decision-making.

However some have also criticized ABC arguing that, such approach was not proven to offer more precise information on product cost (Piper and Walley, 1990, 1991), others have argued that ABC is based on the company's existing cost structure (Neely et al., 1995). This might not provide enough incentive for managers to think outside the box, and explore whether or not their business processes could be redesigned (e.g. redesign their organizational processes to save cost). As a result of such criticism more advanced costing systems were developed such as the total cost of ownership (TCO). TCO has been referred to as purchasing tool and philosophy, needed to understand and identify the true costs associated to buying a product/service from a supplier (Ellram, 1995). Such costing system is a sophisticated approach that involves the focal firm deciding on what strategy (costing system) to purse, when dealing with purchasing, ownership, usage, and consequent disposition of a product or service. Further to the cost paid for a product, TCO could also contain elements such as order placement, supplier qualification, transport, delivery, inspection, refusal, replacement, downtime caused by failure, disposal costs amongst other (Ellram, 1995).

It is argued that traditional accounting systems cannot provide a holistic view of performance in the uncertain and inter-dependent oil and gas supply chains. In such an industry goals of organizations typically overlap with others in providing goods and services. In other words, the oil and gas industry has many layers of overhead cost, which cannot be sufficiently captured or explained by the conventional accounting systems (e.g. ROI). For this reason this study adopts ABC in order to have a better understanding on both the direct (e.g. capital cost) and indirect costs (e.g. operational costs). However adopting such cost measurement has its own drawbacks. It has been argued that the oil and gas supply chain has numerous hidden costs associated to its processes, and that TCO could provide a clearer measurement of such costs. Nevertheless because of time constraints, it would be nearly impossible to capture the life cycle costs (as suggested by TCO). Doing so requires the study to have enough time to follow a specific oil and gas project from start to finish, in order to have better chance of identifying all hidden costs. Thus it is recommended that techniques such as TCO be adopted for future longitudinal studies, in order to develop more robust cost performance measurement for oil and gas supply chains.

## 3.4 Chapter Conclusion

Chapter 3 presented a systematic literature review and discussion on the theoretical concepts under investigation. More specifically this chapter systematically investigated literature on the three constructs of OS (centralization, formalization and hierarchical relationship), SCI (internal, customer and supplier), and operational performance.

The chapter (3.1) on OS started with backgrounds and definitions on the research construct. After providing a background to this field of research, a systematic review was carried out in order to identify and establish the most common dimensions associated to OS. Several different conceptualizations exist in the literature on OS and its dimensions. Despite differences in terminologies, this research identified the most relevant dimensions of OS (formalization, centralization and hierarchical relationship) in examining the structure-performance relationship. Predominantly organizational theorists have focused on the broad OS classifications of organic vs. mechanistic.  Another equally important classification of OS dimensions identified from the literature review, was the structural and structuring classification. Finally the review of the studies on the structure-performance relationship showed that organization strategy plays a critical role (e.g. mediating) between OS and operational performance. Strategies from different fields of management have been used as such mediators (e.g. strategic management, operations management).

The chapter (3.2) on SCI started with backgrounds and definitions on the research construct. Accordingly, a systematic review was carried out in order to identify and establish the most common dimensions associated to SCI. It was argued that developing conceptualizations resulted in unreliable outcomes, on the relationship between SCI dimensions and operational performance. Under this research SCI was conceptualized as a multiple construct consisting of internal, customer and supplier integration and review was conducted on how each individually affect operational performance. Although some studies reported mixed findings on the relationship between the dimensions of SCI and operational performance, majority of authors reported positive associations.

Finally chapter (3.3) on operational performance started with backgrounds and definitions on the research construct. It was argued that organizations in the modern and post-industrial era should not rely solely on their individual organization performance. This research presented that in uncertain and complex industries (e.g. oil and gas), firms were placing more importance on inter-firm associations. Accordingly a number of debates were presented on the different performance measures in SCM. Predominantly studies had classified performance measures as, qualitative or quantitative (Beamon, 1999; Chan, 2003), strategic, operational or tactical focus (e.g. Gunasekaran et al., 2001), and cost or non-cost (e.g. De Toni and Tonchia, 2001; Gunasekaran et al., 2001). This chapter also presented discussions on each of the elements measuring operational performance, namely process quality, process lead-time, process cost and process flexibility.

Therefore by carrying out a systematic literature review in the area of organizational theory, this study identified the most common conceptualization of OS dimensions (e.g. centralization, formalization). While some authors had conceptualized OS as a single (e.g. Adler and Borys, 1996; Zheng et al., 2010), the majority operationalized OS as a multiple construct (Aiken and Hage, 1971; Damanpour, 1991; Grinyer and Yasai-Ardekani, 1981; Nemetz and Fry, 1988; Pugh et al., 1968; Willem and Buelens, 2009). Furthermore a great number of authors had found that OS had a direct impact on operational performance (e.g. Adler and Borys, 1996; Koufteros and Vonderembse, 1998; Lin and Germain, 2003; Schminke et al., 2000). Nevertheless based on the chronological review it was suggested that during the early 1980’s the focus shifted to establishing the empirical link amongst OS, organization strategy, and Performance. For this reason a number of authors noted that the congruent association between OS and performance was also dependent on the type of strategy perused by the organization (Baum and Wally, 2003; Claver-Cortés et al., 2012; Droge and Calantone, 1996; Ettlie et al., 1984; Koufteros et al., 2007b; Lee and Grover, 1999).

A number of different strategies have been reviewed under this study (e.g. just-in-time, new communication technologies, keiretsu, supply chain process variability, and knowledge management). Nevertheless by carrying out a systematic literature review in the area of operations management, SCM was identified as one of the most common strategies and during the past four decades it had received substantial attention from academics and practitioners (Mentzer et al., 2001). Accordingly it was argued that SCI turned into one of the most significant features of SCM and its enablers and outcomes have been researched quite extensively (e.g. Das et al., 2006; Droge et al., 2004; Droge et al., 2012; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002; Swink et al., 2007; Vickery et al., 2003; Zhao et al., 2011). Furthermore majority of the authors in this area, empirically agree that SCI improves performance (e.g. Das et al., 2006; Flynn et al., 2010; Koufteros et al., 2007a; Lee et al., 2007; Petersen et al., 2005; Schoenherr and Swink, 2012; Swink et al., 2007; Zhao et al., 2013) others have however not reported such a relationships (Chen et al., 2007; Cousins and Menguc, 2006; Sezen, 2008). It was concluded that unclear definition and understanding of the dimensions of SCI could have resulted in mixed outcomes on the impact of SCI on operational performance (Das et al., 2006; Devaraj et al., 2007; Fabbe-Costes and Jahre, 2008; Germain and Iyer, 2006; Pagell, 2004). Thus, there was a need to conceptualize SCI as a comprehensive construct, including internal, customer and supplier integration and test its impact on operational performance. This study investigates the relationship between the dimensions of OS (the independent variables) and operational performance as the dependent variable, while it has been shown that SCI has a direct impact on operational performance, this study also explores the mediating role of the SCI dimensions on the relationship between OS and operational performance.

### 3.5 Outline of Research Gaps

Based on the literature review carried out on OS, SCI and operational performance the following research gaps have been identified:

- Although a large body of literature suggests that OS has an impact on operational performance (e.g. Germain et al., 2007; Huang et al., 2010; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Lin and Germain, 2003; Nahm et al., 2003; Wong et al., 2011a, Yang et al., 2014), evolving conceptualizations and broad literature on the main dimensions of OS have resulted in mixed empirical findings, concerning the OS-performance association. It was argued that since a universal understanding (selection) on such dimensions is hard to come across, it was a difficult and daunting task to appropriately conceptualize this field of study. As a result researchers sometimes have named similar dimensions differently and have used them in varying orders and classifications. In order to check whether the dimensions were situated appropriately to each classification, this study utilized Campbell et al.'s (1974) distinction between "structural" and "structuring" characteristics of organizations. It was argued the majority of studies had focused on the organic vs. mechanistic classification of OS; this study also focuses on the structural (hierarchical relationship) and structuring dimensions (centralization and formalization) and their effect on performance.

- Furthermore this research argued that organizational researchers may have been too keen to prove the structure-performance association and in the process could have overlooked significant variables, which could have meditated or affected such association. Accordingly the literature review of the studies on the structure-performance relationship showed that organization strategy plays a critical role (e.g. mediating) between OS and operational performance. Strategies from different fields of management have been used as such mediators (e.g. strategic management, operations management). However no study has examined the mediating role of SCI (as a competitive strategy) on the relationship between OS and operational performance.

- Despite the recent increase of interest from academics and practitioners on SCM, and SCI as one of the most significant features (Das et al., 2006; Droge et al., 2004; Droge et al., 2012; Flynn et al., 2010; Frohlich and Westbrook, 2001; Narasimhan and Kim, 2002; Swink et al., 2007; Vickery et al., 2003; Zhao et al., 2011), there seems to be some disagreement amongst authors concerning its impact on operational performance. Although overwhelming number of authors, empirically agree that SCI improves operational performance (Das et al., 2006; Flynn et al., 2010; Koufteros et al., 2007a; Lee et al., 2007; Petersen et al., 2005; Schoenherr and Swink, 2012; Swink et al., 2007; Zhao et al., 2013), others have however not reported such a relationship (Chen et al., 2007; Cousins and Menguc, 2006; Sezen, 2008). Furthermore in some cases investigation on this issue reported a negative relationship between SCI and operational performance (e.g. Rosenzweig et al., 2003; Vickery et al., 2003). Therefore, this research argued that such mixed findings was as a result of developing explanations and dimensions of SCI. While some authors focused on individual dimensions of SCI (e.g. Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006) not a lot of studies examined the effects of both internal and external (customer and supplier) integration on performance outcomes (Flynn et al., 2010; Koufteros et al., 2005; Wong et al., 2011b) and many of such empirical research generally overlooked the role of internal integration. Additionally a small number of studies employed the same SCI dimensions and variables for a specific region, country or industry. Therefore this study conceptualized SCI as a multiple construct including internal, customer, and supplier integration, and reviewed literature on how each individually affect operational performance.

- It was suggested that several operations management studies examined the role of SCI in improving operational performance. However, the majority of such research predominantly focuses on the manufacturing industries (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Flynn et al., 2010; Koufteros et al., 2010). As argued previously (chapter 2) the oil and gas industry as one of the main source of energy supply, is considered as the lifeblood of the world economy. It is an essential input in the production processes of almost all goods and services globally. Therefore it seems slightly surprising that such an essential sector has been short of empirical investigation, especially in organizational theory and operations management field of research.

- Lastly it was argued that organizations in the modern and post-industrial era should not rely solely on their individual organization performance. This research presented that in uncertain and complex industries, such as the oil and gas, firms were placing more importance on inter-firm associations. Accordingly a number of debates were presented in relation to performance measures in SCM. It was reported that the majority of prior authors focused on quantitative measures as performance indicators (e.g. Beamon, 1999; Gunasekaran et al., 2001; Shepherd and Günter, 2006). Since this study aimed to evaluate the operational performance of oil and gas supply chains, there was a need to develop qualitative measures. In other words, quantitative measures would not provide a clear picture of the operational performance across the SC. It was noted that the oil and gas industry has numerous transition points for products and processes across a large number of players, all of which are vital in providing end consumers with the products and services. It is one of the few industries where a large number of mid-chain customers exist, and thus based on the objectives of this study, measuring the performance of individual organizational performance was not viewed suitable.

In chapter 3 it was presented that the evolving conceptualizing on OS and SCI had resulted in unreliable outcomes in both the association between OS-performance (e.g. Germain et al., 2007; Koufteros et al., 2007b; Lin and Germain, 2003) and SCI-performance (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Koufteros et al., 2010). This research argues that, while such relationships have been excessively investigated, very little is understood about the relationship amongst OS, SCI and operational performance. More specifically little is known about how formalization, centralization, and hierarchical relationship, affect an organization's ability in integrating internally (cross-functionally), and externally (i.e. customer and supplier) across its supply chain. Therefore, suggestions can be made in relation to effectiveness of supply chain performance in relation to OS adopted by oil and gas firms, and whether or not SCI mediates such association. The conceptual framework in this research would therefore suggest a greater holistic view of SCM (views how internal structure and setting affects relationship with customer and supplier). Thus, by recognizing the antecedents of OS as drivers for SCI, this research attempts to bridge the gap between the organizational theory and operations management field. The research gaps were therefore outlined into the following four research questions:

*RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?*
*RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?*
*RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?*
*RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?*

The above research questions are further investigated in chapter 4. This is done in order to describe the conceptual framework and to decide on the research hypotheses.

# Chapter 4: Theoretical Framework

The review of the literature in chapter 3, offered an overview on the current understanding and knowledge in organization structure (OS), supply chain integration (SCI) and operational performance. The aim of this study is to examine the mediating role of SCI on the relationship between OS and operational performance. The systematic literature review identified a number of theoretical approaches used to examine the structure-performance and, SCI-performance relationships. It was argued that researchers had often adopted a contingency theory approach, due to the complex nature of such associations. Therefore, the first section of this chapter reviews literature on the contingency theory in order to examine the role of contingency in the relationship amongst constructs in this study. Accordingly the conceptual framework for this study (based on the contingency theory) is presented. The conceptual framework attempts to elucidate the scope and the context of this research. Based on the conceptual framework a set of research hypotheses on the direct, and mediating relationships amongst OS, SCI and operational performance are proposed.

## 4.1 Theoretical Lens: Contingency Approach to Organization Structure and Supply Chain Integration

During the past two decades, structural contingency theory has been the most used theoretical framework to examine the structure-performance and SCI-performance relationships (Boon-itt and Wong, 2011; Drazin and Van de Ven, 1985; Danese et al., 2013; Flynn et al., 2010; Gimenez et al., 2012; Lin and Germain, 2003; Olson et al, 2005; Stonebraker and Afifi, 2004; Thompson, 2011; Vickery et al., 1999a). Most of the conceptual models developed in the social sciences (especially the management field), are complicated in nature, difficult to conceptualize, and dependent on many factors (e.g. Flynn et al., 2010; Galbraith, 1982; Koufteros et al., 2007a,b; Ouchi, 1981; Pascale and Athos, 1981; Stonebraker and Afifi, 2004). Therefore, it could be argued that all theories are based on the contingency theory. This is because for a hypothesis to be valid, assumptions are to be made in relation to premises, system states, and the research boundary condition (Drazin and Van de Ven, 1985; Galbraith, 1973; Sutton and Staw, 1995). The main difference of the contingency perspective in relation to other theories is in the specific type of the hypothesis made. Fry and

Schellenberg (1984) argued that contingent hypotheses are made between conditional relationships and independent contracts with dependent outcomes. This makes them more complex than congruent hypotheses where by a basic unconditional relationship is made (e.g. differentiation and organizational size).

One of the main arguments of structural contingency theory is that OS and processes must fit the context in which it operates, in order to for an organization to perform well. Therefore, the contingency theory proposes that there is no single effective method to design an organization (Donaldson, 2001; Drazin and Van de Ven, 1985; Lin and Germain, 2003; Olson et al, 2005). In other words, no theory or approach can be practical in all cases (Cole and Scott, 2000; Lawrence and Lorsch, 1967; Thompson, 2011). This implies that firms wanting a better level of operational performance need to match their internal structures, strategies, and procedures with external environments (Child, 1972; Cosh et al., 2012; Droge and Calantone, 1996; Flynn et al., 2010; Ruekert et al., 1985; Walker and Ruekert, 1987).

Accordingly two instinctively interesting statements could underlie the contingency approach: (1) there is no such thing as the best OS and (2) a specific OS or strategy would not be equivalently applicable in varying environmental or institution-specific circumstances (Galbraith, 1973; Galbraith and Nathanson, 1978). Similarly in terms of SCI, the contingency approach would imply that the different dimensions of SCI (internal, supplier and customer) would have varying effects on operational performance. Such differences could be as a result of internal (e.g. OS) and external contingent factors (e.g. environmental uncertainty in the oil and gas). Thus, the most important concept in contingent hypotheses is the notion of “fit”. Some have argued that the type of fit examined, has an impact on theory development, data collection, and method of data analysis adopted (e.g. Colquitt and Zapata-Phelan, 2007; Flynn et al., 2010; Sutton and Staw, 1995; Venkatraman, 1989). The main approaches adopted in relation to “fit” include the selection, interaction, and systems approaches. Each of these approaches considerably changes the implication of the contingency theory on the outcome of empirical studies.

The majority of earlier studies on structural fit were based on the selection approach and congruent propositions (see Drazin and Van de Ven, 1985). In the congruent theory a simple unconditional relationship is proposed to between variables. For instance, some earlier researchers explored the direct associations between structure and performance (Hage and

Aiken, 1969; Hall, 1962; Pierce et al., 1979; Tushman, 1977; Van de Ven and Delbecq, 1974). During the same period some authors also focused on the structure-context (environment) relationship (e.g. Cosh et al., 2012; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Liao et al., 2011; Lin and Germain, 2003; Wilden et al., 2013). However, the relationship amongst OS-context-performance was rarely explored in a single study. Likewise a great number of studies on SCI have also examined congruent relationships between dimensions of SCI and operational performance (e.g. Das et al., 2006; Flynn et al., 2010; Koufteros et al., 2007a; Lee et al., 2007; Petersen et al., 2005; Schoenherr and Swink, 2012; Swink et al., 2007; Zhao et al., 2013). However, it is argued that the outcome of such studies could be limited, since it did not account for other factors (i.e. interaction or contingent), which could significantly affect the direct association.

The second approach to fit is the interaction approach. Based on this approach, fit is viewed as interaction amongst variables, rather than a direct relationship. For instance, organizational researchers have commonly examined the effect of interaction between OS and environment, on organizational performance (Child, 1974; Claver-Cortés et al., 2012; Cosh et al., 2012; Drazin and Van de Ven, 1985; Germain et al., 2008; Liao et al., 2011; Negandi and Reimann, 1972; Wilden et al., 2013). In other words, authors using this fit approach, focus on explaining differences in firm performance in accordance to the interaction between OS and context, rather than focusing on congruent relationships. Some have argued such approach to fit, has an inward perspective on organizational performance (Child, 1974; Negandi and Reimann, 1972), however others suggested that taking such a reductionism approach (selection and interaction), treats the firms OS, SCI, and performance as decomposable factors that could be investigated separately.

A third and equally important approach to fit in the management field is the systems approach. The systems approach to fit argues that the components within a system cannot function in isolation and therefore must be appraised in relation to other contingents. Accordingly Drazin and Van de Ven (1985) have asserted that the interpretation of structure, context and organizational performance association could be improved by simultaneously accounting, for contingent and contextual factors that affect performance. Since the focus of this study is to examine the relationship between operational performance and SCI in the oil and gas industry, it would not be useful to measure the performance of oil and gas companies separately to supply chain performance (i.e. this industry relies on close association between many key supply chain partners). Therefore, instead of accepting the deterministic logic (e.g. all organizations need to decentralized) or an approach in which one believes “all cases differ”, the contingency theorists argue that a middle ground exists in which the variances in OS and SCI, could be analyzed in an orderly way (Birkinshaw et al., 2002; Miller, 1996; Ruekert et al., 1985; Sinha and Van de Ven, 2005). Therefore by taking a contingency perspective in examining the mediating role of SCI, this study offers a systems view on the association between OS and operational performance. This approach is also in line with the objective of this research to examine both the direct and mediating associations amongst these constructs. Through contingency view, this research attempts to provide a comprehensive explanation for the OS-SCI-operational performance associations, and develop mid-range theories of organizational fit in the context of the oil and gas supply chains. It is therefore argued that, the contingency theory provides a suitable research approach, since this study combines constructs from two different fields (organizational theory and operation management) and attempts to link them in one conceptual framework.

## 4.2 Conceptual Framework

So far in this study it has been established that both OS and SCI have a direct impact on operational performance. However, differences in conceptualizing these constructs and also the effect of the study context, has resulted in mixed outcomes. This study also demonstrated the importance of examining the above association in the complex and uncertain oil and gas industry. Despite the contribution of such industry to energy and global economic development, very limited research in operations and supply chain management has explored the structure-strategy-performance of oil and gas supply chains. Furthermore as discussed earlier in this chapter, the contingency theory approach is adopted in developing the conceptual association amongst OS, SCI, and operational performance. Therefore, three objectives were proposed to explore the mediating impact of SCI on the association between OS and operation management:

1. To ascertain the direct impact of OS dimensions (centralization, formalization and hierarchical relationship) on SCI (internal, customer and supplier), in order to suggest improvements in operational performance of oil and gas supply chains.
2. To empirically examine why and how SCI (internal, customer and supplier) mediates

the impact of OS (centralization, formalization and hierarchical relationship) on operational performance in uncertain industries, such as the oil and gas. Therefore shedding some light on the level of integration or structural reconfiguration needed for better performance in such context.

3. Develop and test a conceptual framework based on the first two objectives, in order to progress the current understanding of OS, SCI and operational performance of oil and gas supply chains.

## 4.3 Research hypotheses

Cavana et al. (2001) suggested that research hypotheses are logical speculated associations between two (or more) research variables, which are stated in a line or a statement. By testing such hypotheses and confirming or rejecting such statements, it is anticipated that an answer to the research problem can be obtained. In this section detailed discussions are presented on the proposed associations between the research concepts, alongside the summary of the relevant literature that associates OS-performance, SCI-performance, and SCI as a mediating factor between OS and operational performance.

### 4.3.1 The Direct Impact of Organization Structure on Operational Performance

Beside a small number of studies that illustrated a positive association between high degrees of centralization and organizational performance (e.g. Ettlie et al., 1984; Ruekert et al., 1985), the main body of literature in organizational theory suggests that lower centralization in OS is conducive to organizational performance at both subunit and organizational levels (Burns and Stalker, 1961; Cosh et al., 2012; Daugherty et al., 2011; Dewar and Werbel, 1979; Floyd and Wooldridge, 1992; Foss et al., 2014; Huang et al., 2010; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Lin and Germain, 2003; Pierce and Delbecq, 1977; Rapert and Wren, 1998; Schminke et al., 2000). It has been established that low degrees of centralization encourages communication, improves, improves individual satisfaction, and motivation (Burns and Stalker, 1961; Csaszar, 2012; Daugherty et al., 2011; Hempel et al., 2012; Huang et al., 2010; Olson et al., 1995). Burns and Stalker (1961) argued that in lower centralized structures, streams of lateral and vertical communication are stimulated, and “expert opinion” has a greater impact on decision-making processes compared to “designated authority”. Therefore, it is argued that staff working in such conditions would feel a greater sense of empowerment.

Similarly Germain et al. (1996) suggested that in such organizations employees feel more responsible and are willing to come up with innovative solutions (problem-solving).

Schminke et al. (2000) argued that with lower degrees of centralization, organization responsiveness to market conditions is improved. A highly centralized organization therefore constrains the associations (i.e. inter and intra) amongst individuals in a firm (Gold and Arvind Malhotra, 2001; Olson et al., 1995; Willem and Buelens, 2009) and decreases the prospect of staff development (e.g. Claver-Cortés et al., 2012; Foss et al., 2014; Lin and Germain et al., 2003; Kennedy, 1983). Additionally researchers have also argued that lower centralization improves lead-time (e.g. reducing the reporting line for decision making) (Damanpour, 1991; Germain, 1996; Moenaert et al., 1994). It also enables more efficient internal communication (Bennett and Gabriel, 1999; Csaszar, 2012; Hage et al., 1971; Huang et al., 2010), and increase employee participation and creativity (Ji and Dimitratos, 2013; Khandwalla, 1977; Koufteros et al., 2007b; Miller, 1971). Likewise Sivadas and Dwyer (2000) emphasized that higher centralization, may weaken efficiency, because it raises discernments of bureaucratic structuring. This in turn could reduce the willingness of employees to engage in teamwork or group projects. More recently authors have also highlighted that lower centralization increases organizational flexibility, responsiveness, information distribution, knowledge gathering, and the organization's ability to cope with external uncertainties (e.g. Cosh et al., 2012; Jaworski and Kohli, 1993; Lin and Germain, 2003; Wilden et al., 2013).

Based on this review, it is evident conflicting arguments and conceptualizations of centralization exist in the literature. However these discrepancies could be linked to the different aspects of centralization and how they have been measured. The focus of this study to examine the relationship amongst OS, SCI, and operational performance in the oil and gas supply chains, therefore centralization is conceptualized from an operational perspective. Thus it is hypothesized that in the context of oil and gas supply chains:

*H1.a Centralization is negatively related to operational performance.*

There are conflicting arguments on the different levels of formalization and its impact on performance. Some authors argued that if a minimum level of formalization does not exist, there is a possibility that role ambiguity may occur (e.g. Cosh et al., 2012; Germain et al., 2008; Hempel et al., 2012; Hirst et al., 2011; Nahm et al., 2003; Rizzo et al., 1970). For example, Thompson (2011) suggested that formalization could reduce organizational conflicts, since individual roles are clearly documented or defined. Schwenk and Shrader's (1993) research on small sized organizations found that formalized planning improved performance. In a meta-analytic review by Damanpour (1991) high formalization was found to have a negative impact on operational performance (innovation). The author argued that a number of studies have highlighted the importance of well-established rules and regulations for performance (innovation, assimilation of new employees).

On the other hand, in organizations where employees are empowered to take initiatives, a proactive problem-solving behavior is encouraged. Therefore, it has been suggested that highly formalized structure has a negative impact on staff motivation, autonomy, innovation and performance (Aiken and Hage, 1971; Clercq et al., 2013; Daugherty, 2011; Damanpour, 1991; Pierce and Delbecq, 1977). This is because in such organizations members are discouraged from actively generating new ideas, when faced with non-routine processes (e.g. oil and gas drilling failure). Authors have argued that higher work supervision resulted in the drop of staff morale (e.g. Hempel et al., 2012; Liao et al., 2011; Schminke et al., 2000; Worthy, 1950). Furthermore others have suggested that formalization rigorously limits the level of individual freedom and discretion in carrying out tasks (Forehand and Von Haller, 1964; Koufteros et al., 2007b; Hall et al., 1967; Wilden et al., 2013). Khandwalla (1977) suggested that formalization diminishes organizational performance, because it constrains flexibility, open communication, and quick competitive response. Likewise Zaltman (1979) argued that, formalized structures are less flexible, thus making it difficult to effectively use and share knowledge across organizations. Sivadas and Dwyer (2000) indicated that the use of explicit rules and regulations were barriers to organizational flexibility. Similarly Baum and Wally (2003) noted that formalization inhibits resource flexibility (e.g. resource allocation, and initiative taking in non-routine processes). Lin and Germain (2003) further highlighted that formalization could be viewed negative when it results to insufficient communication, and unanticipated conformity in planning and implementation (see also Mintzberg, 1979).

Therefore, it can be argued that formalization weakens creativity and employee’s capability to adjust to non-standardized/non-routine job environments (e.g. Daugherty et al., 2011; Hirst et al., 2011; Koufteros et al., 2007b). In such case formalization can be used as a tool to cope with external uncertainties, rather than a mechanism for enforcing rigid rules and regulations (e.g. Kelley et al., 1996; Koufteros and Vonderembse, 1998; Wilden et al., 2013). Based on the literature review, this research acknowledges the conflicting arguments and research outcomes on the different levels of formalization and its impact on performance. However such variations could be attributed to the way formalization has been conceptualized and measured in previous studies (e.g. different features, soft or hard factors, context). Due to the high levels of uncertainty in the oil and gas industry, it is an essential capability for employees to make quick and speedy decisions. However, because of the high levels of risk, companies are forced to implement rigid routine processes. So the focus of this study is to explore the impact of formalization of non-routine processes (e.g. supplier, material, and equipment selection). Thus, it is hypothesized that in the context of oil and gas supply chains:

*H1.b Formalization is negatively related to operational performance*.

In the organizational literature hierarchical relationship has also been closely associated with span of control. Vickery et al. (1999a) suggested that "higher number of layers" in an organization would consequently result in "wider spans of control". The authors concluded that decisions that need to pass through excessive hierarchical layers take a lot of time and are usually made by individuals that are not directly in the 'trenches'. Thus, decreasing the number of hierarchical levels, and empowering lower level staff to execute decisions traditionally made by hierarchies, could be carried out simultaneously. It has been argued that hierarchical relationship affects communication, control, and coordination, amongst organizational members (e.g. Huang et al., 2010; Jacobides, 2007; Ji and Dimitratos, 2013; Koufteros et al., 2007b; Stevenson, 1990). Sub-functions within a hierarchical relationship are differentiated from adjacent functions and the total organization according to vertical relationships (Hall, 1996). Accordingly authors have suggested that, the number of layers in the hierarchy enhances relations makes communication channels more complex and could obstruct the flow of information and data (Damanpour, 1991; Huang et al., 2010; Hull and Hage, 1982; Jacobides, 2007; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Nahm et al., 2003; Tushman and Scanlan, 1981). Blau (1968) suggested that organization with many levels of hierarchy usually have more precise promotion principles, emphasizing merit rather than seniority.

On the other hand, Carzo and Yanouzas (1969) investigated such relationship in a laboratory format. They found that the amount of time needed to complete decisions did not vary considerably between organizations with many levels of hierarchy compared to those with low levels. However, organizations with more levels of hierarchy were shown to have fewer issues in relation to conflict resolution and coordination efforts. The authors argued that such results were contextual since they were laboratory constructs rather than organizationally derived. Ivancevich and Donnelly (1975) suggested that salespersons were more efficient in organizations with lower levels of hierarchy. Other authors argued that taller hierarchical relationships decreased the quality of feedback received from supervisors and co-workers (e.g. Foss et al., 2014; Huang et al., 2010; Ji and Dimitratos, 2013; Rousseau, 1978). Studies have also illustrated difference in communication behavior in relation to hierarchical level. For example MacLeod et al., (1992) suggested that more oral and informal communication took place between bank managers in hierarchical firms.

Based on the review, hierarchical relationship was argued to be a significant structural element of OS dimensions. It forms the organizational skeleton, or structural layout; therefore an essential dimension in the conceptualization of OS. Studies have shown that hierarchical relationship has an impact on operational performance. Although there have been varying outcomes on the relationship between hierarchical relationship and operational performance, it is generally understood that flatter OS, positively impact firm performance (more efficient information sharing and faster decision-making) (e.g. Huang et al., 2010; Koufteros et al. 2007b; Nahm et al., 2003; Vickery et al., 1999a). Therefore, it is hypothesized that in the context of oil and gas supply chains:

*H1.c Hierarchical relationship is negatively related to operational performance.*

### 4.3.2 The Direct Impact of Supply Chain Integration on Operational Performance

Researchers generally view that SCI has a positive effect on organizational performance (e.g. Das et al., 2006; Devaraj et al., 2007; Flynn et al., 2010; Liu et al., 2012; Prajogo and Olhager, 2012; Sanders, 2008; Villena et al., 2009). However, some researchers have echoed concerns over the right level of SCI required maximizing operational performance in both practice and research. For example, there were studies that did not find a direct (e.g. Stank et al., 2001a) or found a negative association (Koufteros et al., 2005; Swink et al., 2007) between SCI and operational performance. Such differences in outcome could be mainly because it is difficult to define the scope of SCI, and it may also be costly to implement in practice. It is therefore argued that the relationships between OS, SCI and operational performance cannot be fully appreciated through direct association only. Instead, it is the complex interactions between these variables that lead to better understanding of their impact on organizational performance.

Numerous researchers have argued that internal integration encourages greater intra-firm goal alignment between different functions (e.g., purchasing, planning, manufacturing, and logistics) mainly through higher integration of data/information system sharing and cross-functional collaboration (Schoenherr and Swink, 2012; Williams et al., 2013). For example, Pagell (2004) stressed that internal integration also enables the usage of individual function's competencies, and illustrates the functional interdependencies.

A closer investigation of the current SCI studies specified two significant outcomes. Firstly, a stream of literature indicates that that knowledge sharing and values obtained using internal integration aid companies in strengthening their collaboration with customers and suppliers. Cooperation between different functional units appeared to be a significant element for creating a partnership with the partners outside the company boundaries. Vickery et al. (2003) reported a direct and significant association between SCI (including cross functional team integration) and customer service. In another study Swink et al. (2007) also reported that internal product-process technology integration enhances manufacturing abilities that result in better customer satisfaction.

Secondly, such studies also offered signs that internal integration has either a direct or indirect effect on operational performance (Danese and Romano, 2011; Danese et al., 2013; Frohlich and Westbrook, 2001; Lau et al., 2010; Rosenzweig et al., 2003; Stank et al., 2001a; Stank et al., 2001b) and financial performance (e.g. Droge et al., 2004; Flynn et al., 2010; Frohlich and Westbrook, 2001; Kim, 2009; Koufteros et al., 2005; Narasimhan and Kim, 2002; Petersen et al., 2005; Rosenzweig et al., 2003; Swink et al., 2007). For example, Koufteros et al. (2005) found that a high degree of internal integration activities (e.g. concurrent workflow and early involvement) are critical enablers, which assist the timely trade of key data (know-hows) in relation to competitive capabilities amongst customers and suppliers. Although in some research a direct association was not found amongst internal integration and operational performance (Koufteros et al., 2005; Gimenez and Ventura, 2005), other researchers managed to find direct positive association, including enhancing customer satisfaction, productivity, financial performance and development time (Allred et al., 2011; Chen et al., 2007), developing competitive capabilities (Rosenzweig et al., 2003), improving quality, cost, and delivery (Swink et al., 2007), enhancing quality, delivery, and flexibility (Boon-itt and Wong, 2011; Wong et al., 2011b), improving process efficiency (Saeed et al., 2005), improving responsiveness performance (Danese et al., 2013), increasing time-based performance (Droge et al., 2004), enhancing logistics and service performance (Germain and Iyer, 2006; Stank et al., 2001a; Stank et al., 2001b), developing product development cycle time or responsiveness (Droge et al., 2004), and improving schedule attainment and competitive performance (Zhao et al., 2013). Thus, it is hypothesized that in the context of oil and gas supply chains:

*H2.a Internal integration is positively related to operational performance.*

Supplier integration is considered one of the most common types of SCI (Fawcett and Magnan, 2002). As much as internal integration is vital to an organization success, it cannot by itself guarantee continual improvement of the competitive advantage. For example, Petersen et al. (2005) argued that in uncertain and turbulent business environments, companies require to obtain more precise data and information in order to leverage supplier network and resources. It is vital for a focal company to communicate effectively with its major supplier and to frequently upgrade data gathered in the internal integration processes. This should happen since the focal company may have outdated data that do not expose new or ongoing problems in the real business environment (Das et al., 2006; Handfield et al., 2009; Narasimhan et al., 2010). As argued earlier supplier integration is obtained through data sharing, and collaborations amongst companies and their suppliers (Ragatz et al., 2002). When this occurs, there is more of a chance to facilitate regular deliveries in smaller sizes, utilize more than one source of supply, assess substitute supply sources in relation to quality and delivery instead of cost, and create long-term relationships with suppliers to enhance performance (Handfield et al., 2009). Such mutual and timely exchanging of operational and market data, enables the focal firm to better predict and respond to alterations in customer demands (Zailani and Rajagopal, 2005). A supplier cooperates with the foal company as either a seller offering equipment parts/components or as a strategic collaborator sharing expertise and know-hows (data and information) (Bernon et al., 2013). Koufteros et al. (2010) noted that a supplier is basically included in the focal company's purchasing procedure and has the one and only obligation to produce the goods. It is essential for the focal company to pay a lot of attention in selecting an appropriate supplier, checking delivered goods, and controlling related procedures.

On the other hand some authors have argued that suppliers play an essential role as strategic collaborators, permitting focal companies to access their operational and technological resources (Alfalla-Luque et al., 2013; Droge et al., 2004; Narasimhan et al., 2010). Because suppliers tend to collaborate with the focal company in different processes, this sort of SCI is referred to in literature as supplier process integration. Koufteros et al. (2007a) termed such type of integration as the gray-box approach. The aim of this type of integration is to generate communication, leverage supplier's competencies, and accomplish shared goals. Accordingly Droge et al. (2004) argued that by utilizing the critical technological ability and competency of suppliers, the focal company could then diminish any alteration in design, avoid delays, and give itself a good chance of carrying out parallel processing. The authors further suggested that that qualified and competitive supplier are more beneficial to focal companies since they tend to have technical capabilities, innovative capacity, and a dynamic business network, which they have established through supplier development programs (e.g. certification program, site visit by buying firm, feedback loop in relation to performance evaluation). The view of suppliers acting as strategic collaborators has also been reflect in Petersen et al. (2005), where the authors suggested that suppliers could also support the focal company in a number of product development steps, for example generating ideas, initial technological appraisal, developing concepts and carrying out tests.

Based on the transaction cost perspective, supplier integration is capable of decreasing transactional costs (Flynn et al., 2010; Zhao et al., 2008; Zhao et al., 2011). The shared vision and cooperative goals achieved through supplier integration reduces opportunistic behavior. Additionally supplier integration helps decrease uncertainties, which in itself reduces costs. For example, Das et al. (2006) argued that reduction in environment uncertainties were hugely successful by investing in definite assets (e.g. information systems and committed staff) that enable data sharing and mutual processes. This research argues that supplier integration facilitates the reduction of production costs in two approaches. Firstly the increased level of supplier integration is typically associated with smaller number of suppliers. This enables suppliers to achieve economies of scale and consequently a reduction in material and product costs (Zhao et al., 2013). Secondly by creating trust and collaboration with suppliers, the focal company will be motivated to invest more in fixed assets and R&D processes, in order to enhance the suppliers and its own product/process quality and reduce cost. Similarly Zhao et al. (2013) added that supplier integration also enables the focal firms to decrease their inventory and increase delivery speed, quality, and customer service by sharing data and working closely with their suppliers. Thus, it is hypothesized that in the context of oil and gas supply chains:

*H2.b Supplier integration is positively related to operational performance.*

By taking a marketing perspective customers could be viewed as decision-makers who attain potential purchasing power and assess the features of the products (Boon-itt and Wong, 2011). Customer integration hugely depends on sharing data, know-hows and information between the focal company and the customer (He et al., 2014). Therefore, the lack of information sharing from both ends of the SC could result in tremendous inefficiencies in relation to customer service (Lee et al., 2007). Customers typically provide their insight and judgment on a product through surveys or in person (to selling company), however the focal company offers operational data to customers, such as schedules of their production, level of inventory, and sales forecast (Danese and Romano, 2013; Lau et al., 2010; Moyano-Fuentes et al., 2012). Accordingly customer-driven companies are in more regular contacts with their customers in order to inspire customers to get involved in the product development stages and also to create feedback tools (Koufteros et al., 2010; Swink et al., 2007; Zhao et al., 2011). Such companies typically embrace a variety of tools (information technology) to exchange data with customers. Subsequently, these customer-driven companies will be capable of implementing collaborative initiatives such as automatic replenishment programs including vendor managed inventory, efficient consumer response, and quick response used to capture the exact customer demand and comprehend the changes in customer needs (Daugherty et al., 1999).

Additionally in a study carried out by Flynn et al. (2010) it was suggested that communicating with customers largely depended on the company's technological ability and infrastructure. They also gave examples such as points of sale systems, inventory management systems, and customer ordering systems. By using such systems the focal company can take advantage of the increased accuracy in their demand forecast and also increase their speed in identifying demand variations (Droge et al., 2012; Flynn et al., 2010; Huo, 2012; Vickery et al., 2003). This can also increase the supplier's order quantity decisions in multi-stage serial systems, since information about customer's inventory levels decreases the demand uncertainty faced by the supplier (Danese and Romano, 2012). Therefore, companies that have demand-oriented activities are also enabled to reduce business environment uncertainty, avoid costly errors, and possible delays (Danese and Romano, 2012; Koufteros et al., 2005). Different authors have suggested that data and information sharing is an important aspect of coordination in SCI that affects performance. For example, in a study carried out by Sahin and Robinson (2005) it was suggested that integration at various layers in the SC contributes to performance by improving data and information exchange, and fostering coordination amongst supplier and customer (e.g. joint improvement efforts, close contact and partnership). Accordingly, Swink et al. (2007) argued that SCI involves more efficient information sharing in aligning operational activities (e.g. ordering and payment systems, production planning) amongst a supplier and a customer, and an enhanced co-ordination of strategic activities (e.g. relationship building, joint improvement activities) that enable customer and supplier intimacy. As reported in studies (e.g. Frohlich and Westbrook 2001), coordination enables an attitude of problem sharing, collaboration, open communication, and inter-company decision making practices, which assure more effective problem solving methods are attained (Danese and Romano, 2012). Therefore, it is hypothesized that in the context of oil and gas supply chains:

*H2.c Customer integration is positively related to operational performance.*

### 4.3.3 The Direct Impact of Centralization on Supply Chain Integration

In organization with high levels of centralization, the authority to carry out decisions is given to the managers at the apex of the OS (Aiken and Hage, 1968; Fry and Slocum, 1984; Koufteros and Vonderembse, 1998; Nahm et al., 2003; Zaltman and Duncan, 1977). Under the framework of this research, it is important to note that the focus is on operational level centralization and not corporate (Macro) level (Adler, 2012; Aiken and Hage, 1966; Baum and Wally, 2003).

Centralizing operational level decision-makings could obstruct the flow of information, information processing and collaboration (Daugherty et al., 2011; Fiol and Lyles, 1985;

Galbraith, 1973; Huang et al., 2010; Jansen et al., 2012; Ji and Dimitratos, 2013). In a company with a structure that centralizes operational decision, middle and lower level operational managers are required to report to higher C-level managers and do not have the autonomy to carry out tasks before the approval of their superior (has severe consequences in the oil and gas industry, which requires timely decision across its supply chain). Accordingly it has been suggested that centralized structures necessitate that top-level managers carry out the majority of decisions, which could overstretch their cognitive capabilities and inflict substantial time restriction on such managers (Foss et al., 2014; Hempel et al., 2012; Hirst et al., 2011; Miller, 1987). This could affect and obstruct planning and analysis across the organization (Galbraith, 1973; Huang et al., 2010; Mintzberg, 1973). Whereas if an organization decentralized its structure, it would distribute decision-making tasks between a number of organizational members, and these additional resources would enable better analytical approaches (Fredrickson, 1986). Therefore it could be argued that a higher level of participation and contribution by a broader range of staff members takes place (Csaszar 2012; Germain et al., 1996; Hirst et al., 2011)

Furthermore in centralized structures, decisions are made at levels quite far away from day-to-day operational challenges. It could be argued that, since excessive centralization decreases information sharing amongst functional specialists (e.g. Claver-Cortés et al., 2012; Daugherty et al., 2011; Jansen et al., 2012; Olson et al., 1995), the focus of such organizations would be on controlling vertical relationships in opposite to horizontal relationships related with internal integration. Additionally Hage et al. (1971) suggested that centralization decreases the frequency of impulsive cross-departmental communication and information sharing, and affects a firm's ability to achieve internal integration (e.g. Schoenherr and Swink, 2012; Williams et al., 2013). Lastly, it has also been suggested that high centralization could lead to data and information alteration due to the numerous layers of intermediates in highly centralized firms.

For this reason, this study expects operational level centralization (Micro) to be negatively associated to internal integration.  It is generally accepted that most of the inter-firm contact points in daily operational activities are the middle and lower level staff (e.g. line managers) and not C-level managers (e.g. Mintzberg, 1973). Such operational level managers are usually the experts in the domain they operate in, and are often equipped with the right external contacts for accessing external knowhow and information, required for making quick and accurate operational decisions. For staff members that are required to directly deal with customers and suppliers (for everyday business), centralized structures that disable the authority or autonomy (empowerment) to make or participate in decisions could demoralize them from proactively managing issues they come across. This commonly results in suppliers and customers sensing isolation since they have to interact with procedures and policies rather than an individual. It is therefore argued that, the advantages of enhanced coordination and control are prone to be inhibited by the disadvantages associated to the low level of trust and cooperation that centralized structures create. It is hypothesized that in the context of oil and gas supply chains:

*Hypothesis 3a: Centralisation is negatively related to internal integration.*
*Hypothesis 3b: Centralisation is negatively related to supplier integration.*
*Hypothesis 3c: Centralisation is negatively related to customer integration.*

### 4.3.4 The Direct Impact of Formalization on Supply Chain Integration

A review of the literature revealed that formalization creates greater isolation amongst functional managers and staff (Daugherty, 2011; Koufteros and Vonderembse, 1998; Liao et al., 2011; Mahmoudi and Miller, 1985; Vickery et al., 1999a). It has also been reported that high levels of formalization constrains flexibility, open communication, and quick competitive response (Khandwalla, 1977). Furthermore authors have also suggested that formalized structures create rigid environments which make it more challenging to obtain and use knowledge through organization mediums (Aiken and Hage, 1971; Clercq et al., 2013 Daugherty, 2011; Clercq et al., 2013; Damanpour, 1991; Pierce and Delbecq, 1977; Zaltman, 1979). Therefore firms with high levels of formalization are able to codify job responsibilities and monitor job rules closely (Pugh et al., 1968).

Mintzberg (1979) suggested that less formalized structure are more flexible in responding to demand uncertainties arising from the industry. This could be because less formalized structures enable faster awareness and response time (towards customers and suppliers), allow more efficient communication and information sharing to take place, and decrease the time needed to take actions (e.g. subordinates do not have to refer all task to supervisors for approval) (Daugherty, 2011; Koufteros and Vonderembse, 1998; Liao et al., 2011; Snow and Miles, 1992). Accordingly Moorman et al. (1993) suggested that highly formalized structures constrained communication, collaboration and trust, particularly since the foundation for collaboration and mutual trust is situated in the interpersonal association amongst supply chain partners (e.g. supplier and customers). Since formalization typically constrains organization members to obey the written rules and policies, it could endorse strictness and inflexibility and consequently damaging external integration (with suppliers and customers) (Clercq et al., 2013; Dewar and Werbel, 1979; Dwyer et al., 1987; Liao et al., 2011; Miner, 1982). Similar to centralization, an organization's supplier and customer could end up sensing isolation since they have to interact with procedures and policies rather than an individual. Additionally when an organization is ran by highly formalized rules it can limit flexibility and innovation, and forbid the organizational members to find unique solutions. The effect of such structure could be more severe in an uncertain and dynamic such as the oil and gas, which would require close interaction between the organizational members and supplier or customers. In such an industry whereby know-hows and technologies are advancing at high paste, staff should have autonomy in their activities, in order to be more creative and find solutions to both supplier and customer related problems (problems never faced before or occurred historically).

Operational managers working under tougher and uncertain environments (e.g. oil and gas) require effective usage of information and knowledge in order to make timely decisions. They need structures that enable a flow of rich communication and information sharing across the traditional department boundary, in order to be able to identify cross-boundary risks that would be impossible to spot individually (or each function by itself). In such uncertain business environments, perceptions of uncertainty rises in situations where change is quick, making it difficult to predict the direction of such change and consequently creates a situation where staff would need to act outside their job codification. Therefore by formalizing procedures, organizations could discourage proactive problem solving (Daugherty et al., 2011; Fredrickson, 1986; Hall et al., 1967; Hirst et al., 2011; Koufteros et al., 2007b; Wilden et al., 2013). Thus it could be argued that such organizations focus more on managing vertical relationships in opposite to horizontal relationships related with internal integration. Based on the arguments presented above (and in the literature review), this study hypothesizes that formalization is negatively related to SCI:

*Hypothesis 4a: Formalisation is negatively related to internal integration.*
*Hypothesis 4b: Formalisation is negatively related to supplier integration.*
*Hypothesis 4c: Formalisation is negatively related to customer integration.*

### 4.3.5 The Direct Impact of Hierarchical Relationship on Supply Chain Integration

Hierarchical relationship is an OS dimensions referred to in literature as complexity. Organizational complexity represents the level to which different departments (functions) and subunits are defined with relation to goals, targets, job orientation, time horizon and level of work autonomy, and is typically in two direction, horizontal and vertical (Daft, 2006; Hage and Aiken 1967a; Hage and Dewar, 1973; Hall, 1996; Huang et al., 2010; Koufteros et al., 2007b; Lawrence and Lorsch, 1967; Nahm et al., 2003; Walton, 1984). Accordingly Bedeian (1984) defined complexity as the number of distinct functions within an organization as characterized by hierarchical levels (vertical complexity) and functional labor division (horizontal complexity). Typically, a greater degree of complexity creates problems in obtaining effective internal integration. Such difficulties have been associated to the higher levels of hierarchical divisions between C-level and lower operational managers (Lawrence and Lorsch, 1967; Mintzberg 1979). Additionally Galbraith (1973) highlighted the importance of lower organizational complexity in achieving interdepartmental integration; the author defined such lateral information processing and proposed methods such as direct contact, liaison roles, and integrators to achieve interdepartmental relations. Complexity has also been shown to restrict the aptitude of staff to identify and react to strategic level problems. Data and knowledge barriers, and inward-looking interests and concerns between different levels of division are disadvantages associated to high complexity, which obstruct or limit collaboration, knowledge sharing, and consensus in decision making (Koufteros et al., 2007b; Mintzberg, 1979; Nahm et al., 2003; Vickery et al., 1999a). Hierarchical relationship (or flatness) is therefore measured in terms of the number of management levels in the chain of command (Hall, 1996), and is suggested to affect SCI. The taller OS is more complex, since it includes more hierarchical levels through which data and knowledge is distributed and received by decision-making managers (Jacobides, 2007; Huang et al., 2010; Koufteros et al. 2007b; Nahm et al., 2003; Vickery et al., 1999a). This consequently makes the communication process and coordination slower and less accurate (Damanpour, 1991; Foss et al., 2014; Huang et al., 2010; Hull and Hage, 1982; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Tushman and Scanlan, 1981). Accordingly an organization wanting to achieve a good level of internal integration would require its staff to have a broad knowledge on the procedures, customs, technologies, and practices. Such common knowledge aids staff in comprehending and valuing the potential advantages associated to integration and thus enabling them to take appropriate measures (see Grant, 1996).

In relation to external integration, organizations with higher levels of hierarchical relationship also reduce the number of actors at each layer. This consequently decreases the number of possible contact points the supplier and customers of the organization will have at each layer of the hierarchy (Ji and Dimitratos, 2013; Huang et al., 2010; Kostova and Roth, 2003; Koufteros et al., 2007b; Tushman and Scanlan, 1981). Thus in uncertain industries that many of the potential issues need to be mutually solved between the organization and its suppliers and/or customers, the operational level staff (that are required to solve the issue) can directly come in contact with those who deal with the issue on a daily basis and understand it better. For this reason this research proposes:

*Hypothesis 5a: Hierarchical relationship is negatively related to internal integration.*
*Hypothesis 5b: Hierarchical relationship is negatively related to supplier integration.*
*Hypothesis 5c: Hierarchical relationship is negatively related to customer integration.*

### 4.3.6 Mediation effect of Supply Chain Integration

Centralization of operational decision-makings obstructs the flow of information, information processing and collaboration (Daugherty, 2011; Galbraith, 1973; Hempel et al., 2012; Ji and Dimitratos, 2013; Liao et al., 2011). It is generally agreed that companies in volatile industries require timely flow of data and information amongst different internal departments and teams to be able to better meet performance objectives (higher operational performance). Thus, the negative effect of centralization on the ability of a company to effectively react to (unpredictable) operational alterations in projects is diminished through combining and developing internal information and resources associated to internal integration. This produces know-hows and knowledge beyond the boundaries of single department (Alfalla-Luque et al., 2013; Fabbe-Costes and Jahre, 2007; Koufteros et al., 2010; Sanders, 2007; Zailani and Rajagopal 2005; Zhao et al., 2011; Zhao et al., 2011). Therefore it is hypothesized that in the context of oil and gas supply chains:

*Hypothesis 6a: internal integration mediates the negative impact of Centralization on* operational performance.

Based on the literature review under this research it has been suggested that formalization creates greater isolation amongst functional managers and staff (Daugherty, 2011; Koufteros and Vonderembse, 1998; Liao et al., 2011; Mahmoudi and Miller, 1985; Vickery et al., 1999a). In volatile industries companies could comprise of many non-routine policies and procedures on a regular basis. By essentially codifying the responsibility and closely supervising individual role, companies restrict or force staff to be less motivated in taking initiatives (especially when operational problems occur). Consequently if these individuals (experts in domain) are not able to make up informal and situational rules to tackle such problems, this could result in huge implications in terms of both internal operational performance, and also external and environmental damage. Based on such logic, it is argued that internal integration reduces the negative impact of formalization on operational performance. In other words, by essentially enabling a systematic coordination between departmental functions and mutual problem-solving initiatives, internal integration attempts to abolish traditional departmentalization and functional borders (Aryee et al., 2008; Germain and Iyer, 2006; Zhao et al., 2011). Thus:

*Hypothesis 6b: internal integration mediates the negative impact of Formalization on* operational performance.

It has been suggested that the higher numbers of hierarchical divisions between C-level and lower operational managers obstruct information and knowledge flow (Jacobides, 2007; Ji and Dimitratos, 2013; Huang et al. 2010; Koufteros et al., 2007b; Nahm et al., 2003; Vickery et al., 1999a). In unpredictable and volatile industry, timely flow of data and information amongst different hierarchical divisions is necessary in order to better meet performance objectives (higher operational performance). This implies companies with many different layers of hierarchy could restrict (through hierarchical and departmental bureaucracy) the aptitude of operational staff to identify and react to strategic level problems. Additionally authors have also suggested that such organizations the communication process and coordination slower, less accurate, and with more distributions, since it has to travel through many different layers (Damanpour, 1991; Foss et al., 2014; Huang et al., 2010; Hull and Hage, 1982; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Tushman and Scanlan, 1981). Accordingly by attaining a good level of internal integration, the company is able to produce knowledge beyond the hierarchical distinctions and lessen the communication inaccuracy and distribution (richer flow of data). Thus:

*Hypothesis 6c: internal integration mediates the negative impact of* hierarchical relationship *on operational performance.*

The majority of the inter-firm contact points between company and its suppliers are the middle and lower level staff (e.g. line or operational managers) and not C-level managers. Consequently it is argued that if centralization of operational decision is high (no autonomy to carry out tasks) this will affect the efficiency of such individuals in reacting to operational alterations, in a sense that they would either not be able to act upon their experience, or are not allowed to participate in the decision making process. Through supplier integration the company and its suppliers share and apply operational, financial, and strategic knowledge and data in order to generate mutual benefits (e.g. Childerhouse and Towill, 2011; Danese, 2013; Danese and Romano, 2011; Das et al., 2006; Droge et al., 2012; Huo, 2012; Leuschner et al., 2013; Lockström et al., 2010; Narasimhan et al., 2010; Petersen et al., 2005; Swink et al., 2007; Vereecke and Muylle, 2006). This process enables closer coordination, cooperation, communication between the supplier and a flexible domain expert on the other side. Based on this logic this research suggests that supplier integration can diminish the sense of isolation (interacting with procedures and policies, rather than individuals), suppliers might feel as a result of a centralized OS. Thus:

*Hypothesis 7a: Supplier integration mediates the negative impact of centralization on* operational performance.

As argued above in real life the majority of the inter-firm contact points between the oil and gas company and its suppliers are the middle and lower level (e.g. line managers) and not C-level managers (Koufteros et al., 2007b; Nahm et al., 2003). Accordingly by formalizing non-routine policies and procedure a company restricts its staff's (or domain experts) ability to react (be creative or take the initiative) to its supplier in the uncertain industry they operate in. Furthermore highly formalized structures have also been argued to constrain communication, collaboration and trust, and essentially taking away the human touch in the relationship between the organization and its suppliers (e.g. Daugherty, 2011; Koufteros and Vonderembse, 1998; Liao et al., 2011; Moorman et al., 1993; Snow and Miles, 1992). However, through supplier integration the oil and gas company and its suppliers share and apply operational, financial, and strategic knowledge and data in order to generate mutual benefits (Childerhouse and Towill, 2011; Danese and Romano, 2011; Das et al., 2006; Droge et al., 2012; Huo, 2012; Leuschner et al., 2013; Lockström et al., 2010; Narasimhan et al., 2010; Swink et al., 2007). Thus such interactions can diminish the sense of isolation (interacting with procedures and policies, rather than individuals); suppliers might feel as a result of a highly formalized OS. Therefore it is argued that:

*Hypothesis 7b: Supplier integration mediates the negative impact of Formalization on operational performance.*

It has been argued earlier that companies operating in unpredictable and volatile markets require timely flow of data and information between themselves and their suppliers (e.g. for joint problem solving initiatives, requiring specific material in timely manner). Accordingly companies with many different layers of hierarchy have been argued to reduce the number of actors at each layer and thus reducing suppliers' contact points (Damanpour, 1991; Foss et al., 2014; Huang et al., 2010; Hull and Hage, 1982; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Tushman and Scanlan, 1981). Therefore, this research argues that in organizations with high hierarchical relationship, if staff (operational level experts) are interacted (as a result of internal integration) with in accordance to their expertise (not their individual position in a scalar chain), a better, richer, and mutual understanding is developed between the focal company and its supplier. This diminishes the negative impact of hierarchical relationship on operational performance. Therefore, it is hypothesized that in the context of oil and gas supply chains:

*Hypothesis 7c: Supplier integration mediates the negative impact of hierarchical relationship on operational performance*

If centralization of operational decision were high (no autonomy to carry out tasks), this would affect the efficiency of the lower level manager to operational alterations. By centralizing the authority to make decisions, such domain experts are not be able to act upon their experience or are not allowed to participate in the decision making process. Under this research customer integration has been viewed as the mutual participation of customers (e.g. NOCs) with focal company, strategically distributing data, information and know-how's about their demands and the company's performance level (e.g. such as quality, delivery time, and cost) (Devaraj et al., 2007; Fabbe-Costes and Jahre, 2007; Koufteros et al., 2010; Zhao et al., 2011). Additionally in an industry in which customers are typically not the final consumers (e.g. NOCs that contract or sub contract an oil and gas project to an IOC, whom have their own set of customers and demands), customer integration becomes an essential feature in better understanding the requirements of such customers (Thun, 2010). Thus by closely integrating with its key customers, focal companies are able to penetrate deep into the customers firm, enabling it to develop a better understanding of the customer's preferences, culture, market and organization (Boon-itt and Wong, 2011). This process enables closer coordination, cooperation, and communication between the customer and flexible domain expert on the other side. Based on this logic this research suggests that customer integration diminishes the sense of isolation (interacting with procedures and policies, rather than individuals), the customers might feel as a result of a centralized OS. Therefore:

*Hypothesis 8a: Customer integration mediates the negative impact of centralization on operational performance.*

In industries that the focal company faces uncertainties from a variety of sources such as, political and governmental incentives, world economics (cost implications), geographical distribution of reserves, and war and terrorism; it is generally perceived that by formalizing non-routine policies and procedure companies restrict their staff's (or domain experts) ability to react (be creative or take the initiative) to changes in customer demand. Furthermore by formalizing such processes less flexibility is given to operational experts (line managers) in determining who is able to choose or react, and even how to choose or react (e.g. Baum and Wally, 2003; Daugherty, 2011; Hirst et al., 2011; Liao et al., 2011; Wilden et al., 2013). As presented in the previous section, by closely integrating with its key customers, the company penetrates deep into the customer's company, enabling it to develop better understanding of the customer's preferences, culture, market and organization (Boon-itt and Wong, 2011). Thus it is argued that:

*Hypothesis 8b: Customer integration mediates the negative impact of formalization on operational performance.*

It has been argued above that companies operating in unpredictable and volatile industry require timely flow of data and information between operational decision makers and their customers (e.g. for joint problem solving initiatives, requiring specific material in timely manner). Consequently it has been reported that in taller OS, decisions are passed through excessive hierarchical layers, take a lot of time, and are usually made by individuals that are not directly in the ‘ trenches’ (low level domain experts) (Vickery et al., 1999a). Accordingly companies with many different layers of hierarchy have been argued to reduce the number of actors at each layer and thus reducing customers’ contact points (Huang et al., 2010; Jacobides, 2007; Ji and Dimitratos, 2013; Kostova and Roth, 2003; Koufteros et al., 2007b; Tushman and Scanlan, 1981). Thus this research suggests that in organizations with high hierarchical relationship, if staff (operational level experts) are empowered and interacted (as a result of internal integration) with in accordance to their expertise (and not their individual position in a scalar chain), a better, richer and mutual understanding is developed between the focal company and its customers. This diminishes the negative impact of hierarchical relationship on operational performance. Therefore:

*Hypothesis 8c: Customer integration mediates the negative impact of hierarchical relationship on operational performance.*

## 4.4 Theoretical Model and Associated Hypotheses

Table 4.1 presents the 24 hypotheses in relation to the four research questions under investigation. The research examines the nature of the relationship amongst the seven different research constructs. The negative relationship suggested for direct relationships between OS and operational performance (H1) and OS and SCI (H3), proposes that a simultaneous alteration is expected between the variables selected. A number of different sort of hypotheses have been suggested in the literature, namely directional, non-directional and if-then hypotheses (Cavana et al., 2001). In this research our main focus is on the directional hypotheses, which assess the influence of one variable on the other, through determining the direction of deviation between constructs. Therefore the influence of variables on each other can either be negative or positive. As presented in the previous section, this research found negative associations for the direct relationships proposed. As for the mediating relationship, this research proposed that the negative affect between OS and operational performance variables was positively mediated by SCI.

**Table 4. 1: Research Hypothesis**

| **Research Hypotheses** |
|---|
| **RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?** |
| *H1.a Centralization is negatively related to operational performance.* |
| *H1.b Formalization is negatively related to operational performance.* |
| *H1.c Hierarchical relationship is negatively related to operational performance.* |
| **RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?** |
| *H2.a Internal integration is positively related to operational performance.* |
| *H2.b Supplier integration is positively related to operational performance.* |
| *H2.c Customer integration is positively related to operational performance.* |
| **RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?** |
| *Hypothesis 3a: Centralisation is negatively related to internal integration.* |
| *Hypothesis 3b: Centralisation is negatively related to supplier integration.* |
| *Hypothesis 3c: Centralisation is negatively related to customer integration* |
| *Hypothesis 4a: Formalisation is negatively related to internal integration.* |
| *Hypothesis 4b: Formalisation is negatively related to supplier integration.* |
| *Hypothesis 4c: Formalisation is negatively related to customer integration.* |
| *Hypothesis 5a: Hierarchical relationship is negatively related to internal integration.* |
| *Hypothesis 5b: Hierarchical relationship is negatively related to supplier integration.* |
| *Hypothesis 5c: Hierarchical relationship is negatively related to customer integration.* |
| **RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?** |
| *Hypothesis 6a: Internal integration mediates the negative impact of Centralization on operational performance.* |
| *Hypothesis 6b: Internal integration mediates the negative impact of Formalization on operational performance.* |
| *Hypothesis 6c: Internal integration mediates the negative impact of Hierarchical relationship on operational performance.* |
| *Hypothesis 7a: Supplier integration mediates the negative impact of centralization on operational performance.* |
| *Hypothesis 7b: Supplier integration mediates the negative impact of Formalization on operational performance.* |
| *Hypothesis 7c: Supplier integration mediates the negative impact of Hierarchical relationship on operational performance.* |
| *Hypothesis 8a: Customer integration mediates the negative impact of centralization on operational performance.* |
| *Hypothesis 8b: Customer integration mediates the negative impact of formalization on operational performance.* |
| *Hypothesis 8c: Customer integration mediates the negative impact of Hierarchical relationship on operational performance.* |

The figure 4.1, illustrates the theoretical framework for the 3 direct relationships between OS and operational performance

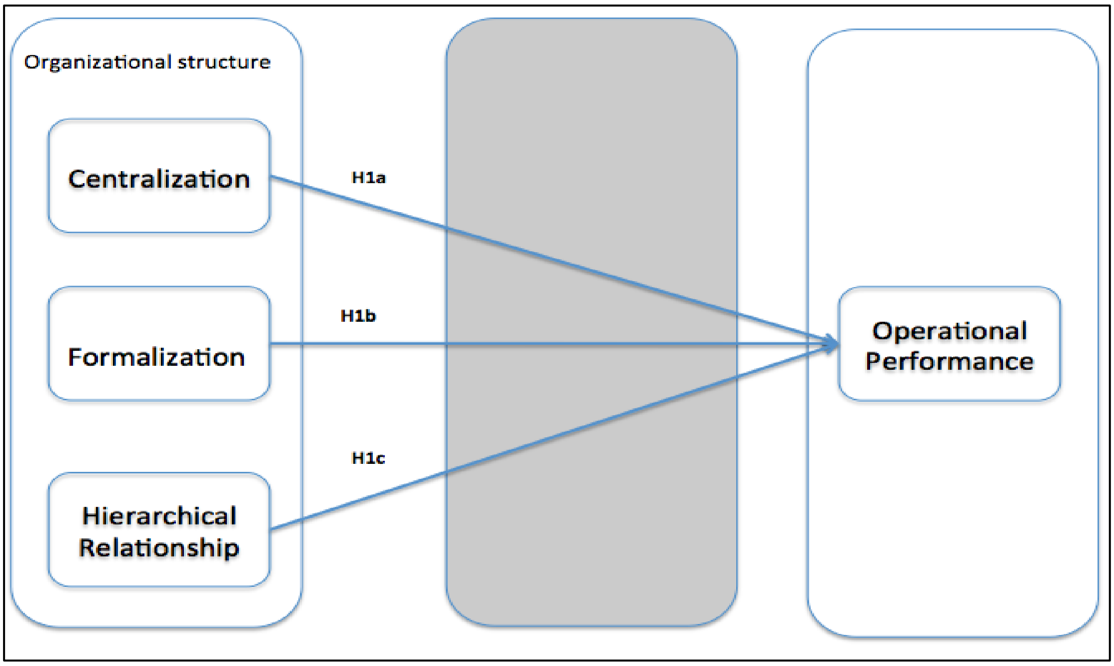



**Figure 4. 1: Direct Relationships between Organization Structure and Operational Performance**

The figure 4.2, illustrates the theoretical framework for the 3 direct relationships between SCI and operational performance.

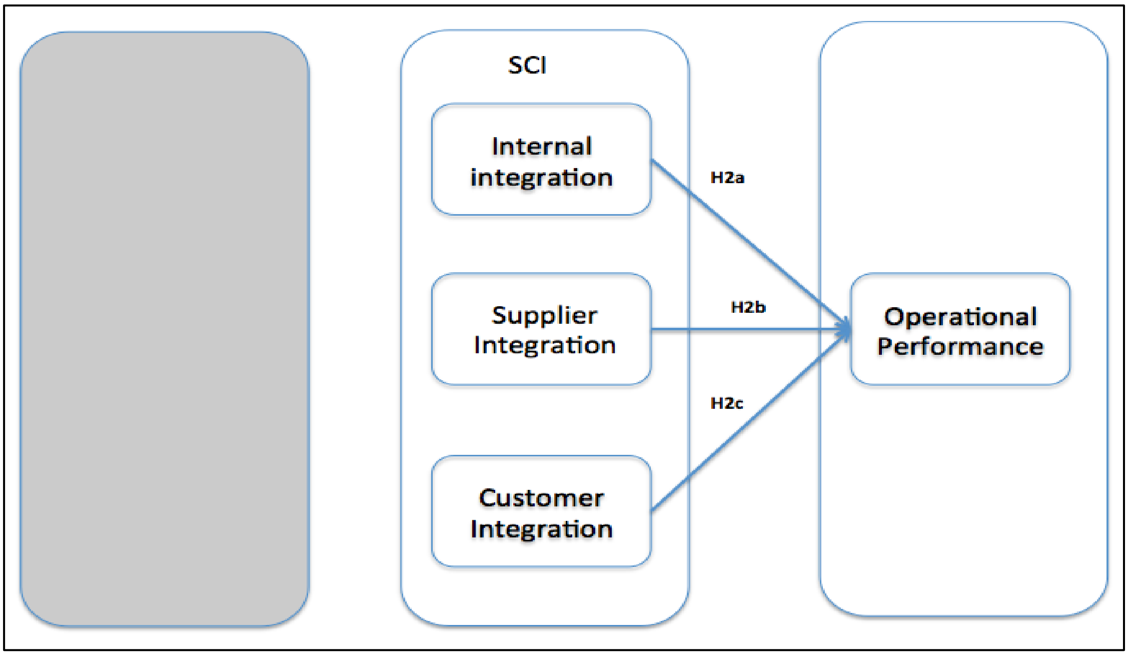



**Figure 4. 2: Direct Relationships between Supply Chain Integration and Operational Performance**

The figure 4.3, illustrates the theoretical framework for the 9 direct relationships between OS and SCI, and also the 9 mediating hypotheses of SCI on the relationship between OS and operational performance.

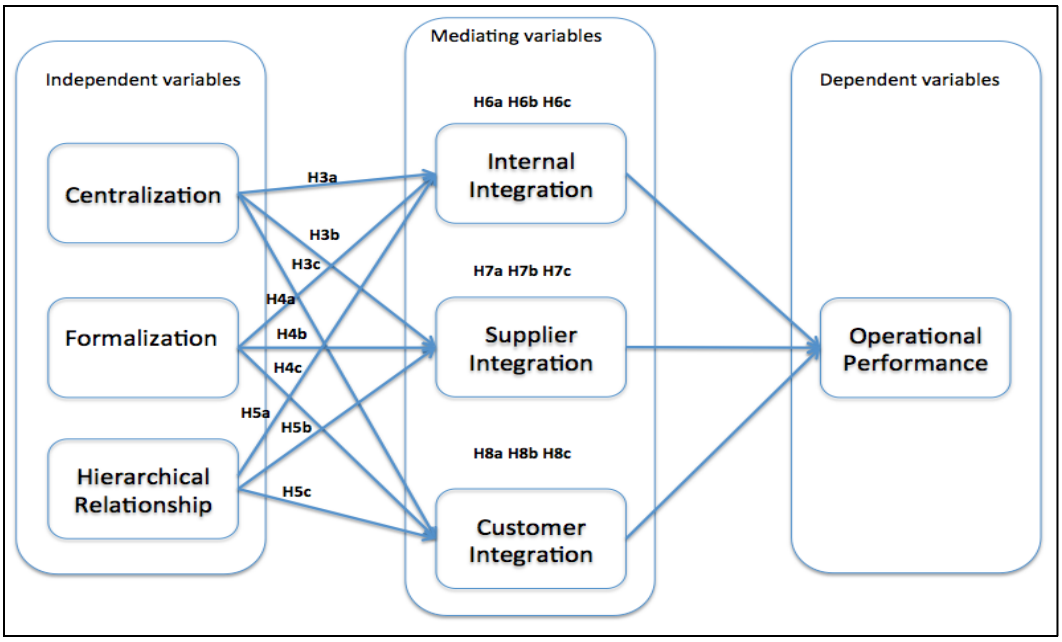



**Figure 4. 3: Mediating Role of Supply Chain Integration**

### 4.5 Chapter conclusion

This chapter began with a discussion on the theoretical lens adopted in examining the relationship between the research concepts. It was argued that during the past two decades, structural contingency theory was reported as the most dominated theoretical framework to examine organizational design (in accordance to their environment) and performance (Drazin and Van de Ven, 1985; Lawrence et al., 1967; Stonebraker and Afifi, 2004; Thompson, 2011). This was because such a relationship was reviewed to be contingent on many internal and external factors. By taking a structural contingency perspective it was therefore proposed that for better organizational performance, companies needed to match their internal structures, strategies, and procedures with the external environment (Danese et al., 2013; Flynn et al., 2010; Gimenez et al., 2012; Lin and Germain, 2003; Olson et al., 2005) Accordingly it was suggested that customers and suppliers formed a significant part of the organization's environment and were required to be closely aligned with. This chapter also reviewed the most common approaches to fit in contingency, and a discussion was provided on why the system approach to fit was the most relevant to this study. It was argued that it would not be useful to measure the performance of oil and gas companies separately of those in its interconnected supply chain (since this industry relies on close association between many key supply chain partners to meet the worlds demand for energy).

Furthermore it was suggested that universal understanding on OS dimensions was hard to come across, and this made it a difficult and daunting task to appropriately conceptualize this field of study. As a result researchers sometimes have named similar dimensions differently and used them in different orders and classifications. This research addressed the gap in the literature by dimensionalizing OS based on the on Campbell et al's. (1974) "structural" and "structuring" classification. In relation to SCI it was argued that contradiction in prior research was as a result of developing explanations and dimensions in relation to SCI and its dimensions (Flynn et al., 2010). While some authors had focused on individual dimensions of SCI (i.e. Sezen, 2008; Shub and Stonebraker, 2009; Vachon and Klassen, 2006) not a lot of researchers have examined the effects of both internal and external (customer and supplier) integration on performance outcomes (Flynn et al., 2010; Koufteros et al., 2005; Wong et al., 2011b) and many of such empirical research generally overlooked the role of internal integration (Flynn et al., 2010). Thus in order to address such issue this research periodically reviewed the empirical measures that have been utilized in past research, and conceptualized SCI as internal, customer and supplier integration. Lastly in relation to organization performance it was reported that the majority of prior authors focused on quantitative measures as performance indicators (Beamon, 1999; Gunasekaran et al., 2001; Gunasekaran et al., 2001; Shepherd and Günter, 2006), and since this study aimed to evaluate the operational performance of oil and gas supply chains, there was a need to develop qualitative measures (quantitative measures would not provide a good picture of the operational performance across the supply chain). Following the research gaps and the research questions identified, this study drew a blueprint in the form of a conceptual framework. Accordingly sets of hypotheses were presented in order to connect and make sense of the different research concepts under investigation. The next chapter introduces the research methodology adopted to test and examine the hypothesized phenomenon.

# Chapter 5: Methodology

The preceding chapter presented the research theoretical framework, developed for the direct relationships and mediating relationships among organization structure (OS), supply chain integration (SCI) and operational performance. Accordingly a number of research hypotheses were proposed in line with the research aim and objectives. This chapter attempts to provide an overview on the research methodology adopted for this study.

First, the main research epistemologies (positivism, interpretivism and realism) and ontologies (deductive and inductive research) are concisely reviewed to provide justifications for the *deductive* and *critical realist approach* adopted under this study. This is followed by a section on the deductive research approach, which attempts to justify the methodological choice and also elucidate the sequences and steps of techniques in conducting this study. Furthermore, this chapter discusses issues related to designing the research survey, beginning with a section on designs requirements and limitations. Discussions are also provided on the ways in which measurement instruments are recognized and modified (in relation to the context of this research). Accordingly, the data collection design process is outlined, and the quantitative analysis procedure is explained. Finally this chapter concludes with a discussion and justification on the selection of the Structural Equation Modelling approach as the analysis technique used to test the hypotheses developed in the previous chapter. Figure 5.1 provides a stepwise guide on the structure of subsequent subsections of this chapter.

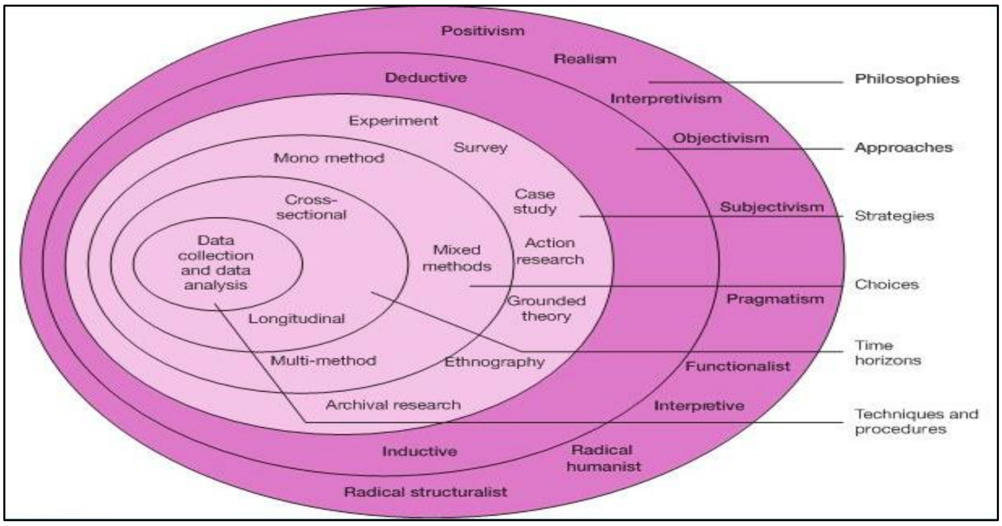



**Figure 5. 1: The Research 'Onion' (Source: Saunders et al., 2011)**

## 5.1 Research Philosophy

It has been argued that researchers must first decide on a suitable research paradigm, prior to selecting the methodological approach (Guba and Lincoln, 1994). Most research questions can be examined from either a quantitative, qualitative or mixed perspective. Therefore, questions related to research method are secondary to those related to the appropriateness of a chosen paradigm. Research paradigm has been defined as the principles, systems or views, which enable a researcher to make informed choices on the appropriate method, epistemology and ontology for a given study (Goles and Hirschheim, 2000). Meredith et al. (1989) suggested that analyzing the development of research paradigms could help researchers to better explain why a selected methodology is more appropriate than others in a study (depending on their context). As shown in figure 5.1 above, there are a number of research philosophies. However, the predominant philosophies used in the social sciences (particularly in management) include positivism, interpretivism and realism (Saunders et al., 2011). In the context of this study, the choice of philosophy dictates the manner in which the relationships between OS and SCI (in the context of the oil and gas) are viewed and explored (quantitatively or qualitatively). Such assumptions further underline the strategy and method chosen to carry out this research.

### 5.1.1. Research Epistemology

Epistemology is a term used to represents the different views on what could be considered as “adequate knowledge" in any given field of research (Saunders et al., 2011). It questions whether the same approach adopted by natural scientist could be used in the social sciences (i.e. management and business studies) (Sekaran, 2006). For example, if researchers are more concerned on actual data (on resources) they are more likely to be associated to “natural scientist” or positivist position. On the other hand, if researchers would like to investigate the feeling and attitude of organizational members they take a philosophical approach, commonly referred to as “interpretivist” (see Goles and Hirschheim, 2000). The following section provides a concise background to different epistemology stances in relation to positivist, realist and interpretivist to justify the approach selected for this study.

Some key assumptions underlie the positivist approach to research in the social sciences. The first assumption is that scientific methods such as controlled experiments can be adopted in the social sciences, in order to explain social interactions (Godfrey and Hill, 1995). The second assumption is that data collected could provide a valid representation of real social interactions (empiricism) if it is analyzed mathematically or statistically, and without interference from the researchers ideology, experiences, values or moral beliefs (Gill and Johnson, 2010). Thus, if research philosophy suggests the values of positivism, then the researcher should adopt the natural scientist (philosophical) stance. Positivist researchers tend to favor measuring observable social realities, which could be generalized (i.e. law-like comparable to what produced by physical scientists) (Collis and Hussey, 2009; Collis et al., 2003). Using such approach, the researcher would review existing theories in order to develop hypotheses, and test such hypotheses (accept, reject, modify) using quantifiable and observable data (e.g. measuring lead-time in terms the time-taken to accomplish specific tasks in a company etc.) (Goles and Hirschheim, 2000).

However, it has been suggested that data gathered under the positivist approach could result in the knowledge becoming too general for a specific context (Cooper and Schindler, 2003). Furthermore some authors do not agree that the positivist approach can be used in every social scientific inquiry (particularly in management), arguing that such an approach sees what it wants to see, and that ignores some unobservable social interactions (between latent/scientifically unobservable constructs such as SCI) that might impact the outcome of a study (Johnson and Onwuegbuzie, 2004). Meredith et al. (1989) explained that the relationships amongst variables are generally examined in three ways. First a measure on the actual *object reality* or direct observation of the effect of a construct. The second approach is making inferences on the *perceptions of object reality* based on people in the observed social setting. The third approach is the *reconstruction of object reality* using computer simulations and modeling. The third approach offers researchers the ability to model unobserved social interactions, and validate such models mathematically or statistically. Therefore, positivists are usually interested in estimating actual object realities based on observable variables.

The focus of this study is to examine the mediating effect of SCI on the relationship between OS and operational performance in the oil and gas supply chains, and to propose a theoretical model for such relationships. Like most social scientific studies, the research framework is built around unobservable latent constructs that are greatly affected by social circumstances. The literature review revealed that diverse measures have been used to capture these constructs depending on the focus of the different studies and the social settings. Thus, adopting a purely positivist approach could be challenging. Researchers have suggested that a purely positivist approach may not be adequate for capturing complex social interactions, especially when several latent (unobservable) constructs are observed together in the same study (see Saunders et al., 2011). It is therefore argued that in order to achieve the outlined objectives for this study, the philosophical approach selected must be flexible enough to also account for the effect of the complex social conditions in the oil and gas industry, on the conceptual framework. A purely positivist approach could place restrictions on the researcher's ability to fully examine the proposed relationships in this study, while accounting for the unique social conditions in the oil and gas industry.

As argued above, the complex social interactions, and the presences of several unobservable constructs in the social sciences makes it difficult for researchers to adopt a purely positivist approach (Saunders et al., 2011). The interpretivist approach is an alternative, which accounts for the dissimilarities between the social actors (not all individuals are the same). (Cooper and Schindler, 2003). In the real world individuals process and interpret information in different ways. Researchers have argued that the interpretivist approach could be suitable for social scientists in management and organizational studies, since organizations are complex, contextual (depending on industry), and unique in terms of their approaches, operations, and management (Saunders et al., 2011). However, in the context of this study such an epistemology may also present some challenges for the following reasons:

1. By taking an interpretivist approach, the study could provide useful and detailed information on the relationship amongst OS, SCI and operational performance in specific organizations. While detailed information could be very useful in this area of inquiry, the relationships explored cannot be generalized across the target population (the mediating impact of SCI on OS and performance of oil and gas supply chains). At best, the above approach can provide a subjective view of such relationships.
2. This study has argued that organizations are structured in accordance to their environment. Therefore it would be difficult and time consuming to appropriately collect data (on the contingent factors of the oil and gas environment) needed to appraise the operational performance of oil and gas supply chains, by just taking an interpretivist approach (e.g. in-depth case study).

Another epistemological approach frequently used in the social sciences to overcome some of the shortcomings of positivism and interpretivism is called realism. It is similar to positivism in a sense that it takes a scientific approach to generate knowledge (Sekaran, 2006), however, realism acknowledges that reality and perception are quite independent (Cooper and

Schindler, 2003). The literature divides realism into direct and critical realism (see Saunders et al., 2011). Direct realism notes that what a researcher experiences directly (using their senses), captures the context accurately. However, critical realism suggests that such experiences are just the researchers' perception of the business world (not the actual thing). In other words, critical realism notes that, individual experience the world in two stages (Patomäki and Wight, 2000): first, the element and the sensation it communicates and second, the individual mental computation that occurs after sensations are received.

It is understood that one of the main concern of management and business studies is the social world. Accordingly a research could better understand the social world if it also focuses on the social structure (and actors) under investigation (Mingers, 2004). Scholars also maintain that critical realism provides a logical basis for observing relationships amongst latent constructs (Goles and Hirschheim, 2000). Critical realists make a clear distinction between the natural world and the social world. The former is observable and can be subject to several experimental and statistical analyses, however and the latter is not. This is partly because critical realists assume that act of "researching" has an impact on the constructs researched, and can also affect the social conditions at play. In addition, the social world is made up of players that are capable of changing their behavior spontaneously, thus empirical studies in the social sciences are not as highly controlled as experiments in the natural sciences.

Taking a critical realists perspective, this study assumes that while the real world exists independently of our perception, it is possible to scientifically/statistically recreate and test a conceptual models to explain the relationships between constructs explored. The oil and gas industry is constantly and rapidly changing (this is in line with the critical realists perspective that views the social world as changing all the time) thus, by taking the above approach (critical realist) the researcher is enabled to make better sense of the information in such context (as opposed to direct realist). Based on the above arguments, the critical realist epistemology is adopted for this study.

### 5.1.2 Research Ontology

Ontology deals with the nature of reality. It is concerned on how the researcher views the world, and how it functions (Saunders et al., 2011). There are two main features (mostly discussed) of ontology that have been argued to produce valid and reliable knowledge, objectivism and subjectivism. Objectivism holds the view that in reality, social structures exist regardless of the social actors and their concern with its existence; on the other hand the subjective views that, the social entities exist in accordance to the social actor's view and relevant actions (Collis and Hussey, 2009; Collis et al., 2003).

It could be argued that management in itself is an objective entity (Saunders et al., 2011). Therefore this research viewed it more relevant to take a deductive and an objective stance, in order to empirically examine the mediating role of SCI on the relationship between OS and operational performance. Viewing the relationship between OS and SCI is not simple, specially investigating such association through a contingent perspective. Accordingly Perren and Ram (2004) have argued that the objective approach reduces complexity and makes it easier to investigate causal relationships between constructs. This study has attempted to bridge the gap between the two disciplines of organizational theory and operations management, and since it is a first attempt to do so, an objective stance would allow for better contributions to practice (policy) and theory.

However, the subjective approach notes that the social phenomena is as a result of the perspective and activates of the social actors (Collis and Hussey, 2009; Collis et al., 2003). Even though such an approach enables the researcher to better interpret the complexity of the social world and discover deeper meanings related to a concept (or strategic intention) (see Saunders et al., 2011), in the context of this study it would not provide an appropriate representation of the relationship among OS, SCI and operational performance of the oil and gas supply chains. As argued above the oil and gas industry is regional (allocation of oil and gas resources), therefore organizations operating in such an industry face different operational challenges in accordance to the region in which they operate. By subjectively looking into each oil and gas company (or case), because of variation in such challenges (operational and other) the research findings could be only related to a specific case under investigation. Additionally it was argued earlier on that research on SCI has been viewed as internal and external (customer and supplier). By taking a subjective approach, the focus is more likely on the social actors and how their organization performers. Therefore it would be difficult to judge the firm's external environment (supplier and customer relationship) and the impact it has on the operational performance (part of the research objective). It is important to note that in general terms, no single approach is better than the other. However it is argued that, one approach may be preferable based on the research questions (aim and objectives) and the study context. As presented in the literature review, similar studies on SCI and OS have predominantly adopted a deductive critical realist approach. Therefore, this study explores the mediating impact of SCI on the relationship between OS and operational performance from a deductive critical realism stance.

## 5.2 Research Approach: Deductive Theory Testing

The degree, to which a researcher indicates the theoretical stance at the start of the study, is significant in relation the research design (Mingers, 2004). There are basically two approaches to research design. The deductive approach allows the research to create the research hypotheses, and design an approach to verify such hypotheses (Gill and Johnson, 2010). The inductive approach allows the research to first collect data and consequently develop theory based on the analysis (Gill and Johnson, 2010). In other words, induction tilts more towards interpretivism and deduction could be considered a more positivist approach.

The deductive approach resembles the natural scientific approach to experimentation. As presented above such an approach requires developing hypotheses (theory), which is then tested using rigorous analysis techniques (Collis and Hussey, 2009; Collis et al., 2003). It is generally understood that deductive research takes a positivist approach. This implies that concepts and subjects are measured more objectively as opposite to subjective interpretation (i.e. by sensation that is associated to qualitative research) (Crotty, 1998). Thus, this type of analysis mainly focuses on identifying relationship and casual explanations between constructs under review, and follows a hypotheses development, observation and verification process (Collis and Hussey, 2009). Accordingly Mingers (2004) suggested that deductive research has five main stages:

- Suggesting hypotheses with strong theoretical foundation (good literature review)
- Stating the hypotheses in operational terms (Specifying variable measurement and suggesting association between variables)
- Assessing the proposed (operational) hypotheses
- Investigating the outcome
- Adjusting the theory in relation to research findings.

The deductive approach retains a number of significant features. For example, it attempts to examine and reveal causal associations amongst contracts.  A quantitative research is frequently referred to as hypothesis-testing research. This type of research approach is predominantly used as a synonym for any data collection technique (i.e. questionnaire) or data analysis procedure (such as graphs or statistics) that generates or uses numerical data, and has a deductive view (Bell and Bryman, 2007) (figure 5.2).

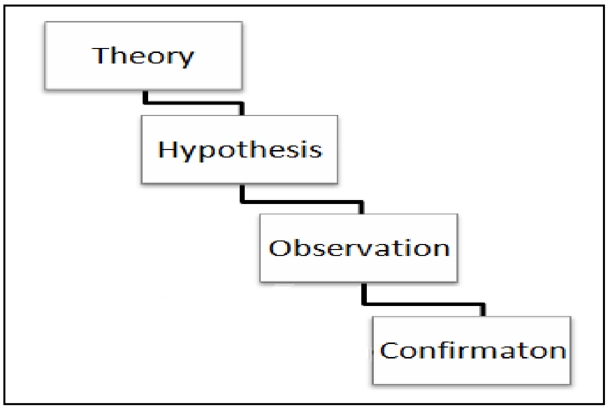



**Figure 5. 2: Research Methodology Approach (source: Bell and Bryman, 2007)**

Gill and Johnson (2010) argued that such a research approach generally has a well-structured methodology, which enables other researchers to replicate the study. However, an important consideration in adopting such approach is that, variables such as OS, SCI and operational performance should be operationalized to capture the fact in a quantitative way (e.g. what constitutes high or low centralization and how that effects internal integration). Thus, in order to understand a problem (using deductive approach) it is better to reduce them into more basic components. Furthermore deductive research also allows for generalization of the research findings, however the research also needs to meet the sufficient sample size criteria (Bell and Bryman, 2007).

## 5.3 Research Strategy/Design

By conducting a literature review and establishing the conceptual framework 24 hypotheses were presented. In order to investigate the hypotheses, this research takes a quantitative (deductive) approach in collecting and analysing the information from the target respondents. The research design (strategies) includes a number of essential logical decisions such as, the aim and objectives, the type, and the reliability limitations of the study (Cavana et al., 2001). Research strategies are then transformed into planning on how the variables are measured, and how the data are actually collected. Accordingly this will enable the research to choose the most applicable method for collecting and analysing the data (Collis et al., 2003). This section of the research identifies the most appropriate methods for gathering and analysing information based upon a deductive approach (single/mono method). Collis et al., (2003) recognised two basic types of surveys: cross-sectional surveys and longitudinal surveys. Cross-sectional surveys are the type of surveys chosen for this research, which collect data and information from a population at a single point in time (i.e., questionnaires). Longitudinal surveys are used to collect data over a period of time, the researcher may then investigate changes in the population and try to explain them (Saunders et al., 2011).

### 5.3.1 Survey (Questionnaire)

Arlene and Mark (1995) define surveys as a system for gathering data from or about an individual, in order to explain or evaluate their behavior and knowledge in a standardized method. Survey has been chosen as the main research methodological process for this study, and questionnaires have been utilized as the data gathering technique. Surveys can be executed in a variety of formats, a questionnaire can be sent over the mail, it can be carried out over the phone or face to face, hand-outs sent to people in groups, emails or a mixture of such approaches. Saunders et al. (2011) categorized surveys in the following format:

A. Descriptive: These surveys are used to identify and count how frequently a particular phenomenon occurs in a population. The questionnaire included some descriptive elements of the sample population (the position of respondents).
B. Analytical: Analytical surveys were used in this research since they represent relationships between variables in a system and are usually used to test out explicit hypotheses. This approach is preferred over the purely descriptive method, because it contains some descriptive elements, and also enables the researcher to test the dependent, independent and mediating hypothesized relationships (accept/reject).

Snow and Thomas (1994) suggested that surveys in the form of questionnaire, are an effective data collecting approach. For example, utilizing a survey enabled this research to collect data repeatedly and with multiple samples (Forza et al., 2005). This particular feature was important, since questionnaires were initially sent out to a panel of industry experts (for initial review and comment). Furthermore surveys are generally easier to understand and they also enable information gathering in an economically feasible way (Saunders et al., 2011). It has also been argued that surveys offer more control in relation to the research process, in other words, they offer the option of comparing standardised scales and keeping the anonymity of the individuals responding (Thietart, 2001). However, this research also acknowledges that surveys have limitations. Collis et al. (2003) argued that the majority of survey issues were linked to biased samples. Additionally Saunders et al. (2011) raised the issue of goodwill and patience of candidates in relation to the number of questions asked (i.e. how many questions it would take for some candidates to lose their patience?). Even though surveys have been argued to be inflexible and challenging (subtle trade-off among validity and rate of response), they are nevertheless effective in producing sizable amount of data, in a time and cost efficient approach (Saunders et al., 2011). This study has attempted to overcome such challenges by (Snow and Thomas, 1994):

- Contacting the target respondents in advance and introducing the research
- Questionnaires were sent out after researcher was introduced.
- Follow-up emails and phone calls were made.
- The researcher administered some questionnaires in person at the convenience of the respondents.
- Other respondents were targeted in person at oil and gas conferences and symposia.

In order to examine the association between OS, SCI and operational performance and to reject or accept such relationships, this research used the hypotheses or proposition testing method. As presented in earlier parts of this chapter, quantitative research originates from a positivist perspective, in relation to creating knowledge and information. Therefore positivist-based studies are suitable to verify theories through examining the specific hypotheses (either accepting or rejecting them). Under this research hypotheses were formulated based on a cautious review of the casual associations amongst the different constructs (i.e. OS and SCI) under study (Saunders et al., 2011). By empirically examining the hypothesized direct and mediating relationships amongst OS, SCI and operational performance, the hypotheses could then be rejected, modified or accepted.

Authors generally agree that in the positivist method, the empirical examination is rigid (Bryman and Bell, 2011; Goles and Hirschheim, 2000). Cavana et al. (2001) suggested that that the population samples under investigation are fixed and the issues to be tested are concisely decided in the theories and developed hypotheses. Accordingly very small divergences could be seen when the theoretical model is established. Furthermore using a questionnaire (survey) is also the most frequently used approach in the two field of research examined (e.g. Flynn et al., 2010; Koufteros et al., 2007a; Koufteros et al., 2007b; Lin and Germain, 2003). Therefore it would also be suitable for this study to apply a quantitative questionnaire survey approach to test the direct and mediating relationships among OS, SCI and operational performance. While observation and interviewing are also commonly used in the social sciences, questionnaire-based surveys are better for field data collection (see Snow and Thomas, 1994). It is argued that the main disadvantage of questionnaire surveys is obtaining an accurate and acceptable response rate. Nevertheless, questionnaires are efficient in producing substantial data samples at comparatively lower costs (Saunders et al., 2011). McGrath's (1981) study on the three-horned dilemma of research illustrated that surveys tend to amplify population generalisablability, but could be low in relation to accuracy of measurement and realism of context. Therefore the survey used in this research was designed with a number of methods (features) to address biases and issues related to validity. The next chapter discusses a number of them.

### 5.4 Questionnaire Validity and Reliability

In order for a study outcome to become generalizable, the validity and reliability of measures used in a questionnaire survey must be determined. Bell and Waters (2014) define reliability as …"the extent to which a test or procedure produces similar results under constant conditions on all occasions". It examines whether items in the questionnaire stay together as a set (homogeneity) yet independently measure the same construct (inter-correlation) (Saunders et al., 2011). A number of factors could affect the reliability of a questionnaire. Accordingly the following sources of potential reliability issues were taken into account when the questionnaire was being designed and drafted:

1. Decreasing unreliability sources: De Vaus (2002) suggests that good questions could go wrong because of bad phrasing or wording. This research removed any sort of ambiguous or repetitive questions as suggested by De Vaus (2002).
2. Multi-item measure: this research attempted to ensure reliability through the multi-item measurement as suggested by De Vaus (2002).
3. Utilizing set of questions from reputable studies: Measures were chosen from and altered based upon previous empirical research.

In addition to the above steps taken, the reliability of the survey instrument used in this study was tested using Cronbach's Alpha coefficient approach.

Yin (1994) defined validity as one of the strategies used to measure how well an answer is given in relation to a research question. In simpler terms it means how accurately a concept has been measured. The following types of validity considered in this study (Anderson and Gerbing, 1988; Cook and Campbell, 1976; Meredith et al., 1989):

1. Internal Validity

   Internal validity is mainly concerned with the causality, in which a cause-and-effect relationship is recommended when a true co-variation exists between the variables under investigation (see Yin, 1994). Accordingly Scandura and Williams (2000) argued that the techniques used to collect data must validate and illustrate that the cause precedes the effect, and that other explanations have been discarded. This sort of validity examined whether or not, what was recognised as the causes, could actually produce what was interpreted as the 'effect' or 'responses.

2. External Validity

   External validity is the degree to which any research findings could be generalised outside the immediate research sample. This type of validity refers to generalisation across times, settings and individuals (Cook and Campbell, 1976). External validity depends on establishing an accurate illustration of the association between two or more constructs. This relationship was also verified with the view that it could be generalised to different populations, measures and settings (Meredith et al., 1989; Scandura and Williams, 2000).

3. Construct Validity

   Construct validity looks to establish how satisfactory the measures utilized would fit the theory for which it was intended (Scandura and Williams, 2000). It has been argued that measures in a research should be valid representations of constructs, so that a true implication can be made (Meredith et al., 1989; Paullay et al., 1994; Stone-Romero, 1994). Construct validity, tests for both convergent validity (the degree to which the operationalization is similar to other theoretical and comparable operationalizations) and discriminant validity (the degree to which a concept differs from other concepts)

(Scandura and Williams, 2000). Based on the advice of Scandura and Williams (2000) the testing of construct validity was carried out in the following order:

A. Exploratory Factor Analysis (EFA), which accounts for discriminant, convergent and predictive validity and was based on correlational techniques (such as Pearson Correlation) and inter-rater reliability (Cronbach Alpha validity)
B. Confirmatory Factor Analysis (CFA), which was used to test and confirm factors underlying latent constructs.

As reported by Scandura and Williams (2000), the type of a dependent construct suggests the nature of measures utilised, and the data source specify the degree to which method variance could exist in measures. Further on the authors argued that the accuracy of measurement by using the self-report data collection (methods) could significantly increase construct validity if multi-item measures were utilised (e.g. likert scale). For this reason multi-item measures have been argued to improve internal consistency by testing for the extent of errors in the measurement of a variable (Scandura and Williams, 2000).

4. Statistical Conclusion Validity (SCV)

This type of validity checks to see whether or not conclusions could be made based on statistical evidence (Cook and Campbell, 1976). SCV could be defined as the unpredictability of measures, and utilising unfitting tests as the extra threats to internal reliability (Cook and Campbell, 1976). SCV also relates to the suitable use of statistical tests in dealing with data errors (Sackett and Larson Jr, 1990). It has been suggested that the best way to appraise SCV, is in terms of overall statistical properties of the population parameters (Sussmann and Robertson, 1986). Under this validity testing, the major factor to consider was the extent to which the design allowed correction in terms of both range restriction, and power of the different designs (Cook and Campbell, 1976). Even though correction techniques for range restrictions exist, Sussmann and Robertson (1986) argued that these formulas are more suitable as the number and variety of population sample (people) rose. Sample size influences the design power (to produce statistically significant results), for this reason in using surveys a sizeable sample must be tested to address the issues of power. Furthermore it is imperative that SCV supports external validity, since random sampling error must be dealt with. This is because clearness and accuracy improves the findings such that, it would hold in a different setting, sample (population) and time (Scandura and Williams, 2000).

5. Face validity

This type of validity looks into how close the operationalization appears to measure what it is designed to measure, and whether or not it is a good translation (Yin, 1994). Face validity is therefore achieved through broad literature review. In order to do so, the operationalization of all the measurements involved was confirmed against the applicable domain for the construct. To overcome issues related to face validity this research attempted to use measurement items that had been empirically test by prior authors.

The main validity and reliability tests carried out in this study are summarised in table 5.1 below. The subsequent parts of this chapter provide discussions on the operationalization (measurement) of the key constructs explored in this study.

**Table 5. 1: Summary of Survey Design Test and Techniques**

| Design Test | Survey Design Techniques |
|---|---|
| Internal Validity<br>Face Validity | Relationship between variables based on the literature review<br>Structure of the survey (questionnaire)<br>Operationalization |
| External Validity | Sample type<br>Profiling the different Respondents<br>Survey data collection batches |
| Construct Validity | CFA<br>EFA<br>Discriminant Validity<br>Convergent Validity<br>Predictive Validity<br>Inter-rater reliability-multiple respondent (Cronbach coefficient)<br>Pilot to experts (academia and practice) |
| SCV | Size of sample<br>Number of dependent constructs<br>Analysis approach and technique |

## 5.5 Operationalization of Research Variables

Operationalization is the process of defining the key aspects of a given concept in order to render it measurable (Cavana et al., 2001; Forza, 2002). Researchers have argued that reviewing literature could aid the process of identifying previously operationalized concepts, and applicable construct measurement scales or questionnaire items (Rowley and Slack, 2004). Accordingly the survey items under this research have been identified and selected from appropriate scales following a thorough literature review. Nevertheless this study has adopted the three-stage approach (see Godfrey and Hill, 2000) in identifying and selecting the appropriate measurement scales:

1. First, the key constructs used in the study were classified. OS dimensions were classed as independent variables; SCI dimensions were classed as mediating variables; while operational performance forms the dependent variable. This action was followed by the identification of a suitable questionnaire items from the existing literature. Lastly the nature of the scale (i.e. scale, ordinal, nominal) was also a key consideration in selecting the studies from which questionnaire items were adapted (Saunders et al., 2011).
2. The likert scale intervals used in previous studies were retained (e.g. retaining the 7 point scale used in previous studies rather than changing them). This was done in order to keep the original and established instruments used by prior authors in the organizational theory and operations management field, to insure higher construct validity and reliability (Flynn et al., 1990).

Chapter 4 illustrated that the theoretical framework and proposed dimensions of each variable and their inter-relationships was based on an extensive review of the literature. Direct negative relationships amongst the three dimensions of OS (centralization, formalization, and hierarchical relationship) and performance were hypothesized. Again, the study hypothesized direct positive relationships amongst the three dimensions of SCI (internal, customer and supplier integration) and operational performance (i.e. quality, cost, lead time and flexibility, measured as a single construct operational performance). Moreover the study hypothesized direct negative relationships amongst the three dimensions of OS (centralization, formalization, and hierarchical relationship) and three dimensions of SCI (internal, customer and supplier integration).  Finally, the study hypothesized that the dimensions of SCI play a critical mediating role on the negative relationships amongst the dimensions of OS and operational performance. Therefore, it is important to highlight how the questionnaire scales are designed in order to collect data from the three different areas (i.e. OS, SCI and operational performance). All variables in this study were measured using a 7-point Likert interval Scale. It has been suggested that due to the nature of some constructs (such as centralization), respondents tend to avoid the extreme categories (central tendency bias) or select only extreme categories (social desirability bias) (Forza, 2002). To deal with these biases, the preferred likert options for some constructs were reversed (e.g. “strongly agree”=1 in some cases and =7 in others) (Flynn et al., 1990).

Table 5.2 presents a summary of all the variables, the related dimensions and the items that make-up the theoretical framework of this research. As presented above all three main variables underlying the research concept were measured using a 7-point Likert Scale. The items in the measurement scales could also be referred to as observable or measurable items, whereas the main variables (OS, SCI), which are being examined as a part of the research objective, are referred to as latent variables (Byrne, 2013; Flynn et al., 1990). In total sixty-eight items (or measurable variables) were selected to measure the seven latent variables in this study.

**Table 5. 2: Research Concepts, Variables, Measurement Type and Code**

| **Research constructs** | **Variables** | **Variable code** | **Number of items/questions** |
|---|---|---|---|
| Operational Performance | Quality | Qlty | 4 |
| | Flexibility | Flex | 4 |
| | Lead-time | Qlty | 4 |
| | Cost | Ccost<br>Ocost | 7 for capital cost<br>4 for operational cost |
| Supply Chain Integration | Internal integration | Iintg | 9 |
| | Customer integration | Cintg | 11 |
| | Supplier integration | Sintg | 13 |
| Organization Structure | Centralization | Cent | 4 |
| | Formalization | Form | 4 |
| | Hierarchical relationship | Hierstr | 4 |
| **Total** | | | 68 |

### 5.5.1 Questionnaire Items for Organization Structure Variables

Three variables (dimensions) were selected based on the literature review carried out in the domain of organisational structures. Table 5.3 summarises these variables, into the code that each have been assigned to, the number of questions measuring them, and also source from which they have been adapted.

The centralization variable included four items, which have all been adapted from the following authors in the field of organizational theory:

1. The power to make considerable operational decisions is concentrated in the organisation (e.g. Inkson et al., 1970a; John, 1984; Lee and Grover, 1999; Liao et al., 2011)

The first item was adapted from Liao et al. (2001) that used the following item to measure centralization "In our company, there is considerable decision by top management". Similarly Lee and Grover's (1999) measure of centralization "Decisions on major changes to manufacturing processes are made only at highest management level" was also utilized to modify the above question and measure the locus of authority in an organization. However since the objective of this study was operational performance the item was modified to capture operational decision-making processes.

2. Even small operational matters have to be referred to someone higher up the hierarchy for a final decision (e.g. Inkson et al., 1970a; Ferrel and Skinner, 1988; Huang et al., 2010; John, 1984)

The second item of centralization has been adapted from John (1984) and Ferrel and Skinner (1988) which had used "In my dealings with my supplier, even quite small matters have to be referred to someone higher up for a final answer" and "In my dealings with this company even quite small matters have to be referred to someone higher up for a final answer" respectively to measure centralization in their studies.

3. Your firm senses that staff would need a great level of control over their responsibilities (e.g. Inkson et al., 1970a; Ferrel and Skinner, 1988; Huang et al., 2010; John, 1984)

The third item used to operationalize centralization was adapted from Huang et al. (2010), whereby the authors used "There can be little action taken here until a supervisor approves a decision" and Ferrel and Skinner (1988) who measured it using "I can take very little action on my own until this company or its reps approve it"

4. Your company encourages lower level (middle managers) participation in operational decision-making process where problems occur (e.g. Huang et al., 2010; Koufteros et al., 2007b)

The last and final item measuring centralization was adapted from Koufteros et al. (2007b) "Our workers have the authority to correct problems when they occur"

The formalization variable included four items, which have all been adapted from the following authors in the field of organizational theory:

1. Your firm has formal strategic planning processes, which result in a written mission, long-range goals and strategies for implementation (e.g. Inkson et al., 1970a; John, 1984; Miller, 1987)

The first item was adapted from Miller (1987) that used the following item to measure formalization "Our plant has a formal strategic planning process, which results in a written mission, long-range goals and strategies for implementation". Similarly Lee and Grover's (1999) measure of formalization "rules and procedures in our firm are very clearly documented" was also utilized to modify the above question and measure the how formalization of non-routine policies in an organization.

2. Your company has strategic plans (coded & put in writing) to respond to customer/supplier (e.g. Ferrel and Skinner (1988) Inkson et al., 1970a; John, 1984; Miller, 1987, 1992)

The second item of formalization has been adapted from John (1984) and Ferrel and Skinner (1988) that had used "My dealings with the supplier are subject to a lot of rules and procedure (coded or documented) stating how various aspects of my job are to be done", and "Usually my contact with my company and its representatives involves doings things by the rule of book" respectively to measure formalization in their studies.

3. Your firm relies on strict supervision (rules and procedures) in controlling day-to-day operation (e.g. Aiken and Hage (1971) Inkson et al., 1970a; Lee and Grover, 1999; Liao et al., 2011)

The third item used to operationalize formalization was adapted from Lee and Grover (1999), whereby the authors used "There is always an extensive reliance on rules and procedures to meet operational activities" and Aiken and Hage (1971) who measured it using "Extent of formal documentation of operating procedures"

4. If a written rule does not cover some situation, staff make up informal rules for carrying out their tasks (e.g. Inkson et al., 1970a; Ferrel and Skinner, 1988; John, 1984; Miller, 1987)

The last and final item measuring formalization was adapted from Miller (1987) "The plant has an informal strategy, which is not very well defined", Lee and Grover (1999) "Violation of documented procedures is not tolerated", and Ferrel and skinner (1988) "I ignore the rules and reach informal agreements to handle some situations”

The hierarchical relationship variable included four items, which have all been adapted from the following authors in the field of organizational theory:

1. A large hierarchical distance exists between operational managers and senior executives (e.g. Koufteros et al., 2007b; Nahm et al., 2003)

The first item was adapted from Koufteros et al. (2007b) and Nahm et al. (2003) that had both used the following item to measure hierarchical relationship “There are many management layers between plant operators and the CEO”.

2. We have a tall OS (see Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Turkulainen and Ketokivi, 2012)

The second item has been adapted from Turkulainen and Ketokivi (2012) that used “Our organization structure is relatively Tall” in measuring hierarchical relationship.

3. There are many levels in our organizational chart (see Aiken and Hage, 1971; Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Turkulainen and Ketokivi, 2012)

The third item used to operationalize hierarchical relationship was adapted from Turkulainen and Ketokivi (2012), whereby the authors used “Our organizational chart has many levels” and Aiken and Hage (1971) who measured it using “There are only few management layers between plant operators and the CEO”

4. “Our organization structure is relatively flat” (see Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Turkulainen and Ketokivi, 2012)

The last and final item measuring hierarchical relationship was directly adopted from Huang et al. (2010) “Our organization structure is relatively flat”, other authors in the organizational theory field such as Koufteros et al. (2007b); Nahm et al. (2003) have also measured it as ”There are few layers in our organizational hierarchy”.

**Table 5. 3: Organizational Structure, Variables, Measurement Type and Code and Sources**

| Variables | Code | No Question | Scale type | Sources |
|---|---|---|---|---|
| Centralization | Cent | 4 | Likert 7 point | Multiple sources in text |
| Formalization | Form | 4 | Likert 7 point | Multiple sources in text |
| Hierarchical relationship | Hierstr | 4 | Likert 7 point | Multiple sources in text |

### 5.5.2 Questionnaire items for Supply Chain Integration variables

Three variables (dimensions of SCI) were selected based on the literature review carried out in the domain of operations management. Table 5.4 summarises these variables, into the code that each have been assigned to, the number of questions measuring them and also source used.

**Table 5. 4: Supply Chain Integration, Variables, Measurement Type and Code and Sources**

| Variables | Code | No Question | Scale type | Sources |
|---|---|---|---|---|
| Internal Integration | Iintg | 9 | Likert 7 point | Flynn et al., 2010; Narasimhan and Kim, 2002 |
| Supplier Integration | Cintg | 13 | Likert 7 point | Flynn et al., 2010; Morash and Clinton 1998; Narasimhan and Kim, 2002 |
| Customer Integration | Sintg | 11 | Likert 7 point | Flynn et al., 2010; Morash and Clinton, 1998; Narasimhan and Kim, 2002 |

The internal integration variable included the following nine items, all of which have been directly adopted from Flynn (2010):

1. "Data integration among internal functions"
2. "Enterprise application integration among internal functions"
3. "Integrative inventory management"
4. "Real-time searching of the level of inventory"
5. "Real-time searching of logistics-related operating data"
6. "The utilization of periodic interdepartmental meetings among internal functions"
7. "The use of cross-functional teams in process improvement"
8. "The use of cross-functional teams in new product development"

9. “Real-time integration and connection among all internal functions from raw material management through production, shipping, and sales”

The supplier integration variable included the following thirteen items, all of which have been directly adopted from Flynn (2010):

1. “Information exchange with our major supplier through information networks”
2. “The establishment of quick ordering systems with our major supplier”
3. “Strategic partnership with our major supplier”
4. “Stable procurement through network with our major supplier”
5. “The participation level of our major supplier in the process of procurement and production”
6. “The participation level of our major supplier in the design stage”
7. “Our major supplier shares their production schedule with us”
8. “Our major supplier shares their production capacity with us”
9. “Our major supplier shares available inventory with us”
10. “We share our production plans with our major supplier”
11. “We share our demand forecasts with our major supplier”
12. “We share our inventory levels with our major supplier”
13. “We help our major supplier to improve its process to better meet our needs”

The customer integration variable included the following eleven items, all of which have been directly adopted from Flynn (2010):

1. “Linkage with our major customer through information networks”
2. “Computerization for our major customer’s ordering”
3. “Sharing of market information from our major customer”
4. “Communication with our major customer”
5. “The establishment of quick ordering systems with our major customer”
6. “Follow-up with our major customer for feedback”
7. “The frequency of period contacts with our major customer”
8. “Our major customer shares Point of Sales (POS) information with us”
9. “Our major customer shares demand forecast with us”
10. “We share our available inventory with our major customer”
11. “We share our production plan with our major customer”

### 5.5.3 Questionnaire Items for Operational Performance Variable

Operational performance shaped the final latent variable in the conceptual framework of this research. Four items have been adopted to measure operational performance, all of which are viewed from a process perspective (Table 5.5). Cost, time, quality and flexibility have frequently come up in the literature as the key operational factors that need to be measured (e.g. Beamon, 1999; Gunasekaran et al., 2004; Gunasekaran et al., 2001; Neely et al., 1995; Shepherd and Günter, 2011).

Since operational performance and their measurements would have a different interpretation from one industry to another, this research has customized each performance indicator to suit the business practices in the oil and gas industry. In order to do so, a systematic literature review was conducted in the above four areas of operational performance, and the most commonly discussed factors were taken into consideration. Based on consultation with the panel of experts (academic and industrial), this research attempted to develop questions that would be easily understood by experts in the oil and gas industry.

**Table 5. 5: Operational Performance, Variables, Measurement Type and Code and Sources**

| Variables | Code | No Question | Scale Type | Sources |
|---|---|---|---|---|
| Quality | Qlty | 4 | Likert 7 point | Multiple in text and based on consultation with panel of experts |
| Lead time | Ltime | 4 | Likert 7 point | Tersine (1994) and based on consultation with panel of experts |
| Flexibility | Flex | 4 | Likert 7 point | Olhager and West, (2002) Sanchez and Perez (2005) and based on consultation with panel of experts |
| Cost | Ccost<br>Ocost | 7<br>4 | Likert 7 point | NORSOK:O-CR-001 (1996), ISO 15663-2:( 2001) and based on consultation with panel of experts |

***Process quality:*** Process quality makes up one of the measurable variables (indicators) of the operational performance. By conducting a systematic review of the total quality management literature and consultation with panel of experts, the most common and relevant factors (in relation to the oil and gas industry) to measure process quality were identified as, supplier quality management; data and reporting (data-driven decisions); benchmarking and continuous improvement. These four elements of process quality were used to form the following questions:

1. Rate the level of your company's ability in utilizing information/data from quality programs (such as quality assurance and quality control) (e.g. Ho et al., 2001; Kaynak, 2003; Kim et al., 2012; Lakhal et al., 2006; Lewis et al., 2006; Rahman, 2004; Rahman and Bullock, 2005)

The first item of process quality, measuring the quality data and reporting (data-driven decisions) was adapted from Kim et al. (2012) "Quality data (for example, error rates, scrap, and defects) is available in our organization" and Kaynak (2003) "Extent to which quality data are available to managers and supervisors".

2. Rate the level of your company's supplier surveys, which indicate the level of qualities set or met by your suppliers (e.g. Chin et al., 2002; Fotopoulos and Psomas, 2009; Gadenne and Sharma, 2009; Ho et al., 2001; Kaynak, 2003; Kim et al., 2012; Lewis et al., 2006)

The second item of process quality, measuring supplier quality management has been adapted from Kaynak (2003) that used "Extent to which suppliers are evaluated according to quality, delivery performance, and price" and Kim et al. (2012) "Our organization has a thorough supplier rating system in measuring hierarchical relationship".

3. Rate the level of your company's quality systems, which measure and monitor the standard of internal quality (e.g. Gadenne and Sharma, 2009; Khamalah and Lingaraj, 2007; Koh et al., 2007; Lewis et al., 2006; Rahman, 2004)

The third item of process quality, measuring benchmarking has been adapted from Gadenne and Sharma, (2009) that used "use of statistical methods (or charts and graph) to measure and monitor internal quality" in their study.

4. How well does your quality management practices determine and reduce defective, failed, or non-conforming item, during or after inspection (i.e. disassembly, repair, replacement, reassembly, calibration control) (e.g. Chin et al., 2002; Demirbag et al., 2006; Flynn, 1995; Gadenne and Sharma, 2009; Jung and Wang, 2006; Khamalah and Lingaraj, 2007; Lewis et al., 2006; Rahman and Bullock, 2005)

The last and final item measuring process quality (continuous improvement) was adapted from Gadenne and Sharma (2009) "comprising the quality management practices of a program for continuous reduction in defects", Jung and Wang (2006) "Reduction of waste through continuous improvement" and Demirbag et al. (2006) "Extent to which top management supports long-term quality improvement process."

***Process Lead-time:*** Process lead-time makes up one of the other measurable variables of the operational performance. It is measured using four items based on Tersine (1994), order preparation, order transit, supplier lead-time and delivery time. Order preparation consists of in-house order preparation time, in simpler words, it is the time required for a focal firm to prepare and place orders to suppliers. Order transit, is the process of order time to supplier. It is the time needed to send a completed order, and for the supplier to receive such order in timely fashion. Issues in order transit could arise when suppliers and focal company use systems with different operating platforms. Supplier lead-time is the time needed for the supplier to process and transport the requested goods to the focal firm. Delivery time is the time associated to in-house goods preparation, and also the delivery time to the customer. Based on Tersine (1994) conceptualization of lead-time and in order to develop measures suitable for the oil and gas supply chains, discussions took place between the researcher and the panel of experts. The following four items have therefore been developed to measure process lead-time:

1. Rate the level of your company's order process for supplier selection (i.e. performing approved vendor list check or evaluating supplier quality records)

The first item of process lead-time, measuring order preparation was adapted from Schoenherr and Swink (2012) "Perfect order process and fulfillment", and Boyer and Lewis (2002) "reduce order lead-time".

2. Rate the level of your company's system/methods for sending orders to suppliers

   The second item of process lead-time, measuring order transit was adapted from Wong et al. (2011b) "reduce order taking time".

3. Rate the level of your supplier's delivery ability/speed.

The third item of process lead-time, measuring supplier lead-time was adapted from Prajogo et al. (2012) "Speed of supplier deliveries".

4. Rate the level of your company's adherence to deadlines set by clients.

The last and final item measuring process lead-time (delivery time) was adapted from Flynn et al. (2010) "Our company has an outstanding on-time delivery record to our major customer" or "The lead time for fulfilling customers' orders (the time which elapses between the receipt of customer's order and the delivery of the goods) is short" and Wong et al. (2011b) "Provide on-time delivery to our customers".

***Flexibility:*** Flexibility was also measured using four questionnaire items. Flexibility types can be reviewed through different frameworks, the most famous of which is the three hierarchical relationship levels (Olhager and West, 2002; Sanchez and Perez, 2005):

- Shop floor level (product, volume, Routing flexibility)
- Company level (delivery, transshipment, postponement flexibility)
- Chain level (launch, sourcing, response and access flexibility).

Since this research is only interested in chain level flexibility (process flexibility), the items measuring this variable are formed based on launch, sourcing, response and access flexibility (Sanchez and Perez, 2005). Accordingly the discussions were also taken place between the researcher and the panel of experts, which resulted in four customized flexibility (chain levels) items, suitable for the oil and gas supply chains:

1. Rate the level of your company's capability to discover alternative suppliers for each of its components and raw materials.

The first item of process flexibility, measuring sourcing was adapted from Toni and Nassimbeni (1999) "Sourcing policy and selection criteria (i.e. your company practice single sourcing?"

2. Rate the level of your company's ability to have access to widespread and alternative equipment in different regions.

The second item of process flexibility, measuring access was adapted from Sanders and Permus (2002) "Access to new technologies and product opportunities" and Wong et al. (2011b) "Able to rapidly change production volume".

3. Rate the level of your company's ability to introduce new/alternative incentive criteria for supply of equipment.

The third item of process flexibility, measuring launch was adapted from Prajogo et al. (2012) "Volume or capacity flexibility" and Schoenherr and Swink (2012) "Production flexibility"

4. Rate the level of your company's responsiveness to changes occurring in industry business practices (i.e. going green, fracturing)

The last and final item measuring process flexibility (response) was adapted from Flynn et al. (2010) "Our company can quickly respond to changes in market demand" or "Our company can quickly introduce new products into the market".

***Cost:*** Cost was one of the trickiest variables to identify and relate to the operational performances in the oil and gas supply chains. As presented under the literature review, this study has used ABC costing in order to measure the operational performance of oil and gas supply chains. In order to do so Kaplan's (1990) classification of cost based on capital and operating (cost) has been utilized. Furthermore Neely et al. (1995) used measures such as running cost and Service cost (Salaries and benefits) for operating costs and Manufacturing cost for capital cost. Measures from Tam and Tummala (2001) have also assisted with the development of cost measures under this study. The authors viewed Capital expenditure (i.e. Capital investment Unit cost) and Operating expenditure (i.e. Operating cost Maintenance cost Cost of support services). Similarly Kasteren and Nisworo (2007) used measurements such as equipment cost to measure capital cost, and working capital for operating cost. More recently authors such as Wong et al. (2011b) measured operating cost by asking questions such as "Produce products with low costs", likewise Prajogo et al. (2012) used "Production costs". Based on several discussions with the panel of experts and by conducting a thorough investigation in the literature, this research has categorised cost as Capital Cost (Ccost) and Operating Cost (Ocost). In order for this study to identify the correct items to measure both set of costs, the NORSOK: O-CR-001 (1996) and ISO 15663-2 :( 2001) handbook of the oil and gas industry standards were utilised. The following 11 items were adapted from the industry standard handbook to measure cost:

*Capital cost (CAPEX):*

1. Rate the level of your company's design cost
2. Rate the level of your company's equipment costs
3. Rate the level of your company's fabrication costs
4. Rate the level of your company's installations costs (e.g. onshore and offshore platforms)
5. Rate the level of your company's commissioning costs
6. Rate the level of your company's insurance spare costs
7. Rate the level of your company's project reinvestment cost

*Operating costs (OPEX):*

1. Rate the level of your company's man-hour costs for each function
2. Rate the level of your company's spare parts costs for each unit (service and maintenance)
3. Rate the level of your company's energy consumption costs
4. Rate the level of your company's logistics support costs

## 5.6 Data Collection

Under this research designing the process of data collection consisted of the following two:

1. The questionnaire development and enhancement process included combining all the measurement items identified and selected for the three areas of OS, SCI and operational performance, in such a way that it could be clearly understood. The research supervisory team and industrial expert then reviewed a draft of the questionnaire. After considering and applying the experts' comments the questionnaire was piloted to a group of respondents in the oil and gas industry.
2. The sampling strategy was then outlined to structure the targeted respondents. This then formed the questionnaire's administration approach, was used in order to report potential challenges in collecting data from the oil and gas industry.

### 5.6.1 Questionnaire Development

The questionnaire under this study was designed to overcome a number of potential research methodology biases (e.g. appropriate and accurate responses from potential respondents).

This study considered the three key principles in designing the research questionnaire (See Cavana et al., 2011; Saunders et al., 2011):

1. Question wording

   All of the questions used in survey where assessed in relation to the following areas:

   - Through a literature review (identifying the original purpose of scale) carried out under this study, the content and reason of each question was assessed
   - With the help of both academic and industrial experts the wording and language of each question was reviewed and piloted
   - With the help of both academic and industrial experts under this study the type of each question was also assessed and piloted
   - With the help of academic experts under this study the sequencing of each question was assessed and piloted
   - With the help of both academic and industrial experts under this study, the biases in each question were reviewed and piloted
   - With the help of both academic and industrial experts under this study, issues related to handling data vs. personal information were also reviewed and discussed

2. Planning for variable measurement, categorization and response coding

   - In this research different categories were assigned in relation to the type of each question
   - In this research different coding were assigned to questions that were derived from different concepts
   - In this study scaling and rescaling were performed based on the measurements from the literature and in relation to the context (oil and gas industry)
   - In this study validity and reliability assessments were also discussed and considered

3. Overall appearance and presentation of questionnaire

   - The appearance and presentation of the questionnaire was assessed and piloted for judgment.
   - With the help of both academic and industrial experts the length and size of the

questionnaire was assessed (through pilot reviews the time taken to answer the questionnaire was measured)

- With the help of both academic and industrial experts the cover letter and introduction of the questionnaire was also assessed (in questionnaire pilot phase)
- With the help of both academic and industrial experts the instruction to completion of the questionnaire was also assessed (in questionnaire pilot phase)

The final draft of the questionnaire can be seen in Appendix D. In addition to the three sections on OS, SCI and operational performance; the questionnaire included two introductory sections. The first being a cover letter which introduced the researcher, the university, the ethical stand, briefly outlined the research objective, and also provided explanations on why the research would benefit the organization willing to participate in the study. The second introductory section was the company background at the beginning of the questionnaire. This section collected information that was non-personal and non-identifiable; so that the target companies could be assured that their sensitive information was kept safe. These questions included the oil and gas sector, type of company, which sort of activities these companies were involved in (sale, purchase of oil and gas), demographics, operational size (e.g. revenue and expenditure), job title and so on. At the end of the questionnaire the respondents were given the option to include their email with a chance of winning a gift voucher of fifty pounds. Accordingly the questionnaire was assembled in the following three stages:

1. Measurement scale incorporation
2. Academic and industrial expert review
3. Pilot test and updates to final draft

The first draft of the questionnaire included the variable items that were reviewed and selected from the literature. The layout of the questionnaire at the beginning was based on the conceptual framework of this research. The improvement of the questionnaire was carried out based on two further drafts. In order to view whether or not the questionnaire was suitable for the research objective, the panel of industrial and academic (supervisory team) experts assessed the second draft. In this draft many of the operational performance indicators were subject to alteration. This was because the practitioners either did not fully understand such items or in some cases felt they did not represent the operational elements in the context of the oil and gas industry. The second review was undertaken in order to confirm face validity; reduce biasness in the questions; ensure content validity of the measurement items; ensure the questionnaire was appropriate for managers in the oil and gas industry; and to see if the population framing was relevant to the research objective. The following criteria were used in selecting the industrial experts for the panel review:

- They were high level oil and gas managers with great level of operational experience
- They had been practicing in the oil and gas industry over 15 years
- They had worked in different sectors of the oil and gas industry (have been rotated and have diverse knowledge in this industry)

These experts were all given a copy of the first draft of the questionnaire and were advised to assess the items and flag those ones that they felt needed modification. More specifically the panel of experts was asked to see if:

- The constructs were consistent in measuring the research concept,
- The wording and if the questions were easy to understand
- Looked or any foreseen misinterpretation
- Checked to see if the sequence of questions were appropriate
- Checked for face validity
- Checked for content validity
- Checked for the suitability of measurement scale, especially the operational performance factor (items created in this research)

The questionnaire was then altered based on comments received from the both panels of academic and industrial experts (in relation to issues raised above). A meeting was organized by the researcher to discuss and resolve the differences on the opinions and comments raised.

In line with findings by Hoskisson et al. (2000) and based on the panel discussion, this research realized that the difficulties of data collection, were usually worse in emerging and developing economies (i.e. Middle East, Africa, South East Asia, South America). This could have potentially created significant problems since many of these regions were the main business and operational focus for oil and gas companies (because of the regional oil and gas distribution). Such problems were usually associated to respondents relating to terminologies borrowed from developed economies (western countries) and whether they understood the questions, in order to participate and provide accurate responses (Riordan and Vandenberg, 1994).

For this reason a meeting was organized between the researcher and an industrial expert from the Middle East. This was done in order to better understand the significance and role of the English Language in the questionnaire. Based on the discussions that took place the researcher was advised to keep the survey in English only, as translating some of the concepts to Farsi (Iran) or Arabic (Persian Gulf countries) might have led to confusion on the subject matter. Although these countries might not have English as their main language, it is however the principal language in the oil and gas sector (since the oil and gas industry is a global one). In other words, because of the global nature of the oil and gas business (i.e. customers and suppliers from all over the world interacting), the majority of high level experts in this industry are fluent in professional English. This was also confirmed during the pilot tests where the questionnaires were targeted towards 30 oil and gas professionals.

Problems related to cultural differences also created difficulties (e.g. collecting data in a timely manner). Therefore the questionnaire was assessed to confirm wordings stayed simple and in most cases the effort was taken to prevent the use of technical jargon or complex expressions that might have been understood differently, based on the diverse cultural background of the respondents in the oil and gas industry (Riordan and Vandenberg, 1994). Considering high diversity across the managers in the oil and gas industry, the panel advised that the seven point Likert scale would be a better option (compared to five point), since it would provide more options or distinctions to respondents.

Furthermore, in order to overcome some of the difficulties mentioned above (e.g. in relation to trusting the research, faster response time), the researcher traveled to the Middle East and almost all of the questionnaires (third and final draft) from that region were completed in face-to-face sessions with C-level and operational managers. Therefore this research had a unique opportunity to discuss many of the questions in a more open dialogue, which resulted in a better understanding of how oil and gas companies view their OS, supply chain activities and also their operational performance.

As mentioned the second draft of the questionnaire was used in a pilot test to capture more improvements and contextual enhancements targeting a small group of respondents. The selected pilot group included managers in oil and gas companies operating in different regions globally. The list included managers that were working in Western based companies (e.g. US, Canada, UK, Italy, France, Netherland, Norway), Eurasian (Malaysia, China, India, Vietnam, Indonesia, Japan, Russia), Middle Eastern (Iran, Qatar, Kuwait, UAE, Oman, Iraq, Saudi Arabia), South America (Venezuela) and Africa companies (Nigeria). The review of the final draft focused on developing the questionnaire, with the following objective:

- To check if it became easier to understand and respond to the questions
- To check the extent of variability in the items measured
- To check how reliable were the items measured
- To check how long (on average) it took to complete the questionnaire

The participants (thirty people were targeted) were directly contacted by a customized email and were asked to answer the survey questions and also comment on the content and the structure of the questionnaire. The majority of the feedbacks received were positive, with minor difficulties reported in relation to question phrasing and length of questionnaire. Furthermore, the average time to fill in the questionnaire (based on the twenty-five people that responded) was estimated at twenty minutes. The feedback received was then used to modify the questionnaire for the final time (mainly the operational performance). For example, the researcher was advised to separate the cost measurements into, operating and capital cost. Originally the cost section was grouped into one section as cost, this created some confusion amongst the pilot group, which viewed the section as quite lengthy. Therefore measures of costs were broken down into capital and operating costs

Furthermore the operating cost measure of "Rate the level of your company's transportation costs, which are related to transporting equipment, materials, as well as various structures and stationary and mobile offshore equipment" was advised to be changed and simplified into "Rate the level of your company's logistics support costs". The researcher was also advised to break down a question phrased as "Rate the level of your company's EPC costs" into "Rate the level of your company's design cost", "Rate the level of your company's equipment costs", and "Rate the level of your company's fabrication costs". The experts suggested that combining engineering, procurement and construction under one measurement would not sufficiently capture the nature of the three steps. One of the pilot experts stated, "even though in the oil and gas industry EPCs are usually under one division, however they have different costing mechanisms and should be measured in separate items").

Another questionnaire item that was suggested to be modified was the "How well does your quality management practices determine and reduce defective, failed, or non-conforming item, during or after inspection (i.e. disassembly, repair, replacement, reassembly, calibration control)". Originally the item did not have the examples provided in the parentheses and was stated as "How well does your quality management practices determine and reduce defective, failed, or non-conforming item, during or after inspection", therefore the researcher was asked to provide the above mentioned examples. The same comment was given for the following question "Rate the level of your company's order process for supplier selection (i.e. performing approved vendor list check or evaluating supplier quality records)", and clarification was needed on what is meant on order process for supplier selection, therefore the vendor list check was suggested as an example. The final version of the questionnaire is presented in Appendix D.

### 5.6.2. Online Survey Design

This study identified the most appropriate method to manage the questionnaires and follow up communication in the context of the global oil and gas industry, was by utilizing online administration and websites. Göritz and Crutzen (2012) argued that online questionnaires tend to be managed easier and also are more convenient for long distance respondents. Under this research emails and electronic questionnaires were preferred over traditional mailing and hard copy questionnaires. Emails offer a faster and more flexible interaction path, they are also free of cost (no postal cost), immediate notifications are provided in cases with wrong email addresses, and follow ups (reminders) are easier to manage. Furthermore electronic questionnaires have many advantageous over hard copy ones most notably they are, easier to store in reliable databases, easier to track online, and easier to convert to statistical programs such as SPSS (see Cavana et al., 2001). Therefore, this study viewed online communication safer and more efficient than traditional routes (post).

For this purpose http://www.qualtrics.com was used and the final version of the questionnaire was uploaded on the server. The researchers' official university email was used to inform the participants of the online questionnaire. This email contained a customized message for each individual manager in the company, so that they did not feel the questionnaire was randomly sent to firms (even though that was the case). Using email as the medium to contact managers and inform them about the questionnaire was judged to be very efficient. All the managers had to do was click on the hyperlink and it would automatically relocate them to the first page of the questionnaire (company background). In the customized message, the managers were informed about the confidentially and anonymous nature of the research as well. In addition, the email also highlighted an incentive factor for participants in which it informed them that a summary of the final thesis will be sent to all that participate in the study. To ensure anonymity the Qualtrics online platform was also configured in a way that it would not record the unique Internet Protocol (IP) assigned to respondents. Additionally to confirm the questionnaire was filled in properly (and no essential section skipped) this research made use of Qualtrics configuration features that would require mandatory responses before going to the next section. At the end of the online questionnaire the respondents were invited to enter their email (optional), to receive the final thesis and also have a chance of winning a gift voucher. For an example of the invitation email sent out to firms refer to Appendix E.

### 5.6.3. Survey Sample

In the second chapter (oil and gas) it was argued that the oil and gas industry contributes enormously to global economic growth. Energy was presented as the essential input in the process of producing almost all goods and services globally. In the words of Peter Voser the former CEO of Royal Dutch Shell,

….. "Energy is the Oxygen of the Economy, without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable."

It was suggested that such an important industry still faced enormous challenges such as, ongoing political unrest in the Middle East, unstable production capacity of oil producers, long and unpredictable lead times due to regional supply and global demand, and the restrictions on transportation method (ships or railway) (see Morton, 2003). In order to overcome challenges resulting from rigid supply chains (e.g. Chima, 2011; Jenkins and Wright, 1998; Mitchell et al., 2012), this research proposed to investigate the mediating role of SCI on the relationship between OS and operational performance. In order to do so, oil and gas companies with complex supply chains with two interconnected streams - the upstream (e.g. exploration and appraisal, fabrication, installation, drilling, production and logistics management) and downstream supply chains (e.g. refining the crude oil into usable products, delivering it to final consumers) were targeted. Furthermore it was suggested that in order to effectively manage the flow of information across both up and down stream, oil and gas managers would require strategic data and information sharing; higher collaboration and better flow of communication; and integrated process management systems with their supply chain members (Chima, 2011; Ikram, 2004; Schwartz, 2000). Based on the literature review carried out under this research, it was hypothesized that inter and intra firm association (communication and information) could mediate how OS affected operational performance of oil and gas companies. However, it was argued that despite the complexity and challenges associated to oil and gas supply chains, very little attention has been given to such a significant industry in operations management research.

In order to carry out the empirical investigation in such a vital industry, this research focuses on the supply chain of National Oil Companies (NOC), International Oil Companies (IOC) and their major contractors, their suppliers and customers. The population frame for this study is the global oil and gas industry, with a focus on the Middle East because of the vast amount of energy reserves, and the number of oil and gas projects and operational activities in this region. In chapter 2 it was presented that the Middle East was the main supplier of the world energy demand because of its reserves, supplies and trade market. Figure 5.3 show that crude oil reserves are highest in the Middle East with 47.9% (808.5 thousand million barrels) followed by South and Central America with the 19.5% of the world total reserves (329.6 thousand million barrels) (BP Statistical Review, 2014). During the same period of time natural gas reserves in the Middle East were 43.2% (80.3 Trillion cubic meters), followed by Europe and Eurasia with 30.5% (56.6 Trillion cubic meters) of the world total reserves (refer to figure 5.4).

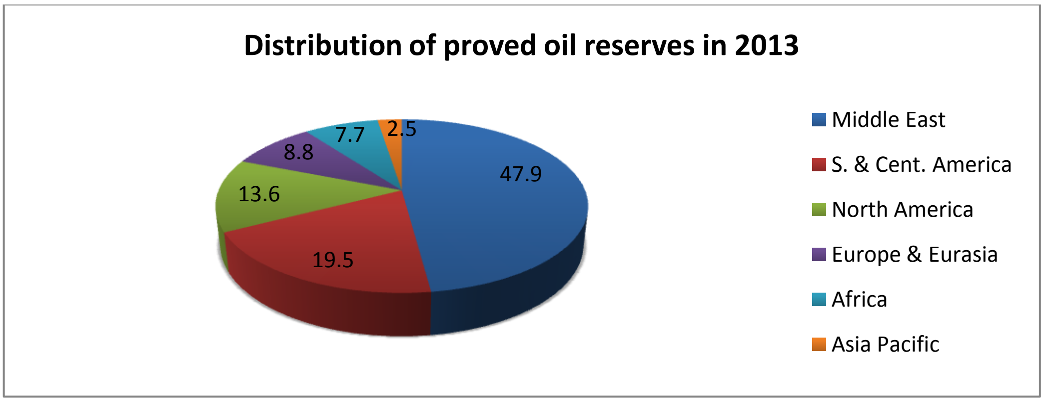



**Figure 5. 3: Distribution of Proved Oil Reserves (BP Statistical Review, 2014)**

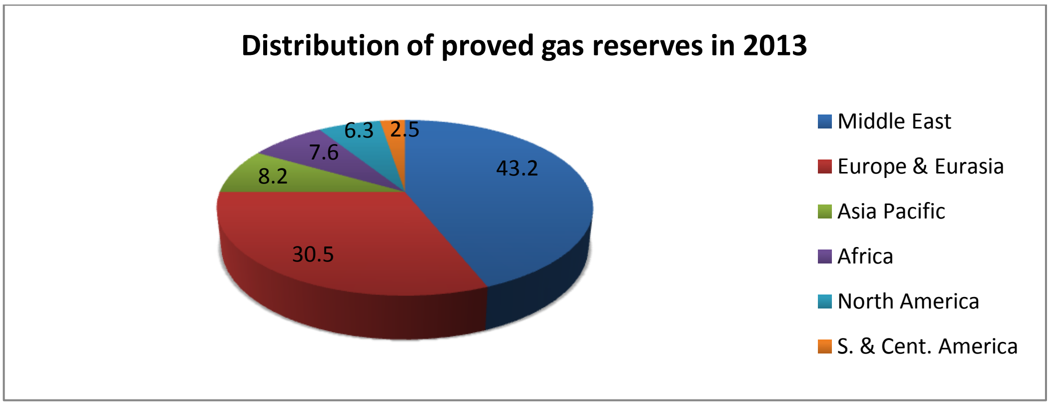



**Figure 5. 4: Distribution of Proved Natural Gas Reserves (BP Statistical Review, 2014)**

The unit of analysis is set at the oil and gas company (focal company) and its supply chain. The OS (centralization, formalization and hierarchical relationship), SCI (internal, customer and supplier) and operational performance are the primary constructs of this research. Furthermore in order to apply the unit of analysis in a more practical and operational sense, the sample frame of this research is targeting focal oil and gas companies (IOC, NOC) (a consortium or group of companies created for the oil and gas project) which are most affected by their supply chain demands and key members in this link. To justify the selection of the oil and gas companies, this research has targeted one of the most complicated and most uncertain industries in relation to supply chain issues (e.g. complications related to supply of equipment at different levels). Additionally it has been argued that the oil and gas industry contributes enormously to global economic growth. Energy is considered as an essential input in the process of producing almost all goods and services around the globe, and it is therefore important to examine its supply chain (since small alterations in such a supply chain will have enormous impact on other sectors).

When discussing the oil and gas industry it is also important to distinguish the forms of entities that exist and through collaboration manage the oil and gas project, each of which may have a different shape of OS with different levels of integration with key members in the supply chain. Based on several face-to-face meetings with strategic level managers and discussions that took place on real life oil and gas related projects, this research has managed to classify three types of organizational set-ups in the following order:

- Company
- Contractor
- Sub-Contractor

Sub-contractors are very similar to contractors with a distinctive feature that they do not answer to the focal oil company and are only accountable to the contractor, which included them in the project. Sub-contractors are usually smaller in size and are less risk taking companies. In the oil and gas industry and especially the Middle East, which is the focal point of the majority of multibillion investments in oil and gas related projects, NOC's engage in partnership agreements with more advanced and technically stronger contractors (whom have the know-how and technologies, which many Middle East companies lack and could be a consortium of contractors together). Accordingly NOC's contract oil and gas projects to contractors in the following forms:

- EPC (Engineering, Procurement and Constructing) NOC will not be responsible for any of the above EPC components and all the risks related to the different stages are transferred to the contractor
- EP (Engineering & Procurement) NOC only responsible for construction related activities in the project, with engineering and procurement activities falling on the contractor
- EC (Engineering & Construction) NOC only responsible for procurement related activities in the project with engineering and procurement activities falling on the contractor
- PC (Procurement & Construction) NOC only responsible for engineering related activities in the project, with procurement and construction activities falling on the contractor
- E/P/C In this case the NOC outsources only one component in the EPC and the other two are the responsibility of the focal company
- Company takes responsibility for all EPC (this is risky and very expensive for NOCs hence such set-ups are rare)

### Types of Organizations

A set of criteria's are used in order to select the appropriate organizations in the sampling frame. The sampling criteria that have been utilized are described in table 5.

**Table 5. 6: Sampling Criteria**

| **Criteria** | **Explanation** |
|---|---|
| Public/private partnership | Consortiums (could be a partnership between NOC/IOC/contractors) that are developed in oil producing nations in order to invest, develop, produce and refine the product from the oil fields |
| Oil and Gas sector | The oil and gas sector shapes the boundaries of what an oil and gas company is capable of executing. Oil and gas companies fall in one of the two areas of **Upstream** (Exploration and Appraisal, Development, Production, Drilling, Pipelines, Services), and **Downstream activities (**Processing (Oil/Gas), Transportation, Storage, Marketing, Refineries (Oil/Gas), Petrochemical plants, Dispatching & Distribution, LNG) |
| Type of Business | Companies were also evaluated and selected based upon the type of business they were operating: **A. Services provider** (e.g. Technical Support and Services (TSA)/Production Support and Assistant (PSAC)/ Logistic Company/ Management Contracting (MC)/ Management Consultancy (MC)) **B. Manufacturer** (e.g. vendors/designer/producer of oil and gas equipment's and materials) or Both Service provider and manufacturer |
| Organization Operational Location | Companies were also evaluated and selected based upon the regions of the world they operate in (i.e. Africa, Asia (pacific), Europe and Eurasia, Middle East, North America and South America) |
| Size of Organization (operation) | Companies were also evaluated and selected based upon the size of their operation high/low input (i.e. measured in the form of (1) the number of company's suppliers and customers (2) average sales revenue per annum (3) average expenditure per annum on operational activities (operational cost) |
| Respondents position | The participants were either senior level manager, typically head of business functions (such as CEO, general manager, director, strategic and planning manager, C-level managers) or operational level managers, (e.g. well reservoir manager, supply chain manager, sourcing manager, project manager, procurement and Logistics Manager) |

Initially a variety of databases and websites were compared in order to establish the list of organizations operating in the oil and gas industry. Databases such as RIGZONE, Pegasus, Oil and Gas Directory Middle East, Oil and Gas UK and etc. were filtered with the inclusion/exclusion criteria that were described in table 5.6. Unfortunately besides the public information such as the name of the company, the sort of services provided (i.e. Drilling, shipping) and the contact to the sales team, not much valuable information could be extracted. In accordance to Hoskisson et al. (2000), this study found out that many of the data sources such as telephone directories and contact emails obtained online were also outdated in developing countries. Hoskisson et al. (2000) argued that the speed of the economic development and policy changes were high in such regions. As mentioned the majority of the company details on online servers only provided their sales and marketing emails, which made contacting the appropriate individuals impossible. In order to overcome the above difficulties in getting access to oil and gas companies, an effective approach was the introduction of this research and the researcher to managers of oil and gas companies through a high-level industrial link. Contact details of managers from the oil and gas industry were obtained from the above-mentioned affiliate from the industry, and 650 questionnaires were sent emailed to potential respondents.

### 5.6.4 Target Respondents

When discussing survey questionnaires, selecting the opposite respondent is a tricky and essential element in any study. The participants' qualification to fill the questionnaire is vital to guarantee reliability and validity (Scandura and Williams, 2000). The questionnaire was directed at the organizations' senior executives (C-level managers), which are usually positions that understand the issues related to oil and gas operations from a high-level and strategic perspective. The questionnaire was also targeted at operational level managers as well. As presented in the previous section the organizational positions of the participants under this study were either C-level managers (e.g. general manager, director, and CEO) or operational level (e.g. supply chain manager, sourcing manager, project Manager, procurement and logistics manager, purchasing Manager, engineering Manager, drilling and well manager, construction manager). Taking a comprehensive approach with a wide range of managerial positions and profiles (setting triangulation) aided this study to increase the external validity. This is because broad ranges of perspectives are taken in to account in relation to the data extracted from the industry, which helps with the data generalizability (Scandura and Williams, 2000).

### 5.6.5. Participants Listed

In order to see the effects of OS on SCI and operational performance this study sampled the views of senior and operational managers in the oil and gas industry. This raised some difficulties because many of the oil producing nations (in which oil and gas projects are carried out), are mainly developing economies (Middle East). In such regions managers might not be as open as the ones in Western (or developed) countries in relation to valuing academic research (see Hoskisson et al., 2000). Trust is another major issue, and managers (e.g. of NOC) in such region might not feel comfortable in providing data in relation to their internal and external structures and also operational performance. Accordingly Hoskisson et al. (2000) argued on the possible issues that could result from the consistency of managers' answers in relation to a long set of questions. Also, the inter-rater reliability (Cronbach's alpha) tests applied in western research could also cause difficulties since it is challenging to access senior managers. Hoskission et al. (2000) further argued that CEO's mainly in developing nations tend to monopolize information more than their colleagues in the developed nations. For this reason it can be argued that the lack of research culture in developing nations could create more mistrust between the research and the target respondents (Hoskisson et al., 2000).

In order to overcome such issues the researcher travelled (two months) to the Middle East (Iran, Qatar, UAE, Kuwait and Oman) and the questionnaires were filled in person, where it was possible. This was done in order to build more trust (i.e. seeing the researcher in person and building a human relationship) between the researcher and the participants. Further on, this research had attempted to utilize a systematic sampling strategy. Systematic sampling could be described as a statistical method, which consists of selecting the target population based on an ordered sampling frame. In other words it could be viewed as random sampling with a system. One of the main advantages of systematic sampling is its simplicity. As argued above it enables this study to add a process or system in randomly selecting a target population, and therefore it overcomes the chance of cluster selection of subjects that is associated to random sampling. Therefore systematic sampling insures the target population could be selected evenly. The oil and gas industry is a global one, with a number of institutions operating directly (upstream and downstream) and also indirectly (i.e. steel manufactures acting as oil and gas suppliers).

Therefore in reality and with the limitation on the research duration, and issues related to money, labor hours, and access to suitable targets (to ensure appropriate response) in such a massive industry, has inspired this study to incorporate a number of control factors for the participants' selection criteria to assemble the database of participants. This was done in order to overcome potential methodology biases:

- Confirm that the collected information took the suitable research context and is able to generate reliable outcome
- To also control factors which resulted in a low response rates
- To make sure appropriate and qualified respondents are targeted
- To make sure respondents trust and are interested in the research and improve the possibility of obtaining more accurate responses
- To increase the chance of accurate response from very busy managers that have little or no time to spare

A number of authors have argued that using multiple or preferable information sources (participants) is significant in gaining acceptable and consistent data (Saunders et al., 2011; Scandura and Williams, 2000). Therefore in order to overcome the potential biases mentioned above (i.e. response rate of at least 30% and more data consistency), this research used a systematic sampling using the following sources:

1. Researchers in-direct contact to the industry
   The researcher’s father has worked in a director level position (Chief of oil and gas contract negotiation) in the oil and gas industry for the past twenty years. His job description required him to deal with all major IOC and Contractors for the duration mentioned above. By using the contacts of such a key industrial connection (business cards), this research sent out customized messages (with an introduction explaining where the email contact was obtained from) to approximately 526 contacts of randomly selected managers.
2. Researchers direct contact to industry
   The researcher graduated from the University of Petronas, owned by one of the biggest oil and gas companies in the world. He has also worked in the hook-up commissioning and decommissioning department of Petronas and has many colleagues in the industry. By using the researchers own connection and associates in the industry, this research sent out customized messages (with an introduction explaining where the email contact was obtained from) to approximately 30 contacts of systematically selected managers.

3. Oil and Gas events

   The researcher has also participated in four International oil and gas events (most notably an event held in Iran by the ministry of oil for top level managers in the industry, looking into how to revolutionize the contract-subcontract framework of oil and gas projects). During the coffee and lunch breaks of these events the researcher was able to go around the conference venue and introduce the research area through a customized cover letter explaining the survey tool and invite participants to the either fill the hardcopy questionnaire are visit the online link. Approximately 94 contacts of key IOC/NOC and contractors were targeted based on this approach.

The participants' database was edited with each of the repetition steps presented above. This was done to confirm that the most suitable contacts were targeted during the data gathering stage and to assemble the participants' list. The email database assembling process (from the above sources) lasted about four months, from October 2013 to January 2014. At the end of this process, at least one email per participants was obtained for all the 650 organizations systematically selected. Such systematic sampling is commonly observed in the literature. In relation to this Smith (2011) argued that even though systematic selection of participants is usually perceived as a good option, but it might result in a sample that is neither representative nor suitable. In order to overcome this potential, the study accounted for control variables (e.g. Oil and gas sector/upstream and downstream; type of the organization public/private; Type of business activities/ service provider, manufacturer) that would filter samples, which were deemed as not suitable for objectives and scope of this study. The control variables will be discussed in more detail in the following chapter (section 6.3.2 demographics).

### 5.6.6. Ethical Consideration

It is important that the data gathered through the oil and gas companies remain totally confidential. The anonymity of all the respondents is a top priority in any field of research and it should be done without conceding the right of the respondent, researcher and the university. In no section of the questionnaire were there questions that could expose identifiable information of the participant. The questionnaire also allowed respondents to enter their work email (optional), which was required for the draw of the prize money and also to send the final analysis to the interested managers. The research institution hosting this study is the University of Sheffield that has a code of research in alignment with the United Kingdom's research policies. All researchers are required to gain ethical clearance from the institution before the actual data gathering commences. In the cover letter sent out to organizations a frame of reference to ethical concerns was also provided, that included the following:

"*All your responses will be treated in the strictest confidence and we will not disclose your personal details to anyone. The Sheffield University Management School's research ethics committee has already approved this project.*"

## 5.7 Approaches to Data Analysis

This section presents the data analysis approaches selected for this study. In choosing statistical method to test the hypotheses, this research takes into consideration the following two categories (Collis and Hussey, 2013):

1. Features related to resources (time, cost and finding appropriate statistical software)
2. Data features related to type of analysis (EFA, CFA), normal distribution (parametric techniques), variable numbers (univariate, bivariate and so on) and scale of measurement (ordinal, nominal, and ratio).

### 5.7.1 Managing Data

Before any of the analysis techniques can be carried out, the data obtained through the industry was organized from its raw shape, to a format that was prepared for the analysis. One of the major benefits of using the online questionnaire was the capability to govern many features of questionnaire input; this results in a fairly cleaner format. For this reason the main data issues related to unclear or missing responses were excluded using online surveys. This study takes the following steps in preparing the data (see Pallant, 2010):

1. Data Editing

   Data editing requirements were mainly dealt with in the formation of the online questionnaire (i.e. using features such as text box formatting to administer clearness in response)

2. Blank Responses

   By using the features of Qualtrics online survey, this research configured the questionnaire in a way that every compulsory question must be answered before the participant could go to the next section. Additionally "not applicable" was also provided as an option.

3. Coding Data

   By using the data export feature of the Qualtrics online survey, this research received assistance with the process of coding the answers into a format fit for analysis. Some non-numerical elements such as company business activity were pre-coded by defining classifications and allocating a number to each option. This study assigned meanings for the scales and the ratings, thus allowing for further statistical assessments (e.g. 1= upstream 2= downstream).

4. Categorizing Data

   By using the features of Qualtrics online survey, this research was assisted in the process of data categorization. Data related to each variable were classified together. Further on non-numerical data were classified together and coded for analysis. Negative worded questions were also recomputed to positive ones using the compute in different variable of SPSS.

5. Entering Data

   Qualtrics had a feature that could export data in the format of SPSS input. For this reason the data collected through the online survey did not need re-entering in to the software. In order to ease the process of data entering, questionnaires that were filled in by hand (hard copy questionnaires) were manually entered on the online survey and a complete data file was then exported.

The online survey designed by Qualtrics will only allow responses in the format of either text (typed in by the participant) or selected from a preconfigured set of choices. Such features enforced the data input, in to a format that was originally envisioned for the questionnaire. Under such conditions the participants could only choose the exact number (for likert scale only one number accepted as answer) in filling the questionnaire. Further on, a feature embedded in the Qualtircs system prevented missing data. This feature did not allow the participant to leave or submit a page without fully answering all compulsory questions. SPSS was chosen as the statistical analysis software used for the data analysis in this research. With Qualtrics having features that could directly export the data file in the form of SPSS the risks associated to manual data entry were reduced significantly.

### 5.7.2 Descriptive Analysis

Statistical texts books (see Pallant, 2010; Tabachnick and Fidell, 2007) typically differentiate between Exploratory Data Analysis (EDA) and Confirmatory Data Analysis (CDA). EDA, which is also known as descriptive statistics, can be used to recapitulate or present quantitative data. CDA, which is also known as inferential statistics, assists with drawing conclusions from a big population by using the data collected through surveys (Tabachnick and Fidell, 2007).

Descriptive statistics summarizes and displays data in the forms of charts, tables, pies, graphs other forms of diagrammatic. This display, aids the research in identifying patterns and associations that may not be visible in raw data. Pallant (2010) stressed that descriptive statistics have a number of uses:

- They assist with describing the characteristics of the research sample
- They check the research variables for any violation of the assumptions underlying the statistical techniques that will be used to address the research questions
- They also help address specific research questions

Further on Tabachnick and Fidell (2007) argued that descriptive analysis should include two steps. The first section of descriptive analysis is to gain a preliminary feel of the data in relation to its representativeness of the sample characters. This primary feel for the data can be accomplished using numerous basic statistical tests. The frequency distribution of the nominal variables (such as job title) can be outlined using different diagrammatic (histograms) in order to obtain graphic demonstration. Further on the descriptive statistics test can also provide the mean, standard deviation and the variance in the sample, which help identify how the participants have replied to the items in the questionnaire. This test also illustrates the skewness and kurtosis in the in the sample population. The second section of the descriptive analysis involves testing the population sample for reliability and validity using correlational analysis. Instituting the goodness of the data sample provides credibility to all following inferential sort of analysis. Further on reliability can be instituted by assessing both consistency and stability in the population sample. Data reliability is also tested through correlation analysis showing how dependent and independent variables relate to each other. Cavana et al. (2001) argued that validity could be measured in various types (such as, factorial, criterion, convergent), which relies on the maturity of instrument used in the research. The second step of descriptive analysis will be conducted as a part of the initial phase of the inferential analysis.

### 5.7.3 Inferential Analysis

Inferential statistics enable researchers to make judgments of the probability that observed differences are not due to chance. This study adopts the following inferential analyses in examining the research hypotheses (Smith, 2011; Tabachnick and Fidell, 2007):

1. Examining the null and alternative hypothesis
2. Recognizing and applying the most suitable statistical test for the sort of hypotheses, nature of sample, and the type of measurement scale.
3. The option and testing of the level of significance at 5% or 1%

This research has identified structural equation modeling (SEM) (exploratory and confirmatory) as a suitable analysis approach. The theoretical framework underlying this research involves a number of concepts (i.e. OS, SCI) with multiple latent variables (i.e. centralization, internal integration). Therefore SEM has been recognized as a suitable technique to examine the nature of the hypothesized relationships. Pearl (2011) defined SEM as a statistical technique that analyses, tests and estimates casual associations that utilize a mixture of statistical data and qualitative casual assumptions. Pearl, (2011) noted that SEM is a robust technique for testing mediation between variables in complex conceptual frameworks.

## 5.8. Structural Equation Modeling (SEM)

According to Bandalos (2002) a strong feature of the SEM analysis technique is the capability to model and construct latent variables (variables that are not directly measured). Latent variables are evaluated in the model based on other measured variables, which are expected to relate to latent ones (Hair et al., 2006). This feature of SEM enables this study to concisely evaluate the reliability of the measurement in the model, indicating that the structural association amongst latent variables can be precisely evaluated (Byrne, 2013; Pearl, 2011). In accordance to Byrne (2013) the measurement model in SEM outlines the relationship amongst latent variables and related indicator variables. SEM is utilized to identify indicators for each of the constructs by evaluating the degree to which observed variables measure items, which are not part of the latent construct. Thus, helping establish the best indicators for a given construct (Hair et al., 2011). The accentuating associations amongst observed and unobserved variables are expressed by factor loadings, which notify the researcher about the degree a specific indicator can measure the variable and functions as validity coefficients (Byrne, 2013). Additionally the measurement model in SEM also includes errors that are related to the observed variable, which represent variances in the indicators and are derived from the following two sources (Byrne, 2013):

1. Random measurement error
2. Error variance, which arise from some specific characteristic related to an indicator variable

Some have argued that SEM also covers partial least squares, path analysis and factor analysis, each as a favored substitute to the ordinary least square regression in certain situations (Bollen and Long, 1993). Although, multiple regressions are restricted to a single (dependent) variable and a number of explanatory variables, path analysis offers a natural extension through enabling an analysis of the interrelationships in variables. In path analysis the dependent variable from one equation converts to the explanatory variable in the second equation (Bollen and Long, 1993). However, according to Maruyama (1998) the issue of unidirectional causation is usual for both traditional regression methods and path analysis. Because of these suitable features (looking into association among variables) SEM has received popularity in the social sciences and especially in organizational studies. Additionally Shah and Goldstein (2006) highlighted that SEM techniques have progressed to become popular in operations management studies.

Many consider SEM similar to other statistical methods such as ANOVA (analysis of variances) and multiple regressions used for hypothesis testing. The following four features of SEM make this analysis technique specifically applicable in the context of this research (all of which are related to enhancing validity, precision and reliability of the final results):

*SEM is confirmatory approach*: The majority of multivariate techniques (such as ANOVA and regression) are descriptive (exploratory) in nature, for this reason testing hypotheses would be a difficult task. On the other hand, SEM has specific confirmatory features that enable the testing of precise hypotheses in a conceptual model, and further remodelling to enhance test parameters and assessment with substitute theories (Byrne, 2013). This study contains three primary contracts (OS, SCI and operational performance) and twenty-four hypotheses to be evaluated in several circumstances whilst excluding acceptable alternate justifications.

*SEM can deal with complexity:* SEM is more inclusive in complicated and specific hypothesis testing, it also enables for concurrent analysis of sequences of structural equation. This feature is appropriate to this research that requires a set of complicated hypotheses to be assessed independently as well as simultaneously, in order to observe the collective impact of the concepts (Hoyle, 1995). According to Hair et al. (2011) SEM is exclusively relevant in research that a dependent variable in an equation can also be observed as an independent variable in the next. This feature is also relevant to this research where SCI can act as a dependent variable to OS, but in testing its relationship with operational performance, it can act as an independent variable.

*Flexibility with latent variables:* SEM provides flexibility with unobservable alongside observed variables. Since measurement error is a serious problem when scaling numerous variables, it becomes vital to divide errors from meaningful effects and enhance both reliability and validity (Hoyle, 1995).

*Assessing model fit:* In assessing for model fit, SEM offers flexibility and precision. Since SEM has the dual usage of exploratory and confirmatory modelling, it can be used for both theory testing and development (Hair et al., 2011). In theory development, SEM is used inductively by defining a model and then utilizing data to evaluate the values of free parameters. Early hypotheses usually need additional alterations based on evidence from the model (Byrne, 2013). However when SEM is utilized for exploration, it often applies EFA techniques to discover new associations not originally expected (Nunnally, 1979). It is noteworthy that this analysis technique also has some weaknesses. For example, SEM usually requires a large sample size in relation to other techniques, and has been argued to be technically challenging to manipulate (See Byrne, 2013; Hair et al., 2011). A two-stage SEM (inferential) analysis is conducted in this study. First, an exploratory factor analysis (EFA) is conducted on all the items measuring the research constructs. This is followed by a confirmatory factor analysis (CFA) to evaluate how well the hypothesized associations fit the data sample. Byrne (2013) stressed that confirmatory modelling start from the primary research hypotheses. For this reason the conceptualized associations are first converted to an equivalent causal model. These concepts are then operationalized to enable hypothesis testing. The model would then be assessed against data gathered in order to observe how well they fit each other.

### 5.8.1. Exploratory Factor Analysis

A good place to begin is to provide a definition of factor analysis, which forms the basis of the SEM technique. Factor analysis is a statistical method used to explain the variability among observed variables, correlated variables and unobserved variables referred to as *factors*. For example, variations in several observed variables (questions asked) could reflect the variations in only a few unobserved variables (e.g. internal integration, supplier integration, centralization) (Hair et al., 2011). Factor analysis uses these joint variations to model the observed variables as linear combinations of the potential factors that will emerge plus "error" terms (Byrne 2013). The information gathered about the interrelationships between observed variables is used to reduce the set of variables to a smaller group of factors (each explained by a set of observed variables or questionnaire items). Statistically speaking, factor analysis is a low-rank approximation of the matrix of observed variables (Hoyle, 1995). Pallant (2010) summarized factor analysis as a technique that

… "Takes a large set of variables and looks for a way that the data may be 'reduced' or summarized using a smaller set of factors or components. It does this by looking for 'clumps' or groups among the inter-correlations of a set of variables".

Tabachnick and Fidell (2007) argued that such method allowed the researcher to be able to tell which group of distinct items measures a specific construct (reasonably impartial from other items). In simpler terms, items that are sufficiently correlated with other items, but at the same time are distinct from each other, are grouped into one factor. Both of these authors have emphasized on a common ground in relation to factor analysis, in that the aim of this technique is to characterize a set of variables in terms of smaller number of hypothesized variables. Exploratory factor analysis (EFA) is the first step of the factor analysis used in SEM. It is done to identify the underlying structural relationships amongst a large set of variables. The goal is to identify the relationships between measured variables, in order to identify the unobserved latent variables that underlie the captured measures (to find out how measures can be grouped). As a sort of factor analysis, EFA also consists of a number of key steps. The key questions that must be addressed in EFA include: Is the data suitable for a factor analysis? How will factors be extracted from the observed variables? What criteria will be used to determine the factors to be extracted? What rotation method will be used? These questions will be addressed in the subsequent subsections.

### 5.8.2. Suitability of Data for Factor Analysis

Pearson's correlation matrix is the most popular statistical test used to check the relationships amongst observed variables in SEM. The objective is to inspect for correlation coefficients (r) above a fixed threshold (0.3). The selection rule suggests that if all correlation coefficients obtained are below 0.30, factor analysis and SEM may not be a suitable statistical method to adopt. This provides the first indication of data suitability for SEM (Byrne, 2013). Other tests of data adequacy for SEM include:

1. *Kaiser-Meyer-Oklin Measure of Sampling Adequacy*

   This measure is estimated for both the correlation matrix and individual variables to appraise the suitability of applying factor analysis. The value of this measure ranges between 0 and 1. A value of 0 specifies that the sum of partial correlations is large in relation to the sum of correlations, specifying dispersal in the pattern of correlation and consequently hinting at the inappropriateness of principal component analysis (PCA). A value close to 1 hint at patterns of correlation being fairly compact, hence PCA should produce consistent factors. Kaiser (1974) emphasized that values above 0.5 are acceptable, between 0.5 and 0.7 are mediocre, 0.7 to 0.8 are good, 0.8 and 0.9 are great, and above 0.9 are excellent.
2. *Bartlett's "Test of Sphericity"*

   Bartlett tests the null hypotheses that the original correlation matrix is an identify matrix and for FA to be suitable the test has to be significant.
3. *Extraction Communalities*

   Extraction communalities are approximations of the variance in each item accounted for by factors in the factor solution. Small values specify items, which do not go well with the factor solution and should be excluded from the analysis. The rule of thumb indicates above 0.5 as the limit for items needed to be reconsidered. Therefore, under this research the variables with values of <0.5 are closely checked.

### 5.8.3. Principal Component Analysis (PCA)

For factors to be extracted, a process known as factor rotation is required. Rotation is used to simplify the factor structure of a group of items, by grouping factors together as measures for each latent variable in a process known as *factor loading***.** There are several ways to extract factors in SEM, however the most commonly used method is the principal components analysis (PCA) (Tabachnick and Fidell, 2007). Pallant (2010) summarized the relationship between EFA and PCA, arguing that:

> …"These two sets of techniques are similar in many ways and are often used interchangeably by researchers. Both attempt to produce a smaller number of linear combinations of the original variables in a way that captures (or accounts for) most of the variability in the pattern of correlations".

In the context of this research, PCA is used to extract the factors from the questionnaire items. It is an effective technique because it accounts for the error variance. PCA can utilize orthogonal transformation on correlated variable observations, in order to transform them into a set of values with linearly uncorrelated variables (Tabachnick and Fidell, 2007). As mentioned above PCA obtains liner combination of variables in a way that the maximum variance is extracted. Thus, this procedure results to an amount of principle components that is either equal or less than the original variables. For this reason PCA is utilized to evaluate latent factor structure in the data set. (Tabachnick and Fidell, 2007).

### 5.8.4. Data Rotation

Rotation is used to maximize high item loadings on factors and reduce low loadings, in order to generate an interpretable and simplified factor solution. The two common rotation techniques used by researchers are orthogonal rotation and oblique rotation. Orthogonal varimax rotation produces uncorrelated factor structures, while oblique rotation produce factors that are correlated (Kline, 2005).

It is argued that although orthogonal varimax rotation is the most commonly used, the oblique rotation is assumed to produce more accurate results when the data does not meet the assumptions made a priori (in human behavioral research). Nonetheless, it is generally accepted that the rotation method chosen should enable easier interpretation of results, and parsimonious factor solutions. The general consensus amongst researchers is that the rotation method that intuitively and conceptually produces the best solution should be used. Thus, the rotation in this study was carried out using both techniques and the orthogonal varimax rotation produced the best factor solution. (Tabachnick and Fidell, 2007). This rotational technique makes sure that factors are rotated at right angles, indicating that the factors are uncorrelated with each other. As explained, the aim of using such rotational method is to achieve a "simple structure". A simple structure basically means generating a factor matrix, in which each factor has comparatively small amount of high loadings (Pallant, 2010). The varimax is normally considered to be the most effective technique; it simplifies factors internally, by maximizing the spread of variance across items and to increase the difference in loadings amongst factors (Tabachnick and Fidell, 2007).

### 5.8.5. Criteria for Number of Factors to be extracted

Deciding on how many factors to extract is a vital step in the EFA process (Tabachnick and Fidell, 2007). The main approaches used in order to extract the right number of factors after rotating the correlation matrix are as follow (Pallant, 2010):

1. Kaiser's criterion (Eigenvalue).

   As explained, PCA identifies the linear relationships amongst variables in a covariance matrix. Mathematically, the PCA of the correlation matrix produces orthonormal "eigenvalues" for the space of the observed data. The greatest eigenvalues represent the principal components with the highest covariability amongst the observed data. Based on this approach factors having Eigen values greater than 1 were selected for common factors (Kaiser's latent root criteria, Eigenvalue>1).

2. Variance Percentage

   Based on this approach factor extraction happens when a specific percentage of variance is explained. Factors representing a minimum of 60% of the cumulative variance have been included. Hair et al (2011) noted that variance above 60% is commonly observed as acceptable in social sciences.

3. Scree test

   This is a graphical representation of eigenvalues in a descending order. The shape of the curve of the latent value in comparison to the factor number is used to extract only the highest factors. Pallant (2010) stressed that the point where the slope of the curve straightens out, represent the maximum number of factors to be extracted. This rule has received a lot of support from the literature and is labeled as very effective (Tabachnick and Fidell, 2007).

### 5.8.6. Criteria for Significance of Factor Loadings

Below a certain point factor loadings stop being significant. Based on rule of thumb the SEM literature recommends in cases that the loading values are bigger or equal to 0.3 are believed to be significant. Although some authors have referred to a level of 0.32 as normal and in some cases values bigger or equal to 0.45 were considered significant. Based on recommendation from the literature this study has chosen to consider value of factor loadings 0.4 or greater (Tabachnick and Fidell, 2007).

### 5.8.7. Confirmatory Factor Analysis (CFA)

In relation to the context of the research, a group of fit assessments must be implemented in order to make sure the model developed is a good fit. A body of literature on SEM recommends model fit testing based on the following three steps (see Byrne, 2013; Hair et al., 2011):

1. Overall (absolute) fit should be examined
2. Increment fit that includes a comparative fit related to a baseline model should be conducted
3. Lastly, model parsimony should be utilized to modify the fit for the several variables in the model

Byrne (2013) emphasized that a usual SEM analysis includes, model specification, assessment of free parameters, evaluation of fit, model adjustment, sample sizing and interpretation and communication. CFA is utilized in the second stage of SEM in order to assess the construct validity of the model, and also the measurement model itself. Employing the factors obtained from the EFA, a structural model with hypothesized associations is developed. Before assessing the model based on structured associations, CFA is employed to validate the measurement model. One of the characteristics of CFA is that it forces all cross loadings to be zero, enabling only the loadings of items associates to each factor to differ freely. Furthermore as mentioned earlier in this chapter CFA is also employed to test the construct validity of the scales in this research. Three measurements are utilized to verify to construct validity (1) factor loadings conveyed through CFA (2) Average Variance Extracted (AVE) and (3) Construct Reliability (CR). In the statistics literature (and as a rule of thumb), factor loadings and AVE reported acceptable for CFA must be above 0.5. However, construct reliability for each construct is reported to be 0.65 or above.

In CFA (SEM) the overall fit of a model can be evaluated employing a number of fit indices. A wide consensus exists thus, a study should not excessively rely on a single measure of overall fit, and numerous indices should be taken in to consideration (Byrne, 2013; Tanaka, 1993). In SEM assessing fit is a simple task, which forms the foundation in accepting or rejecting models (one competing model over next). The output section of SEM programmes contains matrices of the projected association amongst variable. Assessing fit then analyses how related the estimated data are to the matrices comprising the relationship in the actual data. In the SEM literature numerous recommendations having been given on the application of fit indices to test research hypotheses (Byrne, 2013). From one perspective, the "acceptable fit" amongst the hypothesized model and the sample covariance matrix propose the credibility and likelihood of the hypothesized relationship in the research. From another perspective, the "unacceptable fit" indicates the validity of the hypothesized relationship continues to be under question. One of the most usual ways of assessing fit is a significant test using $\chi^2$. Using such test a non-significant value implies that the model fits the sample. However, assessing fit in such method has raised criticism in relation to the sensitivity of such test to larger sample size. To confront such issues Byrne (2013) suggested using alterative fit indices such as (goodness-of-fit) GFI, comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and other developed methods. The literature recommends (Byrne, 2013; Hair et al., 2011) models should be assessed using a mixture of goodness-of-fit indicators. Based on a systematic literature review this study identified NNFI (> 0.9 is good fit), CFI (> 0.9 is good fit), $\chi^2$ statistic ($\chi^2$/df ratio of 3 or below) and RMSEA (<0.8 suitable fit) as the most common fit indicators all of which will be explained in detail in this section:

1. NNFI and CFI

   In this sort of fit indicator (aka Tucker-Lewis index), the proposed model's fit is contrasted to a null model. Parsimony is measured by examining the degrees of freedom from the proposed model to the null model, and as presented above a good fit for this index is 0.9 or above. CFI was created as a non-centrality parameter-based index to tackle issues related to sample size. Its index ranges from 0 to 1 and just like NNFI an index of .09 or above represents acceptable fit (Bentler, 1992).

2. RMSEA

   A particularly informative criterion in assessing model fit. Steiger (1990) argued that RMSEA index calculates the inconsistency amongst observed and predicted covariance matrices (per degree of freedom). This sort of fit indicator measures inconsistency in relation to population and not the sample. For this reason, the value of the fit index helps estimate the population in a more effective way (since not affected by size). Values range between 0 and 1, below 0.05 specifies good fit, up to 0.08 are reasonably fit and between 0.08 and 0.1 specify mediocre fit.

3. Chi-square ($\chi^2$)

   $\chi^2$ has been recognized as the most common approach to assess goodness-of-fit. If $\chi^2$ indicates a low value, it would be non-significant and a suitable fit. The reason for this is that chi-square tests measure the actual and predicted matrices. Hence, non-significant results mean that no substantial alterations exist amongst actual and predicted matrices (Byrne, 2013; Hair et al., 2011). Thus, chi-square values that are low (significance levels bigger than 0.05 or 0.01) imply the actual and predicted inputs do not statistically differ. Therefore, the significance level of 0.1 or 0.2 should exceed prior to non-significance being confirmed (Hair et al., 2011).

When discussing a model's goodness-of-fit it is important to understand that p-values specify whether or not the model significantly differs from the null version. In statistics, null is considered to be 0, however in relation to SEM this is not always the case. The null hypothesis is the hypothesized model, in which parameters (related the hypothesized model) specify whether or not a path exists amongst variables. If the p-value is above 0 one would know that the hypotheses are rejected. Therefore if the p-value is high this implies that the observed model does not significantly differ from the expected one (and vice-versa) (Hair et al., 2011).

One of the limitations of $\chi^2$ is that it does not perform very well with sample sizes above 200. An alternate assessment of the $\chi^2$ is to test the ratio of $\chi^2$ to the degree of freedom. Kline (2005) emphasized that if the $\chi^2$ value is small in relation to its degree of freedom this indicates good fit ($\chi^2$/df ratio of 3 or smaller is good fit). Since this research has an appropriate size sample (200+), it would not face the limitation of the $\chi^2$ test. Table 5.7 illustrates a summary of the indices utilized in this research.

**Table 5. 7: Target Values for Fit Measures**

| **Fit Indices** | **Good fit** | **Average fit** | **Sources** |
|---|---|---|---|
| Chi-square ($x^2$) | < 3 | < 5 | Hair et al. (2011) and Fornell (1983) |
| RMSEA | <0.05 | <0.08 | Steiger (1990) |
| CFI – NNFI | > 0.9 | > 0.8 | (Bentler, 1992) |

Based on the output of the CFA, additive indices of construct items will represent the proposed structural model with: OS as exogenous variables, and SCI as intervening variables, and operational performance as dependent variable. The model under this research is a mediating effect model. In order to further evaluate the competence of the model fit, nested model analysis was conducted by utilizing the "sequential chi model difference test". This model analysis tests the significance of the inconsistency amongst two models. Under this research and as part of this test four models were evaluated and compared:

1. Null model, no associations (paths) amongst the constructs
2. Full model (saturated), consists of two direct and indirect effect of explanatory constructs (on both intervening and dependent variable)
3. Mediating effects model, (specified) only includes mediating effects in saturated model (no direct paths)

4. Direct effects model, allows only direct effects (no indirect paths) amongst explanatory constructs (on both intervening and dependent variable)

### 5.8.8. Path Analysis

The most suitable model is established by comparing the full, mediating, direct and null models. By doing so the structural model is then fitted by generalised least square (GLS) and all the hypothesized relationships (which are characterized by specific paths in structural model) are estimated (Anderson and Gerbing, 1988). GLS is utilized for approximating unknown parameters in the model and is applied frequently in cases where variances of observation are not equal (or where certain degree of correlation exists between observations). The statistical significance is tested through t-test method with p-value of the test below 0.1 specifying a significant path.

### 5.8.9. Structural Equation Modeling Sample Size

SEM literature involves contrasting recommendation of sample sizing. Bentler (1992) argued that a five to one ration of sample size to number of free parameters under examination is sufficient. On the other hand, Tanaka (1993) specified a twenty to one ratio as the target for researchers. Schreiber et al. (2006) emphasized that even though the size of sample is affected by data normality and the evaluation methods utilized, the commonly agreed upon number is ten participants per every parameter. Other authors have suggested another approach to sample size, such as setting the size as a function of least effect, power and significance. For example, McQuitty (2004) emphasized that it is significant to establish the minimum level of sample size needed to attain a preferred level of statistical power with a specified model (earlier to data collection). Iacobucci (2009) argued that many have a wrong impression that SEM needs bigger samples (in hundreds). The author argued a large sample would only be need if the structural model did not differentiate concisely between its constructs, or that predicted effects amongst variables are subtle. Although this research did not find a great amount of consensus on the suggested size of the sample, Sivo et al. (2006) suggested around 200 would suffice. Thus, as a rule of thumb the SEM literature suggests that any number around 200 or greater is agreed to offer sufficient statistical power for data analysis by using SEM.

## 5.9 Chapter Summary

In this study, 24 research hypotheses have been proposed to examine the mediating impact of SCI on the relationship between OS and operational performance of oil and gas supply chains. To empirically investigate these hypotheses, an analysis of the key philosophies and appropriate research methodologies was carried out. This chapter presented the research philosophical stance, the research approach and strategy adopted, and also the research choice. Additionally this chapter also revealed the sequences and steps of techniques in conducting this research analysis.

In relation to the research philosophy (epistemology) this research took a critical realist stance, since it enabled the researcher to better understand the social world through closer attention on the social structure (and actors in the oil and gas industry) (Mingers, 2004). On the other hand, in accordance to research ontology it was suggested that the research had more of an objective approach, since it attempted to reduce the complexity, and make it easier to investigate causal relationships between OS, SCI and operational performance. In order to do so, a single (mono) deductive (theory testing) approach was argued to assist in meeting the research objective. Accordingly survey questionnaire were presented as the research choice, and justifications were made in relation to its advantages and disadvantages. Further on this chapter also summarized the number of steps involved in collecting relevant data from the oil and gas industry. The research concepts under investigation were separated into variables (and operationalized) and relevant measurement items were categorized, adapted, and chosen in the form of a research questionnaire. The methods to manage and control the survey, in order to collect non-bias and accurate data were also discussed. Lastly both the descriptive and inferential analysis methods were presented. Chapter 6 presents a report of the analysis conducted for this study using the SEM approach.

## Chapter 6: Research Analysis (Survey of Oil and Gas industry)

The preceding chapter discussed the research philosophy and approach undertaken in this study. Justifications were provided on the research methodology adopted. Finally the chapter also explained the sequences and steps of techniques involved in research analysis. This chapter attempts to provide an overview on the research analysis. First, discussions are provided on the steps involved in collecting data from the oil and gas industry. Furthermore a section is presented on the descriptive analysis, highlighting the demographics of target respondents (oil and gas companies). Accordingly the results of the inferential analysis are demonstrated in two separate stages. Initially the outcome of the exploratory factory analysis (EFA) is presented. As a second stage of the inferential analysis, results of the confirmatory factor analysis (CFA) and structural equation modeling (SEM) are interpreted and discussed, from a statistical point of view. More specifically the results of the direct relationships between organization structure (OS) and operational performance; supply chain integration (SCI) and operational performance; OS and SCI; and mediating impact of SCI on the relationship between OS and operational performance are offered. At the end of this chapter the outcome of the hypothesized relationships is presented.

### 6.1 The Process of Collecting Data

This research implemented a systematic sampling approach, which targeted organizations operating in the oil and gas industry. Through the different sources presented in the previous, the contact details of 650 oil and gas companies were obtained. Therefore, customized emails were sent out to these 650 companies and the C-level and operational managers were invited to participate in the online survey. Because of the sensitivity towards information disclosure (in oil and gas industry), and in order to reduce late or none respondents, this research attempted to make phone calls and introduce the research, prior to sending invitation emails.

The data collection period was from October 2013 until March 2014. This process was carried out in two batches, with a number of notices sent between the original invitation, and the closure of the data gathering process. This was done in order to make sure the issues and problems associated in the first batch would be addressed in the second.

As presented in the preceding chapter, this research used at least one email address per manager in the oil and gas companies (i.e. C-level or operational). In order to track the respondents and their associate company, managers were asked to include their email addresses. This helped ensure that one respondent per organization was included in the data analysis. Additionally, the reminder options on the online-based surveys was used in order to increase response rates (Sánchez-Fernández et al., 2012). Since it was assumed that high-level managers in the oil and gas industry had heavy workload and tight schedules, a reminding strategy was implemented to increase responses. Furthermore this study used a tracking system, in order to distinguish respondents that had already participated in the survey from those that had not. This ensured that reminders were not sent to the wrong group, since it checked for responses on a daily basis and updated the respondent list. This study then reviewed the tracking system and removed names of companies that had participated and accordingly excluded them from the list of reminders. The above tracking system was a feature of the Qualtircs online survey, and accordingly made managing the questionnaires simpler and easier task.

**First Batch**

As illustrated in figure 6.1, the first batch of data gathering commenced on the 10$^{th}$ of October 2013 and ended on the 10$^{th}$ of December 2013 (approximately 8 weeks). At this point 650 oil and gas companies were contacted through email invitations and requested to complete the online questionnaire latest by 10$^{th}$ of November. The number of participants was monitored daily through features provided by Qualtrics. A follow up email was sent to the participants by week 3, once again reminding that the questionnaire needed to be filled by the 10$^{th}$ of November. However, on the 10$^{th}$ of November, the deadline was extended and the participants were informed that the online survey would remain open until the 10th of December. One final reminder was sent on the 1st of December, to companies that did not respond yet. This study utilized a reminder approach (closure date notification), in order to make sure the participants understood the urgency of the data gathering process. After nearly 2 months, a total of 98 questionnaires were gathered (by December 10th 2013), which was quite a low number for the purpose of this study (quantitative research).


**Figure 6. 1: First Batch of Data Gathering**

During this period a number of follow up phone calls were made to respondents. The key-learning outcome from the first batch of data gathering was that the majority of the oil and gas companies from the Middle East did not answer to the online survey. Although a lot of effort was put into reminding such managers through email and follow up phone calls however, it was understood that managers working in such regions were not as comfortable with online survey system, as the ones in the west (or managers working in developed economies).

**Second Batch**

A number of meetings were set amongst the industrial expert, the researcher, and the supervisory team, in order to address and increase the response rate and other potential biases (e.g. accuracy of response, incomplete questionnaires). The Middle East was identified as the region with the lowest response rate. It has been suggested that differences in research culture could create mistrust between the researcher and participants (see Hoskisson et al., 2000). Therefore, during the meeting the case of cultural differences was brought up and potential issues discussed. Accordingly it was understood that C-level managers especially in the Middle East (typically older generation), might not trust online surveys, particularly when questions are targeted at their operational performances. With further dialogues taking place, the researcher was advised to travel in person to the region to meet some of the managers, and provide them with hard copy questionnaires. This was done in order to build more trust between the researcher and the regional participants. As illustrated in figure 6.2 the second batch of data collection initiated on January 3rd 2014, and lasted until March 2nd, 2014. During these two months, numerous visits were made to the companies that agreed to meet face-to-face. As stated above companies were provided with both a hard copy of the questionnaire and also the link to the online survey, and it was left to the organizations to decide which of the two methods they felt comfortable choosing.

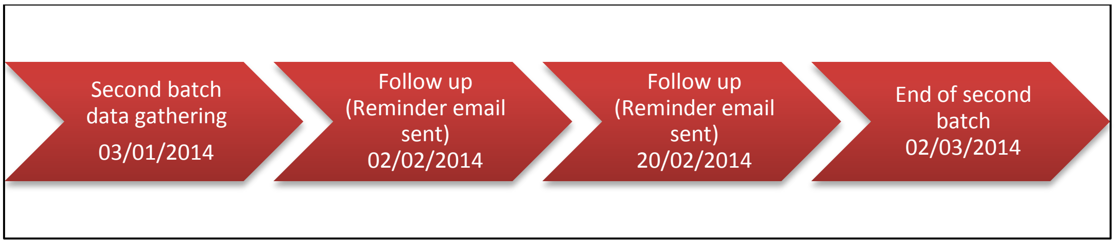



**Figure 6. 2: Second Batch of Data Gathering**

On average up to two visits were organized a day resulting in approximately 120 company visits. This was a challenging process, which in some cases would result in the researcher waiting long hours to meet the manager and discuss the research topic. It soon became clear why many of these companies would not respond. Most of these managers were very busy running different sectors of active oil and gas projects. Nevertheless, approximately 70 hard copy questionnaires were collected during these company visits. The remaining participants, promised to fill the questionnaire online. The names of their companies were also added to the reminder list and two weeks after each of the original meetings, an email was sent to make sure the respondents remember the deadline set (end of February 2014). Follow up phone calls were made (to organizations not responded) a week before the closing date. Additionally during this period the researcher was also able to attend four international oil and gas events (held for C-level managers), most notably two oil and gas summits in late January 2014, held in Tehran - Iran, introducing new type of investment contracts for upstream oil and gas projects. During the coffee and lunch breaks the researcher was able to have small chats with C-level managers, introducing and inviting them to participate in the study. Accordingly hard copies of the questionnaire and the links to the online survey were provided. Approximately 94 contacts were identified during these four events of which only 10 filled in the hardcopy questionnaire (e.g. IOCs, NOCs, and sub-contractors). The remaining company names were included in the reminder list and similar to the approach above, two weeks after the initial contact, an email was sent to inform them about the deadline (end of February 2014). A total of 109 questionnaires were collected by the March 2$^{nd}$, 2014. After 4 months of actively carrying out the two batches of data collection, a total of 207 questionnaires were obtained 650 oil and gas companies acquired a reasonable response rate of 31.84%. Accordingly these questionnaires were screened in order to check if they were usable.

## 6.2 Data Management and Preparation

It has been argued that data management and preparation, is a significant planning section before carrying out data analysis (Smith, 2011). Therefore, a preliminary data management is necessary to ensure accuracy in subsequent phases of the research analysis. Additionally it has been suggested that data management, prepares the data gathered for statistical tests and should also be in line with ethics protocols (Saunders et al., 2011). Table 6.1 below highlights the three data locations been utilized to store data under this research:

**Table 6. 1: Research Storage Location**

| **Location** | **Detail** |
|---|---|
| Laptop | The researcher's laptop was used as the main location to store the data collected. This ensured data safety and confidentiality (i.e. password protecting unauthorized access to the data). |
| External Hard drive | Every two weeks the folder containing the research data was copied in a protected (encrypted) folder on the researcher's external hard drive. |
| Print | The hardcopy of questionnaires were scanned and stored in researcher's laptop and the original copies kept in a safe location. |

By using an online survey to gather data, the process of organizing and managing information becomes simpler (see Sánchez-Fernández et al., 2012). Nevertheless, since the online survey is an external service and not part of the researcher's institute, it was an insufficient storage location. Thus, once the deadline had passed (2nd of March, 2014) all the information was downloaded to the researcher's laptop and data on the Qualtrics server was deleted. Under this research data management has been divided into: data entry and coding, and data editing and cleanup. Similarly the data preparation section is also presented in two sections of cleaning up errors, and confidential data cleaning process.

### 6.2.1 Data Entry and Coding

Data entry and coding was not necessary for more than half of the participant that used Qualtircs to fill the questionnaire. In order to make the process simpler, the researcher manually entered the remaining hardcopy questionnaires on the online survey. The website offers a variety of export features in converting the data sample to formats such as, SPSS and

Excel, and thus making it easier to carry out the analysis. Once the data was exported in a preferred format, it was readily accessible for both coding and analysis. The coding of the data was also a simple task, since the Qualtrics platform facilitates such activity. During the preliminary configuration of the questionnaire on Qualtrics, non-numerical elements such as job title were pre-coded by outlining appropriate classifications and allocating a number to it (e.g. C-level manager =1 and operational manager = 2). In this research SPSS version 21 was used for preliminary statistical analysis such as descriptive analysis and EFA. Once the data was imported to SPSS, each item was given a code. This was done to ease the process of tracking each variable and the items associated to them (table 6.2).

**Table 6. 2: Research Concepts, Variables, Measurement Type and Code**

| **Research constructs** | **Variables** | **Variable code** | **Number of items/questions** |
|---|---|---|---|
| Operational Performance | Quality | Qlty | 4 |
| | Flexibility | Flex | 4 |
| | Lead time | Qlty | 4 |
| | Cost | Ccost<br>Ocost | 7 for capital cost<br>4 for operational cost |
| Supply Chain Integration | Internal integration | Iintg | 9 |
| | Customer integration | Cintg | 11 |
| | Supplier integration | Sintg | 13 |
| Organization Structure | Centralization | Cent | 4 |
| | Formalization | Form | 4 |
| | Hierarchical relationship | Hierstr | 4 |
| **Total** | | | 68 |

### 6.2.2 Data Editing and Cleanup

Utilizing features provided by Qualtrics several data editing and cleanup processes were performed. A 7 point likert scale was used that restricted responses to one, per question. Furthermore using the features of Qualtrics, the questionnaire was designed and configured in a way that required participant answering all compulsory questions before going to the next section or submitting the questionnaire. Furthermore, text box formatting was chosen to administer clarity in responses, where it was applicable. As mentioned in the previous section, after the data was imported from the online survey to the researcher's personal computer (in format of SPSS), the entire questionnaire and all associated data was deleted from Qualtrics. This step was taken in line with the ethics requirement, specifically because the online survey was an external service and not part of the researcher's institute. Additionally many of the participating oil and gas companies personally asked to have their data deleted from the online server, once the data gathering process was complete.

**Cleaning up Errors**

In the data preparation process of this research, errors related to data entry did not represent a major issue. This was because the data was captured on an online platform and transferred directly to the format of the analysis tool (SPSS). Nevertheless, errors related to accuracy of respondents when filling the questionnaire (data entry point) still existed (see Pallant, 2010). Therefore, every single questionnaire was reviewed individually, to ensure the responses were applicable (e.g. not much missing data). For example, this study crosschecked some of the control variables, using public data or from the company website, in order to confirm the oil and gas sector (e.g. upstream and downstream), business activity type (e.g. service and manufacturer), the organization type (e.g. IOCs and NOCs), and regional operation (e.g. North America, Africa, and Middle East). As another precaution a lengthy process took place, in which the respondent screened the questionnaires, in order to examine whether the questionnaire was understood and answered appropriately (e.g. if reverse items were distinguished from others). This process took approximately one month. Accordingly eight responses were eliminated from the population sample, since they did not fit the population frame designed under this study (e.g. Job title, type of company, and size of operation). Furthermore another fifteen incomplete questionnaires were identified as a part of the hardcopy responses received through emails or in person. This was done using the missing data review option in SPSS. The online questionnaires did not suffer from missing data because of the features provided by Qualtrics. Using SPSS's ascending or descending option (variable columns), the emails of organizations was utilized in order to identify duplicate responses. Only six duplicated responses were found and for each of the duplication, one response from the most experienced person in the same organization was kept, and the other deleted from the population sample (i.e. checked through job title).

**Confidential Data Cleaning Process**

Based on the requirements set out by ethics committee at the University of Sheffield, the sample data was assessed for possible confidentiality issues. The researcher used managers email addresses in order to simplify tracking of the respondents during data gathering periods. This was also done, so that reminders were not sent to participants that already filled the questionnaire. The email addresses also helped with the process of checking for duplicated responses from the same organization. As a token of appreciation the participants email addresses is used to send the outcome of the study, and also to enter them into a draw with a chance to win a gift voucher worth £50. Nevertheless as part of the confidential data cleaning process, managers email addresses were removed from prepared data.

## 6.3 Descriptive Analysis

It has been suggested that descriptive analysis facilitates the initial data exploration (Creswell, 2013; Lovie and Lovie, 1986). It enabled this study to summaries, outline, and view the sample data for observable or visible patterns. Under this research the descriptive analysis involved two tests of validation:

1. Data evaluation was carried to comprehend the overall response rate and assess the data for possible non-response bias
2. Descriptive analysis was conducted to determine the demographics associated to data gathered

### 6.3.1 Data Assessment and Descriptive Analysis

In order to verify whether or not the sample gathered is a demonstrative of the oil and gas industry, and to further ascertain probable generalizability limitations, this research has examined the response rate and has also non-response bias.

#### Response Rate

By the end of the data gathering process this research received a total number of 207 questionnaires. From these 207 responses, 23 were eliminated, 8 of which were due to organizations irrelevancy to this research (e.g. organization not directly involved in oil and gas) and the other 15 were taken out due to significant missing data. Another 6 questionnaires were duplicated (from the same company), of which only 3 of the most experienced responses were selected and used as a part of the research population. The total number of usable questionnaires was 181. By comparing this studies response rate to comparable research in organizational studies (e.g. Daugherty et al., 2011; Huang et al., 2010; Nahm et al., 2003) and operations management (e.g. Flynn et al., 2010; Devaraj et al., 2007; Koufteros et al., 2005; Rosenzweig et al., 2003; Swink et al., 2007), a response rate of around 28% is deemed acceptable in management studies (see Anseel et al., 2010; Cooper and Schindler, 2003).

**Non-Response Bias**

A number of tests were conducted in order to make sure the data gathered was a suitable representative of the oil and gas industry, and also free from non-response bias. It is generally accepted that failing to get remarks from certain elements in the population sample could result in problems with data quality (Creswell, 2013). In simpler terms, non-response bias should be clearly addressed, and if not generalizability of data findings could be questioned. In order to ensure non-response bias, this study considered how busy these managers are, and by sending reminders in the two batches of data gathering attempted to overcome this challenge. Furthermore, the willingness of participants was also a potential non-response bias issue. Accordingly phone calls were made prior to sending out the questionnaires, in order to makes sure the manager was happy to receive the survey. This way the study managed to have a better understanding on which company or manager was willing to participate, and included in the list of reminders. Lastly this study also checked for the availability/unavailability of such managers based on their calendars (e.g. through secretaries). This is because such individuals had heavy workloads and responsibilities, and would therefore required closer coordination and patience in scheduling meetings.

**Table 6. 3: Background Characteristics of Sample**

| Sample characteristics | Classification | Total | % | Explanation |
|---|---|---|---|---|
| **Respondent position** | C-Level Manager | 96 | 53 | C-Level (e.g. CEO, General Manager, Director, Strategic and Planning Manager) Operational Manager (e.g. Operations Manager, Supply Chain Manager, Sourcing Manager, Project Manager, Procurement and Logistics Manager) |
| | Operational Manager | 85 | 47 | |
| | | | | |
| **Size of Organization (operation)** | High input/output | 73 | 40.3 | Operational size (measured in the form of (1) the number of company's suppliers and customers (2) average sales revenue per annum (3) average expenditure per annum on operational activities (operational cost) |
| | Low input/output | 108 | 59.7 | |
| | | | | |
| **Region (company's operational location)** | Middle East | 83 | 45.9 | Africa, Asia (pacific), Europe and Eurasia, Middle East, North America and South America |
| | Other regions | 98 | 54.1 | |
| | | | | |
| **Type of Business** | Service Provider | 70 | 38.7 | Services provider (e.g. Technical Support and Services (TSA)/Production Support and Assistant (PSAC)/ Logistic Company/ Management Contracting (MC)/ Management Consultancy (MC)) Manufacturer and Service provider (e.g. vendors/designer/producer of oil and gas equipment's and materials |
| | Manufacturing and service provider | 111 | 61.3 | |
| | | | | |
| **Oil and Gas sector** | Upstream | 109 | 60.2 | Upstream (Exploration and Appraisal, Development, Production, Drilling, Pipelines, Services) Downstream (Processing (Oil/Gas), Transportation, Storage, Marketing, Refineries (Oil/Gas), Petrochemical plants, Dispatching & Distribution, LNG) |
| | Downstream | 72 | 39.8 | |
| | | | | |
| **Ownership (Public/private partnership)** | Public companies | 76 | 42 | Consortiums (could be a partnership between NOC/IOC/contractors) that are developed in oil producing nations in order to invest, develop, produce and refine the product from |
| | Public and Private partnership | 105 | 58 | |

Furthermore this study used a late respondents technique, by checking for significant difference amongst early and late respondents (see Baruch and Holtom, 2008). The results of twenty participants that completed the questionnaire during the first two weeks were compared to twenty participants that completed the questionnaire during the last week. By doing so, no significant divergences were identified between the two sets of responses. Therefore non-response bias was not a major issue under this study.

### 6.3.2 Demographics and Descriptive Analysis

The descriptive section of this research offers demographical classifications of the oil and gas companies in the population sample. In the preceding chapter a number of control variables were briefly introduced, these will be used to create the following demographic profiles (see table 6.3 for all demographics).

#### Organization Demographic

The demographics of the organizations in the oil and gas industry are presented, and analyzed to comprehend the homogeneity, diversity and representativeness of the population sample gathered under this research. The following control variables were designed for this purpose:

- Oil and gas sector (e.g. upstream and downstream)
- Type of the organization (e.g. public, private/ public and private partnership/consortium)
- Type of business activities (e.g. service provider, manufacturer)
- Region the organization operates (e.g. Africa, Asia, Europe and Eurasia, Middle East, North America and South America)
- Operational size of organization (e.g. high input/output, low input/ output)
- Respondent position (C-level or operational)

#### Demographics on Oil and Gas Sector

Table 6.4 below reports the frequency of distribution on the oil and gas sector of the organizations under study. 60.2% of the organizations participating in this study operated in the upstream sector of the oil and gas industry, whereas 39.8% were in the downstream sector. Having a higher percentage of the companies from the upstream sector will provide a better understanding of the supply chain issues. This is because the upstream sector faces more critical and daily operational challenges, in comparison to the downstream supply chains. Nevertheless the frequency of 60.2% upstream and 39.8% downstream still reflects a reasonably balanced insight in both sectors.

**Table 6. 4: Descriptive Analysis, Oil and Gas Sector**

| Sector | Frequency | Percentage |
|---|---|---|
| **Upstream** (exploration and appraisal, development, production, drilling, pipelines, services) | 109 | 60.2% |
| **Downstream** (transportation, storage, marketing Refineries (oil/gas), petrochemical plants, dispatching & Distribution, LNG) | 72 | 39.8% |
| **Total** | 181 | 100% |

### Demographics on Ownership

Table 6.5 reports the frequency of distribution on the company ownership status. 42% of the organizations were government entities (e.g. NOC, state owned enterprise), whereas 58% of the participants were either private (e.g. IOC and contractors), or partnerships amongst public and private entities. Today national oil companies (NOCs) control approximately 90% of the world's oil and gas reserves and 75% of production (Tordo et al., 2011). However, they still need to collaborate and acquire services and know-hows from the IOCs. As argued previously NOCs act as gatekeepers of national oil and gas reserves, and IOC have the technological know-how and capability. Therefore, it is crucial to have a good balance between the two and to capture both the operational challenges of both NOCs and IOCs.

**Table 6. 5: Descriptive Analysis, Ownership Status**

| Ownership status | Frequency | Percentage |
|---|---|---|
| **Public Company** (national state or government owned) | 76 | 42% |
| **Private Company** (i.e. IOC, Oil field developers, EPC contractors), and **Public and Private Partnership** (part government-owned) | 105 | 58% |
| **Total** | 181 | 100% |

### Demographics on Organization Type

Table 6.6 reports the frequency of distribution on the organization's business activity in the oil and gas industry. This reports on whether the oil and gas organization provided services, or if it was a manufacturer. 38.7% of the organizations were oil and gas service providing entities, whereas 61.3% of the participants were oil and gas manufacturing, or manufacturing and service provider. By including both producers and service provides this study represents a good spilt in relation to the primary business activities in this sector (see Tordo et al., 2011).

**Table 6. 6: Descriptive Analysis, Organization Type**

| **Type** | **Frequency** | **Percentage** |
|---|---|---|
| **Service provider** (i.e. Technical Support and Services (TSA)/Production Support and Assistant (PSAC)/ Logistic Company/ Management Contracting (MC)/ Management Consultancy (MC)) | 70 | 38.7% |
| **Manufacturer** (i.e. vendors/designer/producer of oil and gas equipment and materials), and **Both Service provider and Manufacturer** | 111 | 61.3% |
| **Total** | 181 | 100% |

### Demographics on Regional Operations

Table 6.7 provides the frequency of distribution of oil and gas companies based on the different regional operations. In order to be judged appropriately diverse and also heterogeneous, regions were categorized based on the world's energy reserve distribution and production, this is because it would be more economically feasible to explore conventional reserves, especially in regions that have proven oil and gas. In this research 7.7% of the respondents were from Africa, 3.8% from Asia (pacific), 13.8% from Europe and Eurasia, 45.9% from the Middle East (the main supplier of the world's oil and gas demand), 12.7% from North America and 16.1% of the participants were from South America.

**Table 6. 7: Descriptive Analysis, Regional Operations**

| Region | Frequency | Percentage |
|---|---|---|
| Africa | 14 | 7.7% |
| Asia Pacific | 7 | 3.8% |
| Europe and Eurasia | 25 | 13.8% |
| Middle East | 83 | 45.9% |
| North America | 23 | 12.7% |
| South and Central America | 29 | 16.1% |
| **TOTAL** | 181 | 100% |

### Demographics on size of operation

Table 6.8 presents the frequency of distribution on the size of the organization, based on the three factors of (1) number of supplier and customer (2) average expenditure per annum on operational activities (3) average sales revenue per annum. Each of the factors was classified as either high or low. This was done in order to determine the operational size of the oil and gas companies. The thresholds were determined based on several discussions with experts in the oil and gas industry. As illustrated in table 6.8 below 40.3 % of the respondents were high input/output companies. Accordingly 59.7% of the respondents indicated that their companies fell under the low input/output benchmark. Table 6.8 illustrates the specific criteria used to judge the operational size of the sample population.

**Table 6. 8: Descriptive Analysis, Operational Size**

| Operational Size | Frequency | Percentage |
|---|---|---|
| **High Input/output**<br>Supplier >500<br><br>Customer >100<br><br>Sales per annum >10billion$<br><br>Operational expenditure >5billion$ | 73 | 40.3 |
| **Low Input/out put**<br>Supplier <500<br><br>Customer <100<br><br>Sales per annum <10billion$<br><br>Operational expenditure <5billion$ | 108 | 59.7 |
| **Total** | 181 | 100% |

### Demographics on Position of Respondents (Seniority)

The distribution of participants based on the position they held is presented in table 6.9. 53 % of participants were senior and strategic level managers, however 47% of participants were operational and line level managers (usually head of units or business sections). By obtaining a near balance response rate between strategic and operational managers, the population sample is judged to be appropriately diverse (for different level insight i.e. OS, SCI and operational performance) and heterogeneous in relation to the participant characteristics and level of industrial knowledge (e.g. strategic, tactical and operational level) (see Sabri and Beamon, 2000).

**Table 6. 9: Descriptive Analysis, Respondent Position**

| Position | Frequency | Percentage |
|---|---|---|
| **Senior Managers (C-level)**<br><br>Head of business functions (e.g. CEO, General Manager, Director, Strategic and Planning Manager) | 96 | 53% |
| **Business/Operational Managers**<br><br>Operational Manager, Supply Chain Manager, Sourcing Manager, Project Manager, Procurement and Logistics Manager, Purchasing Manager, Engineering Manager, Drilling and Well Manager, Site Construction Manager, Manager of EPC unit, Local Content Manager, Sales and Marketing Manager, Reservoir Manager, Planning and IT Manager, HSEQ Manager, Project Finance and Cost Manager, Expediting Manager | 85 | 47% |
| **Total** | 181 | 100% |

## 6.4 Data Inferential Analysis

The inferential analysis carried out in this research, consisted of two analysis steps: First a preliminary analysis or exploratory factor analysis (EFA) is conducted. This critical step reveals whether or not the data is valid or reliable. As the second step, (and only if the EFA indicates data suitability), a confirmatory factor analysis (CFA) is carried out.

### 6.4.1 Exploratory Factor Analysis (EFA)

Tabachnick and Fidell (2007) argued that descriptive analysis should include two steps. The first section of descriptive analysis is to gain a preliminary feel of the data in relation to its representativeness of the sample characters. This primary feel for the data can be accomplished using numerous basic statistical tests. The frequency distribution of the nominal variables (such as job title) can be outlined using different diagrammatic (histograms) in order to obtain graphic demonstration. Additionally descriptive statistics test can also provide the mean, standard deviation and the variance in the sample, which help identify how the participants have replied to the items in the questionnaire. As presented in the previous chapter (section 5.3) the scales used for each of the OS, SCI, and operational performance, has been adapted and/or adopted from a number of existing studies. For this reason their coherency together has not been previously determined. Thus, there was a need to evaluate the relevant instruments, in order to see if such items where consistently measuring and representing the research variable they belong to. Accordingly scales were investigated using a number of primary tests to make sure of the reliability and validity of the items. As a part of a preliminary analysis testing whether or not the data under this study is normally distributed, the skewness and kurtosis of the data was examined.

Skewness value provides an indication of the symmetry of the distribution. For example the ideal distribution of data is known as the “bell curve”, in which the left and the right side of the bell curve are perfect mirror images of one another. Therefore, a skewed item is an item that, its mean is not in the centre of data distributed. Kurtosis on the other hand provides information about the ‘peakedness’ of the distribution. In statistics it could be defined as a measure of whether or not the data gathered are flat or peaked in relation to a normal distribution. In simpler terms, a distribution is either very flat (thin, long tails) or peaked (thick, short tails). Therefore, if distribution is perfectly normal the value of skewness and kurtosis is expected to be 0, which is a rather an uncommon occurrence in the social science. Positive skewness values illustrate a positive skew, with scores clustered to the left (i.e. at the low values). On the other hand, negative skew values indicate a clustering of scores at the high end or right side of the graph. Furthermore positive kurtosis values indicate that the distribution is rather peaked, and clustered in the centre with long thin tales. If however the kurtosis value is below 0, this shows distribution that is relatively flat with too many cases in the extremes.

It has been argued that in large samples (100+ see Tabachnick and Fidell, 2007), the significance level of skenwess is not as essential as the actual data size and how the data is distributed visually. In other words in larger data sets, an item with significant skewness would not deviate a lot from normality to significantly alter the analysis. Additionally kurtosis can also result in an underestimate of the variance, however this is also reduced with larger samples (see Pallant, 2010; Tabachnick and Fidell, 2007). For instance, underestimate of the variance related to negative kurtosis disappears with data sizes of above 200 cases, and for positive kurtosis (distributions illustrating thick and short tails) such underestimate of the variance diminishes with 100+ cases (Waternaux, 1976).

In order to check to see whether or not the data was skewed the following rule of thumb was used:

- If Skewness is less than -1 or greater than +1 the distribution is highly skewed
- If Skewness is between -1 and -.5 and or between +.5 and +1, the distribution is Moderately skewed
- If Skewness is between. -.5 and +.5 the distribution is approximately symmetric

As illustrated in the figure 6.3 below, all the variables fell between -.5 + 5 with the most notable being C 3.1 with the value of -.361. This illustrated that the data is not skewed and relativity symmetric.

| | Mean | Std. Deviation | Skewness | | Kurtosis | |
|---|---|---|---|---|---|---|
| | Statistic | Statistic | Statistic | Std. Error | Statistic | Std. Error |
| Qlty1 | 4.07 | 1.502 | -.054 | .181 | -.550 | .359 |
| Qlty2 | 4.01 | 1.496 | .021 | .181 | -.733 | .359 |
| Qlty3 | 4.07 | 1.555 | -.067 | .181 | -.653 | .359 |
| Qlty4 | 4.07 | 1.530 | -.056 | .181 | -.570 | .359 |
| Flex1 | 4.01 | 1.483 | -.040 | .181 | -.671 | .359 |
| Flex2 | 3.98 | 1.498 | .078 | .181 | -.643 | .359 |
| Flex3 | 4.09 | 1.450 | -.078 | .181 | -.551 | .359 |
| Flex4 | 4.00 | 1.491 | .041 | .181 | -.631 | .359 |
| Ltime1 | 4.05 | 1.481 | -.034 | .181 | -.673 | .359 |
| Ltime2 | 3.97 | 1.525 | .038 | .181 | -.734 | .359 |
| Ltime3 | 3.95 | 1.529 | .056 | .181 | -.549 | .359 |
| Ltime4 | 4.01 | 1.466 | -.010 | .181 | -.631 | .359 |
| Ccost1 | 4.02 | 1.472 | -.039 | .181 | -.633 | .359 |
| Ccost2 | 4.09 | 1.405 | -.047 | .181 | -.489 | .359 |
| Ccost3 | 4.00 | 1.520 | .010 | .181 | -.629 | .359 |
| Ccost4 | 4.04 | 1.471 | -.035 | .181 | -.603 | .359 |
| Ccost5 | 4.06 | 1.425 | .018 | .181 | -.479 | .359 |
| Ccost6 | 4.08 | 1.396 | -.003 | .181 | -.343 | .359 |
| Ccost7 | 4.10 | 1.446 | -.064 | .181 | -.514 | .359 |
| Ocost1 | 4.07 | 1.451 | -.028 | .181 | -.548 | .359 |
| Ocost2 | 4.07 | 1.472 | -.051 | .181 | -.507 | .359 |
| Ocost3 | 4.06 | 1.411 | .023 | .181 | -.546 | .359 |
| Ocost4 | 4.03 | 1.481 | .025 | .181 | -.564 | .359 |
| Cintg1 | 4.09 | 1.627 | -.144 | .181 | -.836 | .359 |
| Cintg2 | 4.13 | 1.565 | -.178 | .181 | -.758 | .359 |
| Cintg3 | 4.09 | 1.589 | -.088 | .181 | -.791 | .359 |
| Cintg4 | 4.10 | 1.562 | -.097 | .181 | -.691 | .359 |
| Cintg5 | 4.04 | 1.615 | -.048 | .181 | -.760 | .359 |
| Cintg6 | 4.00 | 1.630 | -.008 | .181 | -.794 | .359 |
| Cintg7 | 4.11 | 1.516 | -.131 | .181 | -.714 | .359 |
| Cintg8 | 4.10 | 1.567 | -.114 | .181 | -.728 | .359 |
| Cintg9 | 4.06 | 1.634 | -.091 | .181 | -.867 | .359 |
| Cintg10 | 4.06 | 1.571 | -.067 | .181 | -.820 | .359 |
| Cintg11 | 4.09 | 1.580 | -.122 | .181 | -.924 | .359 |
| Sintg1 | 4.05 | 1.572 | -.057 | .181 | -.721 | .359 |
| Sintg2 | 3.95 | 1.543 | -.008 | .181 | -.799 | .359 |
| Sintg3 | 3.94 | 1.575 | .075 | .181 | -.557 | .359 |
| Sintg4 | 3.98 | 1.516 | .009 | .181 | -.686 | .359 |
| Sintg5 | 4.01 | 1.588 | -.001 | .181 | -.777 | .359 |
| Sintg6 | 3.94 | 1.610 | .059 | .181 | -.792 | .359 |
| Sintg7 | 3.97 | 1.597 | .029 | .181 | -.757 | .359 |
| Sintg8 | 3.97 | 1.586 | .046 | .181 | -.787 | .359 |
| Sintg9 | 4.01 | 1.604 | -.001 | .181 | -.742 | .359 |
| Sintg10 | 4.01 | 1.538 | .000 | .181 | -.743 | .359 |
| Sintg11 | 3.94 | 1.535 | .057 | .181 | -.739 | .359 |
| Sintg12 | 3.97 | 1.520 | -.001 | .181 | -.617 | .359 |
| Sintg13 | 3.98 | 1.524 | .000 | .181 | -.714 | .359 |
| Iintg1 | 4.33 | 1.557 | -.361 | .181 | -.472 | .359 |
| Iintg2 | 4.30 | 1.564 | -.313 | .181 | -.698 | .359 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Iintg3 | 4.25 | 1.460 | -.202 | .181 | -.590 | .359 |
| Iintg4 | 4.27 | 1.504 | -.283 | .181 | -.496 | .359 |
| Iintg5 | 4.29 | 1.490 | -.310 | .181 | -.432 | .359 |
| Iintg6 | 4.24 | 1.530 | -.229 | .181 | -.593 | .359 |
| Iintg7 | 4.27 | 1.542 | -.279 | .181 | -.617 | .359 |
| Iintg8 | 4.24 | 1.504 | -.224 | .181 | -.523 | .359 |
| Iintg9 | 4.26 | 1.500 | -.262 | .181 | -.602 | .359 |
| Cent1 | 3.87 | 1.623 | .184 | .181 | -.856 | .359 |
| Cent2 | 3.90 | 1.529 | .132 | .181 | -.596 | .359 |
| Cent3 | 3.87 | 1.503 | .238 | .181 | -.757 | .359 |
| Cent4 | 4.19 | 1.465 | -.201 | .181 | -.479 | .359 |
| Form1 | 3.91 | 1.608 | .081 | .181 | -.888 | .359 |
| Form2 | 3.93 | 1.531 | .047 | .181 | -.883 | .359 |
| Form3 | 3.97 | 1.547 | .001 | .181 | -.732 | .359 |
| Form4 | 4.04 | 1.486 | -.025 | .181 | -.509 | .359 |
| HierStr1 | 4.02 | 1.600 | -.011 | .181 | -.923 | .359 |
| HierStr2 | 3.95 | 1.634 | .050 | .181 | -.883 | .359 |
| HierStr3 | 4.01 | 1.538 | -.028 | .181 | -.706 | .359 |
| HierStr4 | 4.12 | 1.429 | -.170 | .181 | -.474 | .359 |
| Valid N = 181 | | | | | | |

**Figure 6. 3: Output of Descriptive Analysis**

However kurtosis has no units and is a pure number (e.g. z-score). The reference standard is a normal distribution, which has a kurtosis of 3. Therefore a data set would fall under one of the below three categories:

- A normal distribution has kurtosis exactly of 3 and is called mesokurtic.
- A distribution with kurtosis <3 is called platykurtic. Compared to a normal distribution, its central peak is lower and broader, and its tails are shorter and thinner.
- A distribution with kurtosis >3 is called leptokurtic. Compared to a normal distribution, its central peak is higher and sharper, and its tails are longer and fatter.

To test if the data set for possible kurtosis, this research used a common and easy way of multiplying the std. error by 3 and checking it against the absolute value of the kurtosis. If the kurtosis value was less than 3 times of the standard error, the data set was considered normally distributed. By doing so this research found that in all cases the standard error value exceeded the kurtosis value hinting at a normally distributed data set (.359 x 3 = 1.07). Therefore as illustrated in the figure 6.3 the values of kurtosis in the data set range from -.343 to -.913 all of which are bigger than -1.07 and smaller than 1.07, and therefore not suffering from negative kurtosis.

**Assessing Normality**

Normality is used to describe a symmetrical, bell shaped curve, which has the greatest frequencies of scores centered in the middle, and smaller frequencies towards the extremes (see Pallant, 2010). Normality can be assessed to some degree by skewness and kurtosis values. Nevertheless, skewness and kurtosis alone cannot fully assess the normality of a data set. For this reason, many statisticians prefer to use diagrams and more specific normality tests, to ensure sufficient information are available to make better judgments. Thus, this research used the explore test in SPSS, in order to assess normality. Because of size issues only the output of the first item is presented (Qlty1), the same applies to other items under investigation.

**Descriptives**

| | | | Statistic | Std. Error |
|---|---|---|---|---|
| B1.1 Use data from quality programs (QA and QC) | Mean | | 4.07 | .112 |
| | 95% Confidence Interval for Mean | Lower Bound | 3.85 | |
| | | Upper Bound | 4.29 | |
| | 5% Trimmed Mean | | 4.08 | |
| | Median | | 4.00 | |
| | Variance | | 2.256 | |
| | Std. Deviation | | 1.502 | |
| | Minimum | | 1 | |
| | Maximum | | 7 | |
| | Range | | 6 | |
| | Interquartile Range | | 2 | |
| | Skewness | | -.054 | .181 |
| | Kurtosis | | -.550 | .359 |

**Figure 6. 4: Output for Qlty1, Explore Test for Descriptive**

The figure 6.4 provides descriptive statistics and other information concerning item qlty1. Some of the information is recognizable, as it has been presented in the previous section. One statistic which is unique to the explore analysis, is the 5% Trimmed Mean. This was done through removing the top and bottom 5% of the cases and calculating new mean values. Comparing the original mean (4.07) and the new trimmed mean (4.08) illustrates whether the extreme scores in this data set had a strong influence on the mean value. If the two mean values were very different, further investigation was required on these data points. However under this study, the majority of the items investigated showed that the difference between the mean and the 5% trimmed was not more than .01 (e.g. Hierstr4 having the biggest difference of .02).

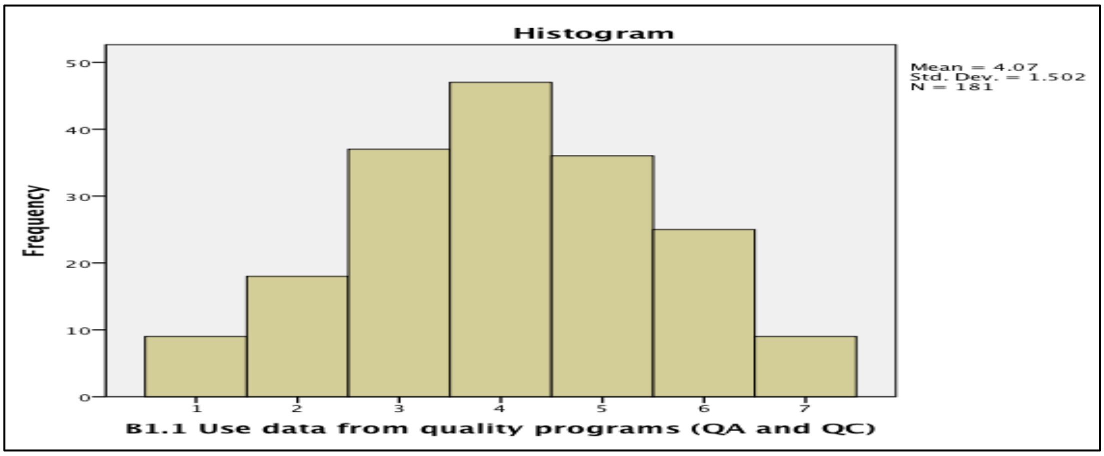



**Figure 6. 5: Histogram Output for Qlty1**

The actual shape of the distribution for item Qlty1 is illustrated in the above histogram (Figure 6.5) In this case scores appeared to be normally distributed (i.e. resembling a bell shape), the same outcome was witnessed for other items.

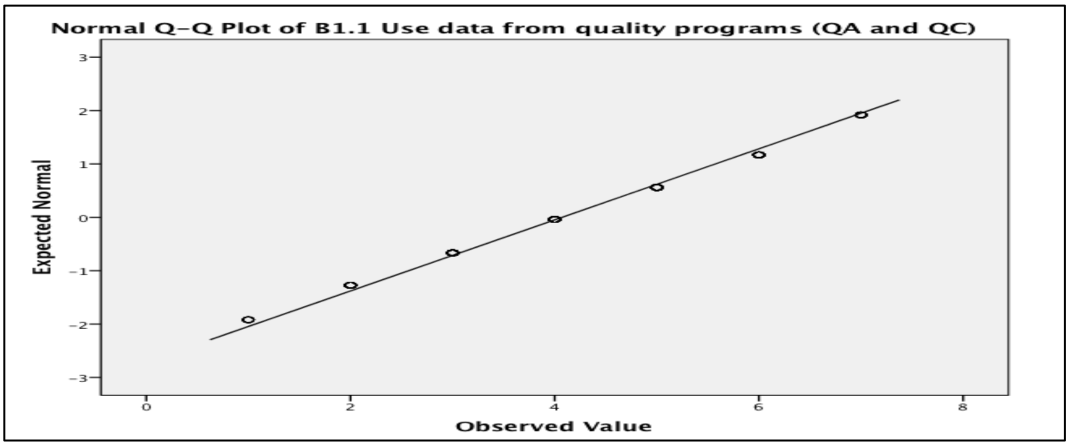



**Figure 6. 6: Normal Q-Q Plot Output for Qlty1**

This was also supported by an inspection of the normal probability q-q plot, which enabled the comparison of two probability distributions (which plots the observed against the excepted value from the normal distribution)(figure 6.6). The q-q plot illustrated a reasonably straight line. This confirmed the normal distribution of the data set, and the same outcome was witnessed for other items.

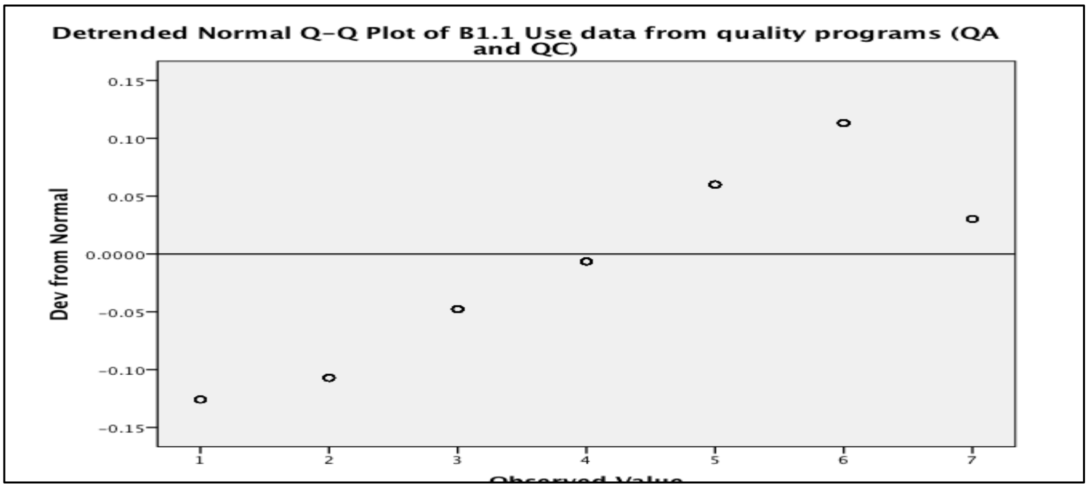



**Figure 6. 7: Detrended Normal Q-Q plot for Qlty1**

The detrended Normal Q-Q plot is used to show the variances between observed and expected values. As illustrated in the figure 6.7, the points are clustered with no specific pattern around the zero line. This also confirms the normal distribution of the items (item Qlty1). The same outcome was witnessed for other items.

**Checking for Outliers**

It has been suggested that most statistical techniques are sensitive to outliers (Creswell, 2013; Tabachnick and Fidell, 2007). Therefore, in order to check and treat for outliers under this study the following two methods were adopted:

- Histograms were used to check the tails of the distribution for each item under investigation. The majority of the histogram resembled a bell shape (i.e. scores dropped in a reasonable slope).
- Boxplots were also utilized to show the distribution of scores given to a question/item. The rectangle represents 50 per cent of the cases. The two whisker lines extend horizontally from the box ranging from the highest to the lowest value. Any score that was considered an outlier by the *explore analysis* in SPSS, appeared as small circles with an ID number of the case attached to it. As illustrated in the boxplot below (figure 6.8) item Qlty1 did not have any outliers. However in a few cases where

outliers were identified, the values were changed from 1s and 7s to 2s and 6s (10 cases) respectively.

It is therefore significant to examine the nature of the outlier prior to deciding on what to actually do with it. By closely screening the questionnaire using the above-mentioned options, this study established that such outliers were as a result of incorrectly entered responses (i.e. nearly all the responses were in the range of 6 and only one stood out to be 7). These are one of the most common types of outliers that occur because of human errors (e.g. errors in entry, recording and data collection) (Barnett and Lewis, 1994). Additionally by running some normality tests such as the explore option in SPSS, it was also found that the outliers under this research did not significantly affect the outcome of the test. As presented above one statistic which was unique to the explore analysis, was the 5% Trimmed Mean. This was done through removing the top and bottom 5% of the cases and calculating new mean values. Comparing the original mean and the new trimmed mean illustrated that the outliers in this data set did not have a strong influence on the mean value. Under this study the majority of the items investigated, it was found that the difference between the mean and the 5% trimmed was not more than .01. In such scenarios it has been suggested to replace the outlier value to a more plausible value (i.e. watered down) and to not get rid of the outlier completely. By doing so authors such as Osborne and Overbay (2004), and Pallant (2010) have argued that, the possibility of data bias is eased through maintaining an attenuated form of the data.

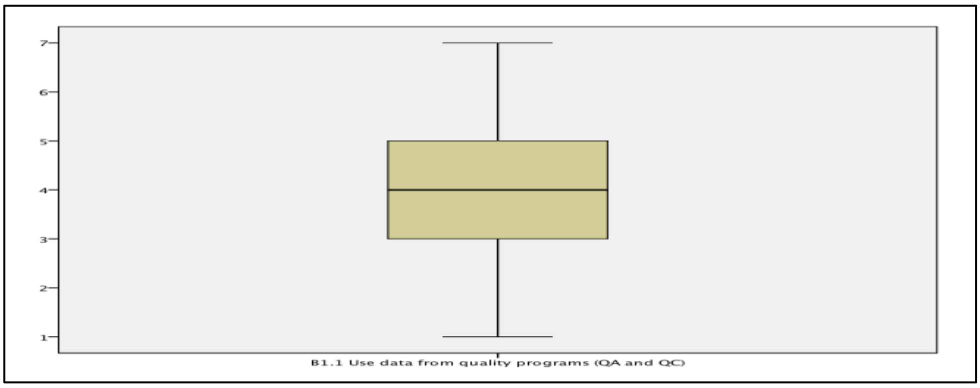



**Figure 6. 8: Boxplot Outcome for qlty1**

## Reversing Negatively Worded Items

In some variables the wording of particular items were reversed, in order to prevent response bias. This was done to check whether the respondent was paying attention to the questionnaire, or simply ticking boxes. Therefore the last item (fourth) of each of the centralization, formalization, and hierarchical relationship variables was reversed prior to checking the reliability of each variable.

## Checking the Reliability of the Variable

In order to check for the reliability of the variables (e.g. internal integration) under investigation, this study used Cronbach's alpha coefficient. This test measures the internal consistency within each variable (i.e. the degree to which the items that make up the variable 'hang together'). In order to illustrate that the items are measuring the same variable, Cronbach's alpha coefficient value should be above 0.8 (see De Vaus, 2002). Table 6.10 illustrates that all seven variables under this study met the internal consistency requirement.

**Table 6. 10: Cronbach Alpha for Research Variables**

| Variable | Cronbach's Alpha Based on Standardized items | Number of items |
|---|---|---|
| Centralization | .931 | 4 |
| Formalization | .945 | 5 |
| Hierarchical relationship | .939 | 4 |
| Internal Integration | .980 | 9 |
| Customer Integration | .982 | 11 |
| Supplier Integration | .986 | 13 |
| Operational Performance | .987 | 23 |
| Total number of items | | 68 |

## Exploratory Factor Analysis Results

By carrying out an EFA this study is able to tell which group of distinct items measures a specific construct (reasonably impartial from other items). In other words, items that are sufficiently correlated with other items, but at the same time are distinct from each other, are grouped into one factor. The aim of this test is to characterize a set of variables in smaller number of hypothesized variables. Therefore, EFA is the first step of the factor analysis used in SEM. It is done to identify the underlying structural relationships amongst large sets of variables. The goal is to identify the relationships between measured variables (to find out how measures can be grouped).

Accordingly EFA was carried out on the 68 items, as the first stage of the inferential analysis. Prior to performing EFA, the suitability of data for factor analysis was also assessed. As shown in figure 6.9, the exploratory analysis reported a KMO measure of sampling adequacy of .964. Bartlett's test of sphericity rejects to null hypotheses that correlation matrix is proportional to an identity matrix as, $x^2$ (2278) = 17957.406, $P<.001$.

**KMO and Bartlett's Test**

| | | |
|---|---|---|
| Kaiser-Meyer-Olkin Measure of Sampling Adequacy. | | .964 |
| Bartlett's Test of Sphericity | Approx. Chi-Square | 17957.406 |
| | df | 2278 |
| | Sig. | .000 |

**Figure 6. 9: KMO and Bartlett's Test**

A principle component analysis (PCA) with varimax rotation was carried out on the 68 items. It was argued in the preceding chapter that, varimax rotation maximized the extent of variance explained by the factors. It further minimizes the correlation amongst the factors as well. Communality values reported to be above the 0.50 benchmark set. PCA resulted in a simple structure with seven factors, which explained 83.58% of the total variance. This was also confirmed by the eigenvalue criteria illustrated in figure 6.10, in which only components with eigenvalues exceeding 1.00 were extracted.

**Total Variance Explained**

| Component | Initial Eigenvalues | | | Extraction Sums of Squared Loadings | | | Rotation Sums of Squared Loadings | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % | Total | % of Variance | Cumulative % |
| 1 | 39.224 | 57.683 | 57.683 | 39.224 | 57.683 | 57.683 | 17.871 | 26.280 | 26.280 |
| 2 | 5.175 | 7.610 | 65.293 | 5.175 | 7.610 | 65.293 | 12.160 | 17.883 | 44.163 |
| 3 | 4.293 | 6.313 | 71.607 | 4.293 | 6.313 | 71.607 | 10.221 | 15.031 | 59.194 |
| 4 | 3.378 | 4.967 | 76.574 | 3.378 | 4.967 | 76.574 | 8.009 | 11.778 | 70.971 |
| 5 | 1.900 | 2.794 | 79.368 | 1.900 | 2.794 | 79.368 | 3.238 | 4.762 | 75.733 |
| 6 | 1.489 | 2.190 | 81.557 | 1.489 | 2.190 | 81.557 | 2.776 | 4.083 | 79.816 |
| 7 | 1.377 | 2.024 | 83.582 | 1.377 | 2.024 | 83.582 | 2.561 | 3.766 | 83.582 |
| 8 | .744 | 1.094 | 84.676 | | | | | | |
| 9 | .598 | .880 | 85.556 | | | | | | |
| 10 | .520 | .765 | 86.320 | | | | | | |
| 11 | .484 | .712 | 87.032 | | | | | | |

**Figure 6. 10: Total Variance Explained (PCA with Varimax Rotation)**

Further on an inspection of the screeplot (figure 6. 11) revealed a break after the seventh component. This further confirms that a seven-factor structure could best explain the conceptual framework under investigation.

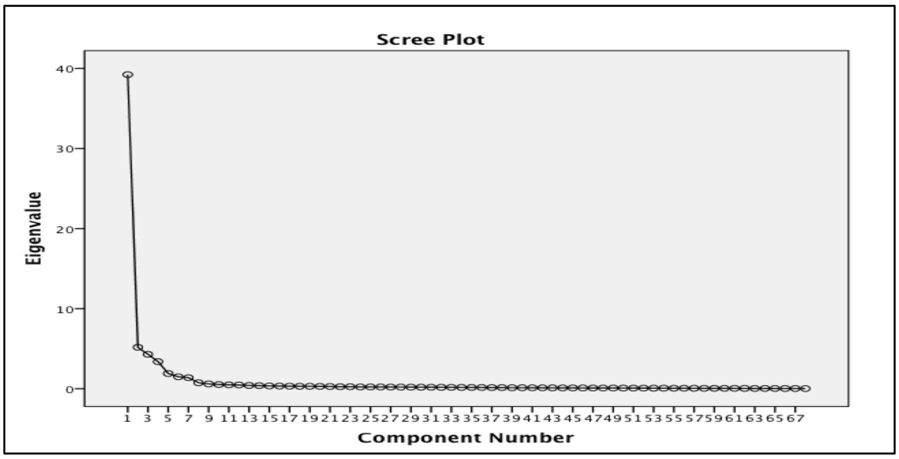



**Figure 6. 11: Scree Test**

Table 6.11 illustrates the factor loadings based on the rotated component matrix for each individual component; only factor loadings of above 0.4 are reported. The rotated component matrix under this study illustrates a seven-factor solution. The next section presents outcome of the second stage of the inferential analysis.

**Table 6. 11: Rotated Component Matrix**

Operational performance (OP), supplier integration (SI), customer integration (CI), internal integration (II), hierarchical relationship (HR), formalization (Form), centralization (cent)

| **Factor Loadings** | **Factor 1 OP** | **Factor 2 SI** | **Factor 3 CI** | **Factor 4 II** | **Factor 5 HR** | **Factor 6 Form** | **Factor 7 Cent** |
|---|---|---|---|---|---|---|---|
| Ccost1 | **.816** | | | | | | |
| Ccost3 | **.814** | | | | | | |
| Ocost2 | **.797** | | | | | | |
| Ccost5 | **.789** | | | | | | |
| Ccost7 | **.789** | | | | | | |
| Qlty1 | **.787** | | | | | | |
| Ccost4 | **.781** | | | | | | |
| Ocost3 | **.780** | | | | | | |
| Flex4 | **.779** | | | | | | |
| Ocost1 | **.779** | | | | | | |
| Ltime2 | **.778** | | | | | | |
| Qlty2 | **.774** | | | | | | |
| Flex3 | **.774** | | | | | | |
| Ccost2 | **.772** | | | | | | |
| Ccost6 | **.770** | | | | | | |
| Qlty4 | **.753** | | | | | | |
| Qlty3 | **.752** | | | | | | |
| Ltime1 | **.751** | | | | | | |
| Ltime4 | **.750** | | | | | | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ocost4 | **.746** | | | | | | |
| Flex1 | **.743** | | | | | | |
| Ltime3 | **.724** | | | | | | |
| Ltime2 | **.719** | | | | | | |
| Sintg8 | | **.864** | | | | | |
| Sintg4 | | **.852** | | | | | |
| Sintg12 | | **.846** | | | | | |
| Sintg10 | | **.842** | | | | | |
| Sintg5 | | **.840** | | | | | |
| Sintg9 | | **.837** | | | | | |
| Sintg2 | | **.827** | | | | | |
| Sintg11 | | **.825** | | | | | |
| Sintg3 | | **.822** | | | | | |
| Sintg7 | | **.821** | | | | | |
| Sintg6 | | **.815** | | | | | |
| Sintg13 | | **.811** | | | | | |
| Sintg1 | | **.797** | | | | | |
| Cintg7 | | | **.845** | | | | |
| Cintg11 | | | **.829** | | | | |
| Cintg6 | | | **.827** | | | | |
| Cintg5 | | | **.826** | | | | |
| Cintg4 | | | **.824** | | | | |
| Cintg10 | | | **.822** | | | | |
| Cintg8 | | | **.816** | | | | |
| Cintg9 | | | **.816** | | | | |
| Cintg2 | | | **.815** | | | | |
| Cintg3 | | | **.782** | | | | |
| Cintg1 | | | **.774** | | | | |
| Iintg7 | | | | **.807** | | | |
| Iintg9 | | | | **.792** | | | |
| Iintg5 | | | | **.785** | | | |
| Iintg2 | | | | **.784** | | | |
| Iintg6 | | | | **.778** | | | |
| Iintg8 | | | | **.772** | | | |
| Iintg1 | | | | **.767** | | | |
| Iintg4 | | | | **.765** | | | |
| Iintg3 | | | | **.752** | | | |
| Hierstr3 | | | | | **-.838** | | |
| Hierstr1 | | | | | **-.818** | | |
| Hierstr2 | | | | | **-.785** | | |
| Hierstr4 | | | | | **.623** | | |
| Form2 | | | | | | **-.750** | |
| Form1 | | | | | | **-.699** | |
| Form3 | | | | | | **-.677** | |
| Form4 | | | | | | **.662** | |
| Cent3 | | | | | | | **-.732** |
| Cent1 | | | | | | | **-.714** |
| Cent2 | | | | | | | **-.703** |
| Cent4 | | | | | | | **.549** |

### 6.4.2 Confirmatory Factor Analysis (CFA)

CFA is the second stage of the inferential analysis and assesses the variable validity of the measurement model. Employing the factors obtained from the EFA, a structural model with hypothesized associations was developed. Before assessing the model based on the structured associations, CFA was employed to validate the measurement model. In CFA, the overall fit of a model can be evaluated employing a number of fit indices. A wide consensus exists in which, one should not excessively rely on a single measure of overall fit and that numerous indices should be taken in to consideration (Byrne, 2013; Tanaka, 1993).

One of the most usual ways of assessing fit is a significant test using $\chi^2$. Using such test a non-significant value implies that the model fits the sample. However, assessing fit in such method has raised criticism in relation to the sensitivity of such test to large sample size. To confront such issues Byrne (2013) suggested using alterative fit indices such as (goodness-of-fit) GFI, comparative fit index (CFI), non-normed fit index (NNFI), root mean square error of approximation (RMSEA), and other developed methods. For this reason the literature recommends (Byrne 2013; Hair et al., 2011) models should be assessed using a mixture of goodness-of-fit indicators. Based on a systematic literature review this study identified NNFI (> 0.9 is good fit), CFI (> 0.9 is good fit), $\chi^2$ statistic ($\chi^2$/df ratio of 3 or below) and RMSEA (<0.8 suitable fit) as the most common fit indicators. Accordingly by using modification indices, this study co-varied different error terms amongst the measurement items. The resulting overall fit of the seven-factor model is acceptable. The model fit statistics utilized are namely; Chi-square ($\chi 2$) =3237.482, degrees of freedom (df) = 2169, chi-square goodness of fit ($\chi 2$/df) =1.493, comparative fit index (CFI) =0.942, parsimony comparative fit index *(*PCFI) =0.897, Normed fit index (NFI) = 0.843, root mean squared error of approximation (RMSEA) =0.052, PCLOSE=0.154. For in detail debates on the desirable cut off points acceptance refer to Gerbing and Anderson (1992), Hu and Bentler (1999) and Byrne (2013).

In order to identify the measurement model this study fixed one factor loading in each construct to 1. This item is known as the marker variable, and verifies whether the total number of indicators is adequate to identify each construct (Higher than two indicators in each construct) (Hair et al., 2011). Furthermore, the variance inflation factor (VIF) of each construct also fell below the desirable cut off point of 10 for multicollinearity (all < 2) (Byrne, 2013).

**Validity and Reliability**

As presented in the preceding chapter this study tests for convergent validity that was described as the extent to which two items of a variable that must be theoretically related, are actually associated. Therefore, in testing for convergent validity, the average variance extracted (AVE) for each variable should be above 0.50. As illustrated in table 6.12 the lowest AVE reported is 0.874, indicating that each variable explains more than half of the variance (in indicators). Furthermore, all values in the varimax rotated component matrix were above the suggested level of 0.4 for the 181 sample size (Hair et al., 2011). The seven-factor model also met the Fornell–Larcker criterion for discriminant validity. By comparing the square root of the AVE of each variable with the correlation between variables, it was found that on average each variable is more strongly related to its own measures than of others (see table 6.12 for square root of AVE and correlation matrix) (Fornell and Larcker, 1981; Hair et al., 2011). Furthermore the model reliability, the Cronbach's alphas, and the composite reliability values (CR) for each variable was higher than the suggested 0.7 (Nunnally et al., 1967; Raykov, 1997). In relation to internal reliability (the Cronbach's alphas) results indicate that internal consistency exists within each variable (i.e. the degree to which the items that make up the variable 'hang together') and therefore showing that the items are measuring the variable they belong to. Finally the composite reliability that measures the overall reliability of heterogeneous (and similar) items, illustrated that each variable (latent) was above the required 0.7. Therefore it is confirmed that the items only measure one variable, and subsequently convergent validity achieved.

**Table 6. 12: Convergent Validity Test**

Composite reliability (CR), Average variance extracted (AVE) Cronbach's alphas (α) and bivariate correlations between study variables. The bold numbers on the diagonal are the square root of the AVE

| | CR | AVE | α | Form | OP | SI | CI | II | HR | Cent |
|---|---|---|---|---|---|---|---|---|---|---|
| **Form** | 0.822 | 0.815 | 0.945 | **0.903** | | | | | | |
| **OP** | 0.987 | 0.764 | 0.987 | -0.698 | **0.874** | | | | | |
| **SI** | 0.987 | 0.850 | 0.986 | -0.614 | 0.638 | **0.922** | | | | |
| **CI** | 0.982 | 0.831 | 0.982 | -0.592 | 0.655 | 0.551 | **0.911** | | | |
| **II** | 0.980 | 0.845 | 0.980 | -0.669 | 0.686 | 0.606 | 0.585 | **0.919** | | |
| **HR** | 0.814 | 0.798 | 0.939 | 0.565 | -0.570 | -0.578 | -0.513 | -0.586 | **0.893** | |
| **Cent** | 0.797 | 0.776 | 0.931 | 0.618 | -0.724 | -0.585 | -0.587 | -0.664 | 0.570 | **0.881** |

## Common Method Bias and Measurement Model Invariance Test

It has been argued that common method bias could be a problem in social sciences (i.e. bias which are associated to the measurement method instead of the variables the measures symbolize) (Parker, 1999; Podsakoff et al., 2003; Scullen, 1999). Since under this study a single instrument was utilized (i.e. survey) for both dependent (e.g. operational performance) and independent variables (e.g. OS), it was required to also test for common method bias. For example, the survey method could have influenced the outcome for those individuals in the oil and gas industry that were more familiar to the OS of their firm, in comparison to those whom might not have been familiar with OS or other aspects of the questionnaire (SCI and operational performance). In order to test for common method bias, this study utilized "unmeasured latent factor" (Podsakoff et al., 2003). No significant difference was reported for the standardized regression weights, before and after the inclusion of the Common latent factor (CLF) (exception Ccost2) (refer Appendix F). Therefore, it was not required to preserve the CLF in the process of creating the composite variables for the SEM. In simpler terms under this study no common methods bias was reported.

Furthermore it was argued that the oil and gas industry is a dynamic and uncertain one that could affect the way companies are structured and also the strategies (e.g. SCI) they implement in such context. For this reason, a number of control variables were introduced to check whether it affected the way in which the respondents answer each questions. Therefore, this study used the measurement model invariance test, in order to illustrate how the same variable or construct is measured across different controls in this research (e.g. upstream – downstream, operational managers vs. strategic managers) and whether the responses differ based on such control variables. In other words such a test could be utilized in order to identify whether an item is conceptually interpreted the same way by respondents with different backgrounds (i.e. being from a manufacturing vs. service providing firm or that being regionally located in the Middle East in comparison to Europe) and if this would result in statistically significant differences in the responses.

Based on the measurement model invariance tests conducted (i.e. metric and configural tests) it was found that the factor structure of the measurement model was consistent for both multi-groups A (Sector= upstream and midstream/downstream; ownership = public, and public/private) and B (Company type= service and manufacturing/Service; respondent = manager and operational) of the data sample, before the actual composites were created from the factor scores. As illustrated in table 6.13 and 6.14, good configural model fits were achieved for both multi-group A and B.

**Table 6. 13: Multi Group A, Measurement Model Invariance Tests**

| Model Fit Statistic | Computed Statistic | Desirable cut off for acceptance |
|---|---|---|
| CMIN/DF | 1.757 | <5.0 |
| CFI | .863 | >0.80 |
| PCFI | .822 | >0.8 |
| NFI | .734 | >0.8 |
| PCLOSE | 1 | > 0.05 |

**Table 6. 14: Multi Group B, Measurement Model Invariance Tests**

| Model Fit Statistic | Computed Statistic | Desirable cut off for acceptance |
|---|---|---|
| CMIN/DF | 1.741 | <5.0 |
| CFI | .866 | >0.8 |
| PCFI | .824 | >0.8 |
| NFI | .735 | >0.8 |
| PCLOSE | 1 | > 0.05 |

Furthermore, a non-significant chi-squared difference test was obtained for multi group A with the unconstrained ($\chi 2$= 19056.6; df=10845), and the fully constrained model ($\chi 2$= 19218.050; df=11117); and also multi group B with the unconstrained ($\chi 2$= 18876.2; df= 10845), and the fully constrained model ($\chi 2$= 19029.8; df=11117), both signifying good metric invariance. A comparison of the standardized regression weights from both groups and their critical ratios for the differences in regression weights also yielded non-significant z scores for all the items at p-value < 0.05. The next section presents the findings from testing the structural model.

## 6.5 Results and Findings of Survey

The overall fit of the hypothesized structural model was adequate ($\chi 2$=3398.686, df =2306, $\chi 2$/df =1.474, CFI= 0.941, NFI =0.837, RMSEA =0.051 and PCLOSE =0.277. All hypotheses were also tested while controlling for operational size, and region. To maintain theoretical clarity and parsimony, the direct relationship, and mediation tests were conducted independently on the full model.

### 6.5.1 Reporting on the Direct Relationships

Since the aim of this study was to investigate the relationship amongst OS, SCI and operational performance of oil and gas supply chains, fifteen direct hypotheses were presented subject to empirical investigation. As illustrated in figure 6.12 all three OS dimensions of centralization (-.313), formalization (-.197) and hierarchical relationship (-

.029) reported significant negative associations on operational performance of oil and gas supply chains.

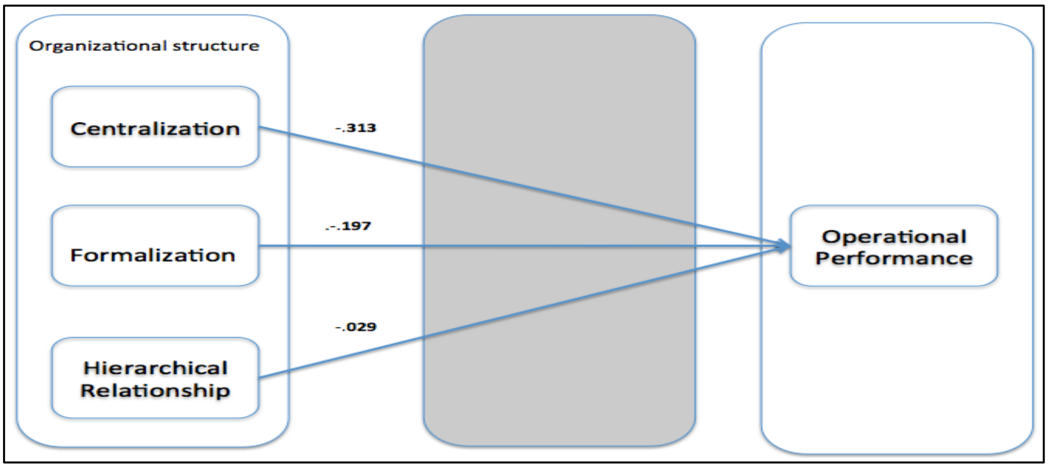



**Figure 6. 12: Path Relationship between Organization Structure and Operational Performance**

As illustrated in figure 6.13, it was found that all three SCI dimensions of internal (.148), supplier (.13) and customer integration (.182) significantly and positively impact operational performance of oil and gas supply chains.

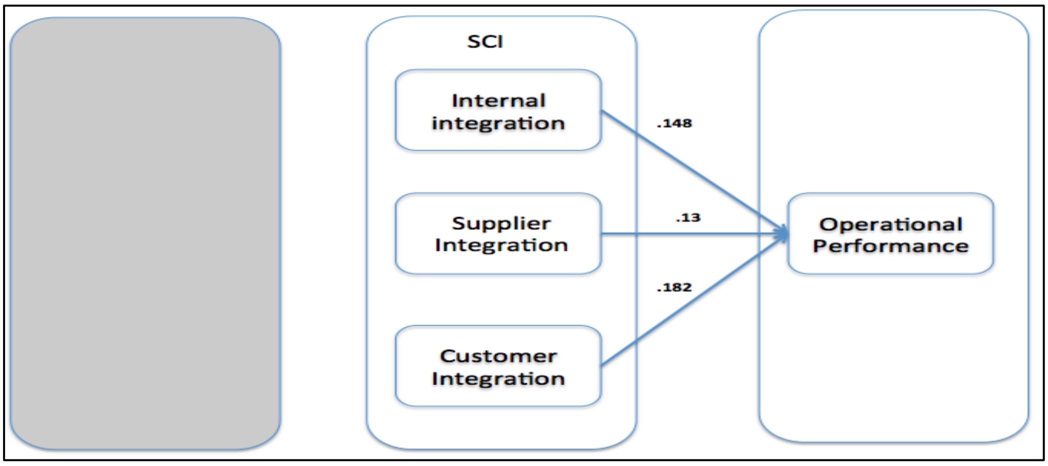



**Figure 6. 13: Path Relationship between Supply Chain Integration and Operational Performance**

Furthermore by testing for the direct relationship between OS and SCI, in this study it was found that centralization (of operational decision-making) was significantly and negatively related to achieving internal (-.342), supplier (-.246), and customer integration (-.35) in the surveyed oil and gas companies. Furthermore formalization (job autonomy and rule observation) was also significantly and negatively related to achieving internal (-.353), supplier (-.32), and customer integration (-.315). Lastly as hypothesized, hierarchical relationship (individual's position in a scalar chain) was also significantly and negatively related to achieving internal (-.193), supplier (-.26), and customer integration (-.166) (figure 6.14).

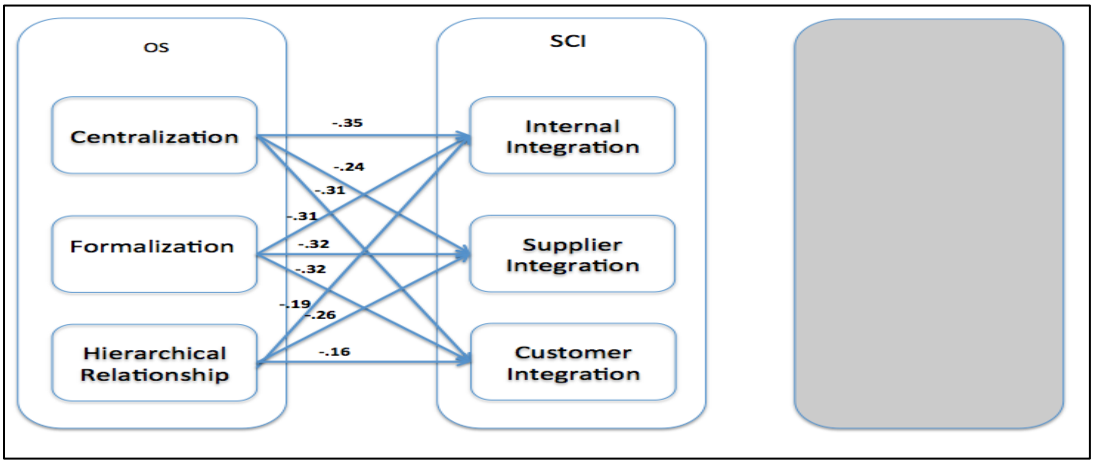



**Figure 6. 14: Path Diagram between Organization Structure and Supply Chain Integration**

Table 6.15 summarizes the above direct relationship between OS on operational performance, SCI on operational performance, and OS on SCI result of the relationship amongst the OS and SCI construct. The standardized path coefficient presented, shows that all relationships were significance at <0.001 except HR → II; Form → OP; CI → OP (Significant at 0.005 level) and HR → CI; HR → OP; II → OP; SI → OP; (Significant at 0.05 level).

**Table 6. 15: SEM Results, Direct Relationships**

Operational performance (OP), supplier integration (SI), customer integration (CI), internal integration (II), hierarchical relationship (HR), formalization (Form), centralization (cent)

| Independent | Path | Dependent | Standardized path coefficient |
|---|---|---|---|
| Cent | → | OP | -.313*** |
| Form | → | OP | -.197** |
| HR | → | OP | -.029* |
| II | → | OP | .148* |
| SI | → | OP | .13* |
| CI | → | OP | .182** |
| Cent | → | II | -.342*** |
| Cent | → | CI | -.305*** |
| Cent | → | SI | -.246*** |
| Form | → | II | -.353*** |
| Form | → | CI | -.315*** |
| Form | → | SI | -.32*** |
| HR | → | II | -.193** |
| HR | → | CI | -.166* |
| HR | → | SI | -.26*** |

* Significant at 0.05 level, ** Significant at 0.005 level, *** Significant at <0.001

### 6.5.2 Mediation Effect of Supply Chain Integration

Furthermore this study examined the mediating impact of SCI on the relationship between OS and operational performance. Figure 6.15 illustrates the standardized path coefficients for the direct relationships from centralization, formalization and hierarchical relationships to operational performance, and the mediated paths through SCI as hypothesized in H6, H7 and H8. As reported in table 6.16 a significant drop in the path coefficients (β) is reported when SCI mediates the direct relationship between the variables for OS (centralization, formalization and hierarchical relationship) and operational performance. Furthermore, the standardized indirect effects for all paths (a measure of the strength of each mediation path) after bootstrapping (2000 bootstrap samples) were significant at 95% confidence interval (Fritz et al., 2012; Hayes and Preacher, 2013; Shrout and Bolger, 2002).

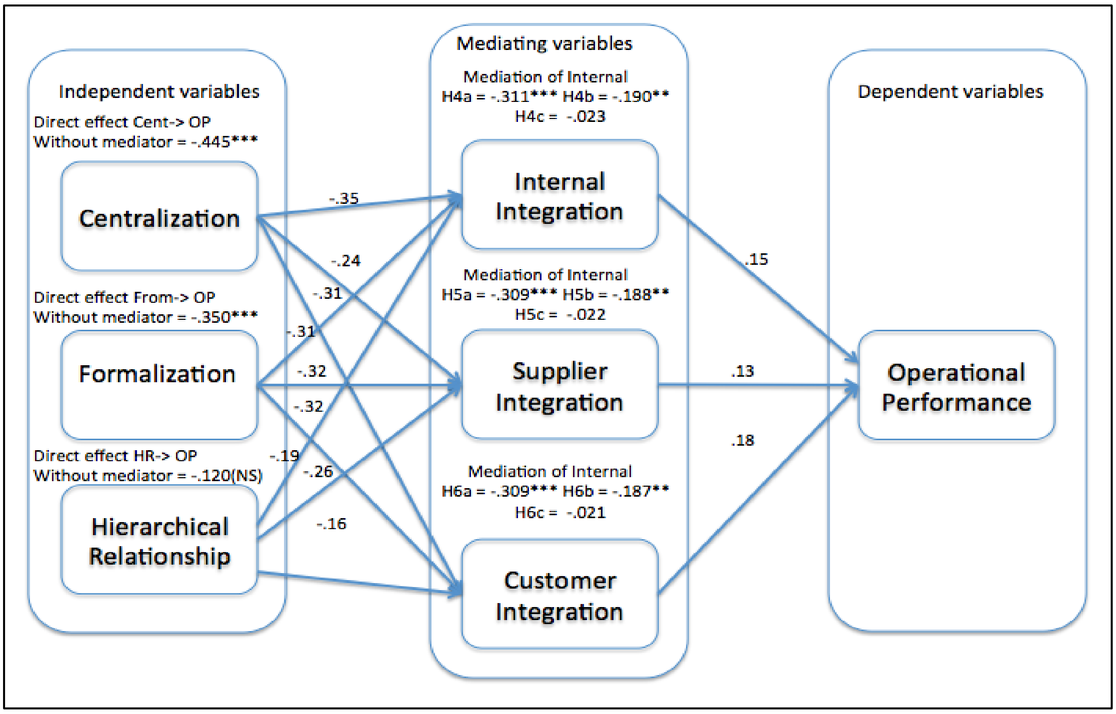



**Figure 6. 15: Path Diagram of the Final Model and the Standardized Path Coefficient**

**Table 6. 16: SEM Results, Direct, Mediating and Indirect Relationships**

Operational performance (OP), supplier integration (SI), customer integration (CI), internal integration (II), hierarchical relationship (HR), formalization (Form), centralization (cent)

| Relationship | Direct effect without mediator | Direct effect with mediator | Indirect effect | Remarks |
|---|---|---|---|---|
| H6.a Cent →II → OP | -.445*** | -.311*** | ** | Partial mediation |
| H7.a Cent →SI → OP | -.445*** | -.309*** | ** | Partial mediation |
| H8.a Cent →CI → OP | -.445*** | -.309*** | ** | Partial mediation |
| H6.b Form →II → OP | -.350 *** | -.190 (.005)** | ** | Partial mediation |
| H7.b Form →SI → OP | -.350 *** | -.188 (.005)** | ** | Partial mediation |
| H 8.b Form →CI → OP | -.350 *** | -.187 (.005)** | ** | Partial mediation |
| H6.c HR →II → OP | -.120 (.061 NS) | -.023 (NS) | ** | Partial mediation |
| H7.c HR →SI → OP | -.120 (.061 NS) | -.022 (NS) | ** | Partial mediation |
| H8.c HR →CI → OP | -.120 (.061 NS) | -.021 (NS) | ** | Partial mediation |

* Significant at 0.05 level, ** Significant at 0.005 level, *** Significant at <0.001

## 6.6 Chapter Conclusion

The 24-research hypotheses described in the theoretical framework (chapter 4) were subject to empirical investigation under this chapter. Furthermore this chapter applied the research design and methodology framed under chapter 5, in order to gather appropriate information from the oil and gas companies. Accordingly a detailed explanation was provided on the process of collection (i.e. first and second batch of data collection). The data collected was then prepared through entering, coding the data, and also editing/cleaning up processes, prior to testing for the proposed relationships (research hypotheses). As a part of the analysis process, this research first tested for descriptive, which (1) comprehend the overall response rate and assessed the data for possible non-response bias and (2) determined the demographics (organization and respondent) associated to data gathered. After analyzing the descriptive, the research carried out the steps for EFA and CFA. Beyond the single hypothesis assessment, path analysis through SEM was carried out and illustrated the suitability of accumulating OS, SCI and operational performance. The outcome for both the direct testes between the variables and also the mediating test were presented in sub-chapters 6.5.1 and 6.5.2 accordingly. As presented in table 6.17 all 24-research hypotheses were accepted, illustrating the hypotheses under this study was accurately composed and reflects the literature review conducted.

**Table 6. 17: Survey Analysis Result**

| Research Hypotheses | Study findings |
|---|---|
| **RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?** | |
| *H1.a Centralization is negatively related to operational performance.* | ***(accepted)*** |
| *H1.b Formalization is negatively related to operational performance.* | ***(accepted)*** |
| *H1.c Hierarchical relationship is negatively related to operational performance.* | ***(accepted)*** |
| **RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?** | |
| *H2.a Internal integration is positively related to operational performance.* | ***(accepted)*** |
| *H2.b Supplier integration is positively related to operational performance.* | ***(accepted)*** |
| *H2.c Customer integration is positively related to operational performance.* | ***(accepted)*** |
| **RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?** | |
| *Hypothesis 3a: Centralisation is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 3b: Centralisation is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 3c: Centralisation is negatively related to customer integration* | ***(accepted)*** |
| *Hypothesis 4a: Formalisation is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 4b: Formalisation is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 4c: Formalisation is negatively related to customer integration.* | ***(accepted)*** |
| *Hypothesis 5a: Hierarchical relationship is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 5b: Hierarchical relationship is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 5c: Hierarchical relationship is negatively related to customer integration.* | ***(accepted)*** |
| **RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?** | |
| *Hypothesis 6a: Internal integration mediates the negative impact of Centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 6b: Internal integration mediates the negative impact of Formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 6c: Internal integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |
| *Hypothesis 7a: Supplier integration mediates the negative impact of centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 7b: Supplier integration mediates the negative impact of Formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 7c: Supplier integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |
| *Hypothesis 8a: Customer integration mediates the negative impact of centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 8b: Customer integration mediates the negative impact of formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 8c: Customer integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |

The last chapter of this research (chapter 7 discussion and conclusion) will provide a detailed debate in relation to the outcomes and findings of the research analysis, and its overall contribution. More specifically chapter 7 will discuss the implications this research has had on operations management and organizational theory, and also its practical implication on oil and gas managers.

# Chapter 7: Discussion and Research Conclusion

The oil and gas industry contributes enormously to global economic growth. Energy is considered an essential input in the process of producing almost all goods and services globally. In the words of Peter Voser the former CEO of Royal Dutch Shell:
*"Energy is the Oxygen of the Economy, without heat, light and power you cannot build or run the factories and cities that provide goods, jobs and homes, nor enjoy the amenities that make life more comfortable and enjoyable"* (World Economic Forum, 2012).

As argued in chapter 2, the oil and gas industry faces enormous operational challenges such as, on-going political unrest in the Middle East, unstable production capacity of oil producers, sudden decline in oil price, rising operational costs, long and unpredictable lead-times, regional supply and global demand of oil, and logistical limitations (e.g. transportation, pipelines) have made it essential for companies to effectively manage the flow of resources (e.g. information, products, technology, know-how) across the supply chain (i.e. upstream, downstream). Nevertheless the high levels of risk associated to the oil and gas industry, has forced companies to implement rigid organization structures (OS) and consequently supply chain linkages (i.e. functionally utilizing resources). Furthermore the attitude concerning collaboration and information sharing amongst supply chain members is another major issue. While such activities are closely tied to supply chain efficiency, oil and gas companies are sometimes cautious in implementing them (i.e. critical relationship between IOC-NOC). It was argued that poor collaboration and information sharing could diminish a company's ability to effectively improve its operational performance (e.g. capital and operational cost). Furthermore it could also hinder the ability of operational managers to make quick and speedy decisions in an unpredictable business environment. It is therefore important to examine the impact of OS on operational performance and the mediating role of supply chain integration (SCI) in such association.

However, despite the complexity and challenges associated to oil and gas supply chains, very little attention has been given to such a significant industry in both organizational theory and operations management research (e.g. most current studies on manufacturing and retail sector). It was argued that uncertain, dynamic and essential industry provides a unique learning opportunity for academics and practitioners to improve current understandings in operations management (SCI) and organizational theory (OS). For this reason, literature in the area of OS, SCI, and operational performance were systematically reviewed to identify research gap, and formulate the conceptual framework for this study. As presented in the first chapter, this research attempted to answer the following questions in the context of the oil and gas industry:

*RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?*
*RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?*
*RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?*
*RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?*

In order to answer the above research questions, this research utilized survey questionnaire from oil and gas companies, and carried out a quantitative analysis. Table 7.1 provides a summary of the research findings. The following chapter offers a discussion in relation to the outcomes of the analysis, and the overall research contribution. More specifically this chapter is broken down into theoretical implications to the fields of operations management and organizational theory, and also practical implication in relation to oil and gas managers. Furthermore research limitations and also guidelines to future research are also presented.

**Table 7. 1: Survey Analysis Result**

| Research Hypotheses | Study findings |
|---|---|
| **RQ 1: What is the relationship between the dimensions of organization structure and operational performance in the oil and gas supply chains?** | |
| *H1.a Centralization is negatively related to operational performance.* | ***(accepted)*** |
| *H1.b Formalization is negatively related to operational performance.* | ***(accepted)*** |
| *H1.c Hierarchical relationship is negatively related to operational performance.* | ***(accepted)*** |
| **RQ 2: What is the relationship between the dimensions of supply chain integration and operational performance in the oil and gas supply chains?** | |
| *H2.a Internal integration is positively related to operational performance.* | ***(accepted)*** |
| *H2.b Supplier integration is positively related to operational performance.* | ***(accepted)*** |
| *H2.c Customer integration is positively related to operational performance.* | ***(accepted)*** |
| **RQ 3: What is the relationship between the dimensions of organization structure and supply chain integration in the oil and gas supply chains?** | |
| *Hypothesis 3a: Centralisation is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 3b: Centralisation is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 3c: Centralisation is negatively related to customer integration* | ***(accepted)*** |
| *Hypothesis 4a: Formalisation is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 4b: Formalisation is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 4c: Formalisation is negatively related to customer integration.* | ***(accepted)*** |
| *Hypothesis 5a: Hierarchical relationship is negatively related to internal integration.* | ***(accepted)*** |
| *Hypothesis 5b: Hierarchical relationship is negatively related to supplier integration.* | ***(accepted)*** |
| *Hypothesis 5c: Hierarchical relationship is negatively related to customer integration.* | ***(accepted)*** |
| **RQ 4: Does supply chain integration mediate the relationship between organization structure and operational performance of oil and gas supply chains?** | |
| *Hypothesis 6a: Internal integration mediates the negative impact of Centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 6b: Internal integration mediates the negative impact of Formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 6c: Internal integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |
| *Hypothesis 7a: Supplier integration mediates the negative impact of centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 7b: Supplier integration mediates the negative impact of Formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 7c: Supplier integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |
| *Hypothesis 8a: Customer integration mediates the negative impact of centralization on operational performance.* | ***(accepted)*** |
| *Hypothesis 8b: Customer integration mediates the negative impact of formalization on operational performance.* | ***(accepted)*** |
| *Hypothesis 8c: Customer integration mediates the negative impact of Hierarchical relationship on operational performance.* | ***(accepted)*** |

## 7.1 Discussion on Direct Relationships

Table 7.2 reports on the direct relationships between the constructs under this study. This study hypothesized direct relationships for OS and operational performance, SCI and operational performance, and lastly OS on SCI. As illustrated all three OS dimensions of centralization (-.313), formalization (-.197) and hierarchical relationship (-.029) reported significant negative associations on operational performance. However, the three SCI dimensions of internal integration (.148), supplier integration (.13), and customer integration (.182) reported significant impacts on operational performance of oil and gas supply chains. Lastly this study also examined the direct relationship between dimensions of OS and SCI. The results of the data analysis indicate that centralization was significantly and negatively related to internal (-.342), supplier (-.246), and customer integration (-.35). Similarly formalization was significantly and negatively related to internal (-.353), supplier (-.32), and customer integration (-.315). Lastly hierarchical relationship was found to be significantly and negatively associated to internal (-.193), supplier (-.26), and customer integration (-.166). The standardized path coefficient presented in table 7.2, shows that all relationships were significance at <0.001 except HR → II; Form → OP; CI → OP (Significant at 0.005 level) and HR → CI; HR → OP; II → OP; SI → OP; (Significant at 0.05 level).

**Table 7. 2: SEM Results, Direct Relationships**

Operational performance (OP), supplier integration (SI), customer integration (CI), internal integration (II), hierarchical relationship (HR), formalization (Form), centralization (cent)

| Independent | Path | Dependent | Standardized path coefficient |
|---|---|---|---|
| Cent | → | OP | -.313*** |
| Form | → | OP | -.197** |
| HR | → | OP | -.029* |
| II | → | OP | .148* |
| SI | → | OP | .13* |
| CI | → | OP | .182** |
| Cent | → | II | -.342*** |
| Cent | → | CI | -.305*** |
| Cent | → | SI | -.246*** |
| Form | → | II | -.353*** |
| Form | → | CI | -.315*** |
| Form | → | SI | -.32*** |
| HR | → | II | -.193** |
| HR | → | CI | -.166* |
| HR | → | SI | -.26*** |

* Significant at 0.05 level, ** Significant at 0.005 level, *** Significant at <0.001

### 7.1.1 Direct Relationship between Organization Structure and Operational Performance

Research findings indicate that centralization was significantly and negatively related to operational performance (-.313). Similarly it was found that formalization was significantly and negatively related to operational performance (-.197). Finally this study also reports a significant and negative between hierarchical relationship and operational performance (-.029).

These findings are in line with the main body of literature in organizational theory that suggests that lower centralization in OS is conducive to organizational performance at both subunit and organizational levels (Cosh et al., 2012; Daugherty et al., 2011; Dewar and Werbel, 1979; Floyd and Wooldridge, 1992; Huang et al., 2010; Koufteros et al., 2007b; Lin and Germain, 2003; Pierce and Delbecq, 1977; Rapert and Wren, 1998; Schminke et al., 2000; Sivadas and Dwyer, 2000). Therefore, this study reinforces the significance of lower centralized decision making in enhancing operational performance of oil and gas supply chains. This could explain that highly centralized oil and gas companies obstruct or slow down communication, information and collaboration. For instance, if an engineering manager has to refer the smallest operational matters to someone higher up the hierarchy for a final decision, this could affect (slow down process) the lead-time performance. Furthermore it was reproted that formalization was significantly and negatively related to operational performance. This is also in line with a number of studies that have reported similar outcomes (e.g. Daugherty et al., 2011; Kelley et al., 1996; Koufteros and Vonderembse, 1998; Lin and Germain, 2003). This implies higher formalization constrains flexibility, discourages proactive problem solving, open communication, collaboration, and quick competitive response in an oil and gas company. However, if such domain expert were allowed to use informal rules in relation to non-routine policies the outcome would have been less serve on company performance (time saved on decision making).

Finally as argued above, this study also found that higher hierarchical relationship was negatively related to operational performance, which is in accordance with prior research (e.g. Huang et al., 2010; Koufteros et al., 2007b; Nahm et al., 2003; Vickery et al., 1999a). This could explain that in an oil and gas company with higher hierarchical relationship, communication process and coordination is slower, less accurate, and with more distributions, since it has to travel through many different hierarchical layers. The consequences of such structure could be more severe in the uncertain environment such as the oil and gas industry, where many of the potential issues need to be mutually solved between the organization and its suppliers and/or customers (timely decisions).

### 7.1.2 Direct Relationship between Supply Chain Integration and Operational Performance

This study empirically tested the direct relationship between SCI and operational performance. Under this research it was found that internal integration significantly and positively affects operational performance (.148); supplier integration significantly and positively affects operational performance (.13); and customer integration significantly and positively affects operational performance (.182). These findings are similar and in line with other researches that have investigated and reported that SCI enables and improves operational performance (e.g. Das et al., 2006; Devaraj et al., 2007; Flynn et al., 2010; Liu et al., 2012; Prajogo and Olhager, 2012; Sanders, 2008; Villena et al., 2009). As argued above this study reported a positive association between internal integration and operational performance. This was consistent with the findings from several other SCI studies (Danese et al., 2013; Droge et al., 2004; Germain and Iyer, 2006; Huo et al., 2012; Zhao et al., 2013). Therefore, this study reinforces the significance of internal integration in enhancing operational performance of oil and gas supply chains. This implies that cross-functional teams could be used for process improvement and new product development. For example, in an oil and gas company coordination and collaboration between the engineering and R&D department could enable technological advancement, and consequently improve operational performance (e.g. operating cost such as service and maintenance).

Furthermore the results also indicate that customer integration had the highest significance in relation to operational performance (e.g. Germain and Iyer, 2006; Koufteros et al., 2005). This could explain the importance of customer integration in the context of the oil and gas supply chain. It is argued that such industry customers are usually not the final consumers, and could act as suppliers to other customers along the supply chain. They are typically the giant NOCs or IOC that enter into relationships in order to carry out the project, and thus viewed as strategic collaborators and are very significant to the focal company. Finally this study also found a positive significant association between supplier integration and operational performance, further reinforcing previous research findings (e.g. Das et al., 2006;

Devaraj et al., 2007; Frohlich and Westbrook, 2001; He et al., 2014; Koufteros et al., 2010; Vereecke and Muylle, 2006). However, there were studies that did not find a direct association (e.g. Droge et al., 2012; Stank et al., 2001a) between supplier integration and operational performance. By comparing the results of this study to other SCI research, it is argued that such mixed findings could be explained by examining the impact of individual dimensions of SCI on performance. It is therefore suggested that association between SCI and performance can be a more comprehensive one, when all three dimensions of SCI are measured collectively. Therefore, based on the structural contingency theory it is argued that the three dimensions of SCI should be aligned together to represent the best operational performance.

### 7.1.3 Direct Relationship between Centralisation and Supply Chain Integration

Research findings indicate that centralization was significantly and negatively related to internal integration (-.342). This could explain that oil and gas companies with higher levels of centralization, allocate the authority to execute operational decisions to managers at the apex of the OS, and that operational level managers are not included in the decision making process (lack of participation). Highly centralized oil and gas companies could therefore hinder communication, information and collaboration. For instance, if an engineering manager has to refer the smallest operational matters to someone higher up the hierarchy for a final decision, this could affect (slow down process) the lead-time performance of other operational units such as procurement and construction (which rely on engineering). Considering that oil and gas companies operate in an unpredictable and volatile industry, they would require timely flow of data and information amongst different internal departments and across members in their supply chains. However, this would be difficult to achieve in a structure where firm senses that staff would need a great level of control over their responsibilities. Therefore, it is argued that such structures obstruct collaboration and communication between units, since the line of command forces each employee to remain and report to higher level hierarchy within their function. For instance, if a technical spec needed modifying instead of an organization that enables engineering and procurement guys discussing its technical implication on the oil and gas project, a highly centralized one would force them to communicate through their departmental leaders (C-level managers). This could lead to an organization that necessitate top-level managers carrying out the majority of decisions, therefore overstretching their cognitive capabilities and inflict substantial time restriction on them. In the above example higher-level management, would still probably take the engineering managers opinion in relation to the technical spec (since they are not involved in the daily operations), nevertheless time is wasted in approving such decisions.

However, if the above oil and gas company had lower centralization, the company resources (operational manager) could be utilized (deployed) more flexibly, and form better collaboration and understanding with other functional units. Such structure will help different departments to better deal with unpredictable alteration in oil and gas project. It is argued that such managers require a flow of knowledge and technical know-hows across different functional boundaries. For example, a sudden increase of price in specific drilling equipment, would affect all three operations departments of engineering, procurement and construction. If such operational experts had the autonomy to carry out their tasks, a richer cross-functional integration could take place amongst them, and risks could be identified that might have not been visible to each department by itself. Therefore, it is argued that such interaction amongst domain experts (as a result of lower centralization) creates knowledge, which could also enable strategic level managers to make better-judged decisions.

Additionally research finding also indicated that centralization was significantly and negatively related to supplier integration (-.246), and Customer integration (-.35). In the oil and gas industry the majority of inter-firm contact points in relation to daily operational activities are the middle and operational level (not C-level managers). For example, it is generally known that oil and gas procurement managers are one of the best-suited individuals to make the judgment on where to source goods and services. They would know exactly who to contact in the suppliers firm, and have more knowledge on supplier surveys (which indicate the level of qualities set or met by your suppliers), thus ensuring better operational performance (e.g. higher flexibility, lower operational/capital cost and lead-time). For such experts, working in centralized organizations (that hinder autonomy) could result in demoralizing them from proactively and efficiently manage issues they come across. For example, if during an oil and gas project, the supplier does not meet a delivery deadline for specific equipment (e.g. Christmas trees, drilling, pipes and wellhead), by including the procurement manager in the decision to target alternative suppliers, operational performance improves. This is because a procurement manager is more experienced in performing, order process for supplier selection (i.e. performing approved vendor list check or evaluating supplier quality records). Furthermore in the oil and gas industry, experts view that customers and suppliers that deal with high-centralized companies could feel isolation since they interact with structures, procedures and policies rather than a flexible domain expert as a counterpart. Out of the three SCI constructs it was interesting to see that centralization had the highest negative impact on customer (-.35), followed by internal (-.342), and supplier integration (-.246). This could imply that in the oil and gas industry, customer integration is typically less foreseeable in comparison to other forms of integration. In such context customers are usually not the final consumers, and are suppliers to other customers along the supply chain. They are typically the giant NOCs or IOC that jointly operate in carrying out projects, and thus are very significant to the focal company.

### 7.1.4 Direct Relationship between Formalization and Supply Chain Integration

The findings under this research illustrate that formalization was significantly and negatively related to internal integration (-.353). This could imply that oil and gas companies with higher formalization rely more on strict supervision (rules and procedures) in controlling day-to-day operation. In such companies it is argued that formalization could result in greater isolation amongst different functional experts (e.g. engineering and site construction manager). Furthermore since the oil and gas industry is highly skill based, the majority of individuals working in such companies are part of the skilled and professional workforce (i.e. nearly all have high levels of university degrees). Such individuals with strong academic and/or practical background would not need a strict supervision from higher hierarchy, are viewed to take the initiative, and make better judgment in relation to those non-routine policies and procedures that could occur on a daily basis. For example, if a company is facing a valve or cladding problem never faced before, having formalized rules and regulation (strict supervision) could force a site-commissioning manager, to follow protocol and wait for approval (before acting). Such lengthy process, could affect lead-time and ultimately operational performance. Therefore in such industry, perceptions of uncertainty rises in situations where change is quick, making it difficult to predict the direction of such change and consequently creating a situation where staff may need to act outside their job scope. However, if such domain expert were allowed to use informal rules in relation to non-routine policies the outcome would have been less serve on company performance (time saved on decision making).

Furthermore formalized structures could also result in higher levels of conflicts and alienation amongst the professionalized oil and gas workforce. For example, purchasing and engineering managers could be subject to more conflicts, since they deal with each other on a regular basis. The engineers send the invoice of what equipment they require, to the purchasing department. The purchasing team might not understand the specifications and require extra clarification, and therefore time is wasted between two internal functions. Therefore, it is argued that higher formalization constrains flexibility, discourages proactive problem solving, open communication, collaboration, and quick competitive response. Open communication and collaboration are essential features of internal integration. If the above managers worked in structures that provided them access to richer communication and coordination, they would be more capable to overcome cross-boundary risks (i.e. across traditional sales and operation department) and become more innovative.

Additionally research finding also indicated that formalization was significantly and negatively related to supplier (-.32), and customer integration (-.32). This could imply that in oil and gas companies with high levels of formalization, customers and suppliers deal with policies and systems rather than individuals. This is because such firms have formal strategic plans (coded and put in writing) in responding to their external players. For example, in a high formalized structure, an expediting manager that needs timely information (technical clarification) regarding pressure valves used in improved oil recovery (e.g. well injection), could face issues in relation to supplier order transit (purchase order). However in less formalized structures, more efficient communication and information sharing takes place. This enables the expediting manager to develop higher levels of expertise (know-how), and is consequently trusted with more autonomy in dealing with supplier counterpart. Therefore, it is argued that formalization typically constrains operational managers to obey by written rules and policies. The inflexibility opposed can consequently hamper relationships with suppliers and/or customers. Consequently supplier/customer could end up sensing isolation, since they have to interact with procedures and policies rather than individuals.

### 7.1.5 Direct Relationship between Hierarchical Relationship and Supply Chain Integration

Research findings indicate that hierarchical relationship was significantly and negatively related to internal integration (-.193). This indicates that oil and gas companies with many different layers of hierarchy could restrict the aptitude of operational level managers, to identify potential challenges and also process improvements initiatives. It has been argued that the oil and gas is a highly-skill based industry. Therefore it is a general understanding that process improvements could be developed locally amongst operational experts. For example, a well manager might propose a more effective, oil well consolidation practice (e.g. act of drilling from one to multiple wells from a single pad). If the company had a number of management hierarchy, the well manager would need to first to get approvals of the department managers and, regional/division heads, before the idea is presented to the director or CEO. Such delays decrease operational flexibility and have been associated to lower levels of internal integration (horizontal relationship). Therefore, in taller OS communication process and coordination is slower, less accurate, and with more distributions, since it has to travel through many different hierarchical layers. It is argued that in oil and gas companies, a good degree of internal integration is achieved once operational level managers have access to broader knowledge on procedures, customs, technologies, and practices. Thus, by having many layers of hierarchy, such knowledge becomes less accessible, and the potential advantages associated to internal integration less accessible.

The findings also indicate hierarchical relationship was significantly and negatively related to supplier integration (-.26), and Customer integration (-.166). It has been argued throughout this research that higher levels of hierarchical relationship reduce the number of actors at each layer. This results in a lower number of contact points for the customers and suppliers. In an uncertain environment such as the oil and gas industry many of the potential issues need to be mutually solved between the organization and its suppliers and customers. For example, offshore operational managers are the ones close to the actual oil exploration, however a large number of managing hierarchy could affect their ability to appropriately collaborate with key suppliers (e.g. hampering innovation in oil exploration). Therefore, oil and gas companies with lower hierarchical relationship enable more access point to customer/suppliers at an operational level. This allows suppliers/customers to be in direct contact with operational and domain experts who understand them better, rather than interacting with systems and processes.

## 7.2 Mediating Role of Supply Chain Integration

Table 7.3 shows the standardized path coefficients for the direct relationships from-centralization, formalization and hierarchical relationships to operational performance, and the mediated paths through SCI, as hypothesized in H6, H7 and H8. Findings indicate a significant drop in the path coefficients (β) when SCI is introduced as the mediating factor on the direct relationship between OS (centralization, formalization and hierarchical relationship) and operational performance (e.g. H6a direct effect without mediator -.445***, with mediator -.311***). Furthermore, the standardized indirect effects for all paths (a measure of the strength of each mediation path) after bootstrapping (2000 bootstrap samples) were significant at 95% confidence interval (see Fritz et al., 2012; Hayes and Preacher, 2013). Thus, as hypothesized in H6, H7 and H8, when oil and gas companies increase their SCI internally or externally with customers and suppliers, the negative effect of centralization, formalization and hierarchical relationship on operational performance decreases. The following section of the research will present discussions on each of mediating roles of SCI (internal, customer and supplier).

**Table 7. 3: SEM Results, Direct, Mediating and Indirect Relationships**

Operational performance (OP), supplier integration (SI), customer integration (CI), internal integration (II), hierarchical relationship (HR), formalization (Form), centralization (cent)

| **Relationship** | **Direct effect without mediator** | **Direct effect with mediator** | **Indirect effect** | **Remarks** |
|---|---|---|---|---|
| H6.a Cent →II → OP | -.445*** | -.311*** | ** | Partial mediation |
| H7.a Cent →SI → OP | -.445*** | -.309*** | ** | Partial mediation |
| H8.a Cent →CI → OP | -.445*** | -.309*** | ** | Partial mediation |
| H6.b Form →II → OP | -.350 *** | -.190 (.005)** | ** | Partial mediation |
| H7.b Form →SI → OP | -.350 *** | -.188 (.005)** | ** | Partial mediation |
| H8.b Form →CI → OP | -.350 *** | -.187 (.005)** | ** | Partial mediation |
| H6.c HR →II → OP | -.120 (.061 NS) | -.023 (NS) | ** | Partial mediation |
| H7.c HR →SI → OP | -.120 (.061 NS) | -.022 (NS) | ** | Partial mediation |
| H8.c HR →CI → OP | -.120 (.061 NS) | -.021 (NS) | ** | Partial mediation |

* Significant at 0.05 level, ** Significant at 0.005 level, *** Significant at <0.001

### 7.2.1 Mediating Role of Internal Integration

Similar to the findings reported under the direct relationship, it was found that higher internal integration mediated the negative relationship between centralization and operational performance (-.445 without mediator, and -.311 with the mediator). Furthermore based on the findings higher internal integration also mediated the negative relationship between formalization and operational performance (-.350 without mediator, and -.190 with mediator). Lastly results indicate that higher internal integration mediated the negative relationship between hierarchical relationship and operational performance (without mediator -.120, is reduced to -.023 with mediator).

It is argued that centralization of operational decision-makings obstructs the flow of information, information processing, and collaboration. In practice it is generally accepted that oil and gas companies operate in an unpredictable and volatile industry, and could benefit from timely flow of data and information amongst different internal departments. Therefore, using periodic interdepartmental meetings between operational experts (such as engineering and procurement) could lead to a better understanding and development of knowledge. For example, if there were needs to develop extend drilling abilities (reaching deeper oil wells) in a company with high levels of centralization, operational managers would be restricted in carrying out their tasks (low autonomy). Accordingly the chances are that such process would take time and turn costly (fabrication cost). However, as argued above if cross-functional teams (engineers, procurement, and construction) were used, the company could produce know-hows and knowledge beyond borders of single department. It has been suggested that formalization creates greater isolation amongst functional managers and staff. In practice the oil and gas companies deal with non-routine policies and procedures on a regular basis. By essentially codifying such responsibility and closely supervising individual role, operational level managers are less motivated in taking initiatives when operational problems occur (every member's job strictly forces them to act accordingly). For instance, if an environmental disastrous such as drilling failure happens, and the drilling manager is not able to act (based on expertise/informal rules) and has to wait on higher-level approval, this could result in huge implication on both firm performance and environmental damage. Internal integration would enable such managers to develop a systematic coordination between departmental functions and improve mutual problem-solving initiatives. Thus, individuals in such companies (formalized rules and regulations) are still able to share knowledge and have cross-functional interaction, consequently diminishing the negative implications associated to the relationship between formalization and operational performance. Lastly it has been suggested that the higher numbers of hierarchical divisions between C-level and operational managers obstruct information and knowledge flow. In such oil and gas companies the many different layers of hierarchy, could restrict the aptitude of operational level managers, to identify and overcome potential operational challenges in a timely manner. The many levels in the organization chart, makes it a difficult task for operational managers to be heard or even develop their expertise. Therefore, by having many layers of hierarchy, such knowledge becomes less accessible. However, by attaining a good level of internal integration, the company is able to produce knowledge beyond the hierarchical distinctions and lessen the communication inaccuracy and distribution.

As presented in chapter 3, mechanistic structures have higher levels of formalization, centralization and hierarchical relationship. Based on the findings it is argued that, as an oil and gas companies become more internally integrated, the negative impact of the mechanistic structure on operational performance reduces. Furthermore by also classifying OS as structuring and structural, this study found that internal integration had a greater significant mediating role on the structuring (centralization, formalization) elements rather than structural (hierarchical relationship). It is argued that even though oil and gas companies have rigid structures and rightly so, it is the structuring elements that are causing the main damage to operational performance.

### 7.2.2 Mediating Role of Supplier Integration

Based on the data analysis it was found that that higher supplier integration mediated the negative relationship between centralization and operational performance (-.445 without mediator, and -.309 with the mediator). The study also reported that higher supplier integration also mediated the negative relationship between formalization and operational performance (-.350 without mediator, and -.188 with mediator). Similarly it was found that higher supplier integration mediated the negative relationship between hierarchical relationship and operational performance (without mediator -.120, is reduced to -.022 with mediator).

Considering that oil and gas companies operate in an unpredictable and volatile industry, they would require timely flow of data and information amongst different internal departments and across members in their supply chains. However this would be difficult to achieve when there is high centralization of decision-making. In such companies operational level managers are not given the necessary authority to deal with day-to-day challenges effectively. For example, a breakdown in drilling equipment (e.g. rotary hose and water tanks) requires the sourcing manager to get approval from other departments and supervisors, before orders are made to suppliers. However, through closer supplier integration and establishing quick ordering systems, the sourcing manager and the supplier counterpart can better coordinate and manage the process. Therefore, it is argued that closer coordination and collaboration between operational managers and supplier, leads to higher operational performance. Similarly by formalizing non-routine policy and procedure an oil and gas company restricts operational-level managers' ability to react appropriately to external uncertainty. The oil and gas industry has become increasingly complicated and technologically challenging (e.g. hydraulic fracturing and deep-sea oil explorations). It is argued that closer coordination with suppliers is necessary for successful oil and gas projects (i.e. create stable procurement through network with major suppliers) and therefore diminishes the negative effects of formalization on operational performance.

It has been suggested that oil and gas companies operate in an unpredictable and volatile industry (varying prices for oil and costs for oil and gas projects), and thus require timely flow of data and information between themselves and their suppliers (e.g. for joint problem solving initiatives, requiring specific material in timely manner). Furthermore oil and gas companies with higher-level of hierarchical relationship, reduce the number of actors at each layer. Therefore, instead of a direct interaction between operational-level managers and their supplier counterpart, approvals from upper hierarchy are needed. However, by enabling supplier integration the above association can be a direct one between domain experts on both sides (e.g. strategic partnership with our major supplier). Based on the findings it is argued that, as oil and gas companies achieve higher levels of supplier integration, the negative impact of the mechanistic structure on operational performance decreases. Furthermore by also classifying OS as structuring and structural, this study found that supplier had a greater significant mediating role on the structuring (centralization, formalization) elements rather than structural (hierarchical relationship).

### 7.2.3 Mediating role of Customer Integration

Similar to the findings reported under the direct relationship, it was found that that higher customer integration mediated the negative relationship between centralization and operational performance (-.445 without mediator, and -.309 with the mediator). The study also reported that higher customer integration also mediated the negative relationship between formalization and operational performance (-.350 without mediator, and -.187 with mediator). Lastly it was found that higher customer integration mediated the negative relationship between hierarchical relationship and operational performance (without mediator -.120, is reduced to -.021 with mediator).

This could imply that oil and gas companies with higher levels of centralization, allocate the authority to execute operational decisions to managers at the apex of the OS. Furthermore in such firms, operational level managers are not included in the decision-making processes. For example when centralization is high, a customer service manager is not given authority to effectively deal with customer request. This is more significant in an industry, whereby customers are typically not the final consumers, and have their own commitments. These could be the IOCs or NOCs that enter into oil and gas project (where service and expertise needed). Thus, centralization will not be applicable in such uncertain context, since flexibility to react will not come from the C-level management, and is a capability usually developed in operational experts. In this regard customer integration becomes an essential feature in better understanding customer service processes, preferences, and policies for a company or specific department. It also enables mutual participation between customers and the focal firm, strategically distributing data, information and know-how (e.g. sharing of point of sales or demand forecast information with the focal company). Similarly formalizing non-routine policies and procedure, limits the effectiveness of operational level managers who have been dealing with customer problems for a while. However, closer customer integration will increase the regular contacts with key customers, inspiring them to get involved in the product development stages and feedback tools. For example, this could be achieved through direct linkages between the logistic manager and major customer (through information networks, computerization of customer ordering, and sharing of market information from the customer, amongst other important factors). Subsequently, focal companies with efficient customer integration will be capable of implementing collaborative initiatives such as, automatic replenishment programs including vendor managed inventory, efficient consumer response, and quick response used to capture the exact customer demand and comprehend the changes in customer needs. Therefore, the above logistic manager will be able to develop more coordination, cooperation, communication between the focal company and their counterparts. So instead of customers dealing with procedures and policies (as a result of highly formalized OS) they are able to build cohesive relationships with individuals they come to trust. As argued above oil and gas companies operate in unpredictable and volatile situations, and may necessitate timely flow of data and information between operational decision makers and their customers (e.g. for joint problem solving initiatives, requiring specific material in timely manner). However, the many levels in the organization chart as associated to tall structures, could affect the ability of domain experts. For example, if customer specification changes, the first person to know its implication would be the operational level individual dealing with the customer firm. Furthermore such expert could need departmental approval and this could accordingly affect the company’s adherence to deadlines set by clients and overall lead-time. Thus, by attaining a good level of customer integration, the company is able to develop operational knowledge beyond the hierarchical distinctions. Based on the findings it is argued that, as an oil and gas companies achieve higher levels of customer integration, the negative impact of the mechanistic structure on operational performance decreases. Furthermore by also classifying OS as structuring and structural, this study found that customer integration had higher significant mediating role on the structuring (centralization, formalization) elements rather than structural (hierarchical relationship).

### 7.3. As-is and To-be Scenario Analysis

Based on the above discussions it was argued that as more SCI develops, flexibility is provided to rigid (mechanistic) OS. In order to provide a practical illustration for the above arguments, the following scenario analysis (as-is and to-be) examines the role of internal and external integration (customer and supplier) in OS of oil and gas companies, by providing examples of industrial challenges.

**As-is: Organization structure without The Role of Internal Integration**

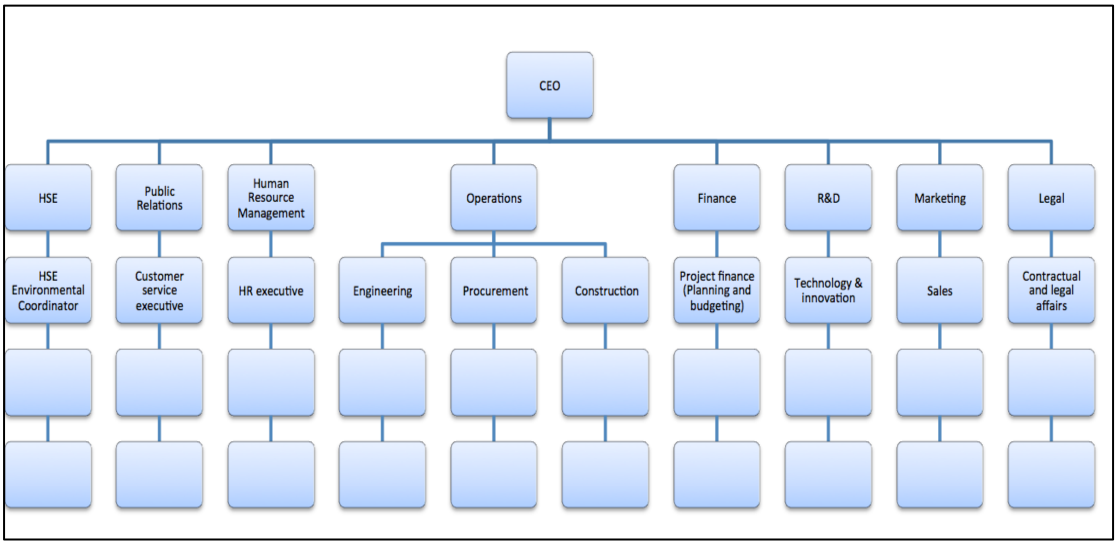



**Figure 7. 1: Functional Organization Structure (without Internal Integration)**

Figure 7.1 provides an example of a traditional (functional) OS of an oil and gas company, without the effect of internal integration. In such structures individuals are divided based on functions. Furthermore it is assumed that centralization is high, and that individuals work in a structure with higher formalized planning processes, and many levels of management hierarchy. In this setting, once the oil and gas project is initiated (e.g. exploration and appraisal), the tasks are divided, and the different parts of the project are carried out by separate functions/departments/units. One of the potential problems with such mechanistic structures is that, interdepartmental communication can become rigid, and therefore lead to slower and inflexible organization as a whole.  A good example would be in the dealing that takes place between the finance and engineering department. Here the purchasing department receives requests for buying specific equipment for the oil and gas operation. However, because of functional differentiation, individuals from the sales might not understand the technical specs given to them in the form of a purchasing order (e.g. which one to choose). This could result in a number of redundant interactions occurring at C-level management, in order to clarify the technical issues prior to actual purchase. In other words, both the engineering and sales would need approval through superiors and department hierarchy, before the specific equipment is bought. This lengthy process could have consequent impact on company's equipment cost (e.g. valves and fittings, electric cables, cladding). This is because employees from the purchasing department are not involved in the technical engineering details, and mistakes or misunderstanding could happen, which can have huge implications on the supply chain performance.

**To-be: Organization Structure with the Role of Internal Integration**

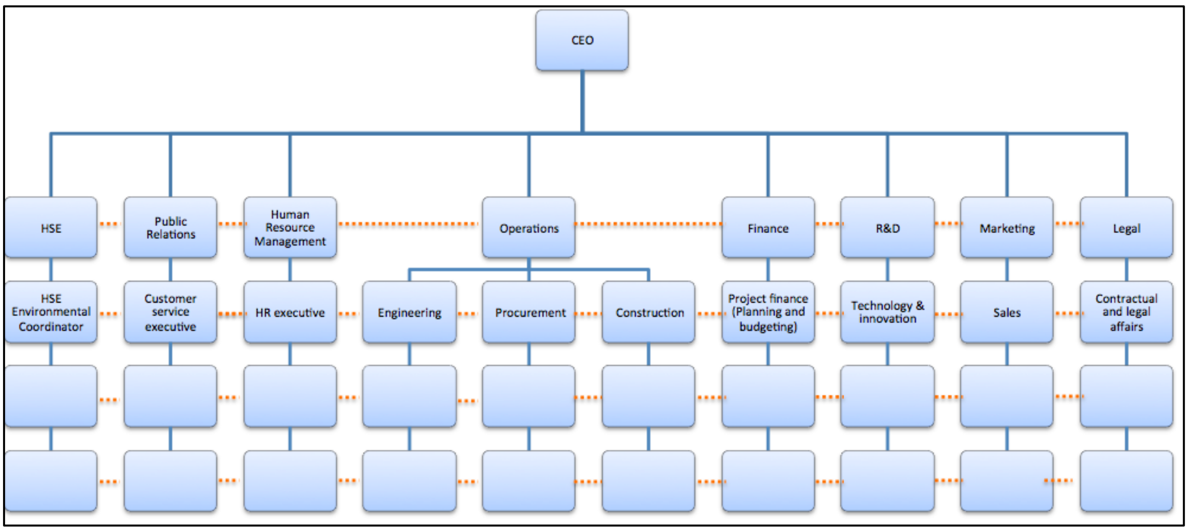



**Figure 7. 2: Functional Organization Structure with Internal Integration**

Figure 7.2 provides an example of the same (functional) OS of an oil and gas company, this time with the mediating role of internal integration (i.e. doted red lines). In this structure the engineering manager is enabled to directly send the purchasing order to an individual in finance, which is at the same hierarchical level. Furthermore the frequent interdepartmental meetings between finance and engineering could lead to better decision-makings. For example, data integration between the two departments will enable a better understanding of the engineering manager on financial implications (and also the purchasing manager on the technical engineering specs). Additionally cross-functional teams could also be used for process improvement and new product development. A closer coordination and collaboration between the engineering and R&D could enable technological advancement, which is needed for the more unconventional reserves (e.g. such as oil sands, shale gas and coalbed methane). As argued earlier the oil and gas industry is highly skilled based, therefore by implementing internal integration, oil and gas companies can reduce the negative impact of their mechanistic structure on operational performance. In other words, they can be more effective in reacting to external uncertainties, by developing cross-functional synergy or knowledge (i.e. helps them identify risks that might not have been visible to each department separately).

**As-is: Organization Structure without Supplier Integration**

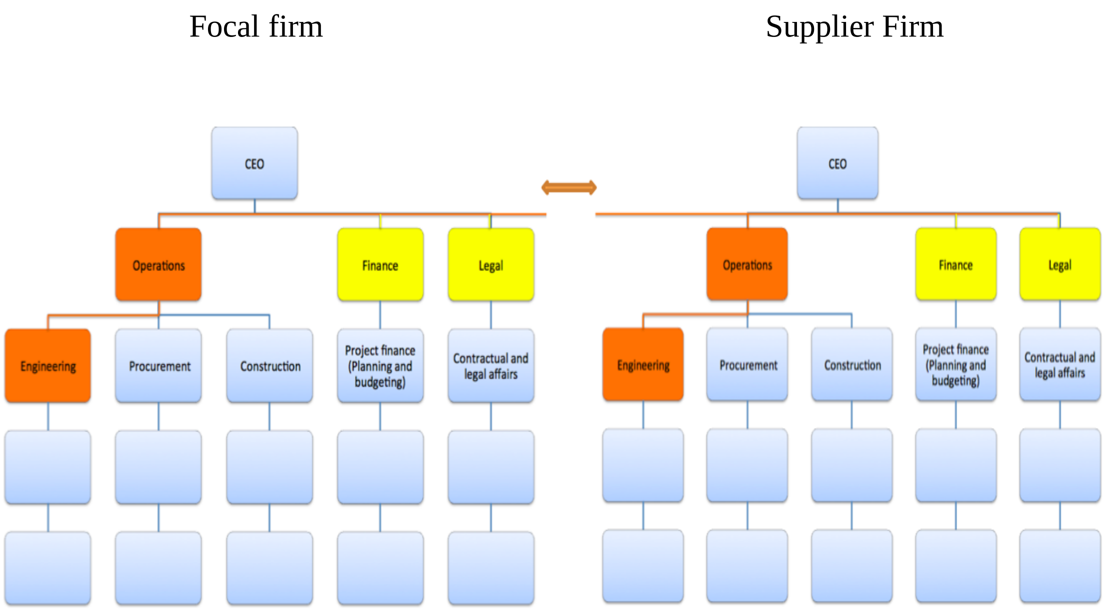



**Figure 7. 3 Relationship between Focal Firm and Supplier (without Supplier Integration)**

Figure 7.3 provides an illustration of how OS of an oil and gas company interacts with OS of suppliers/customers, without the effect of supplier integration. In this case the operational level managers have standardized tasks. They rely on strict supervision and have a subordinate-superior relationship. Furthermore the power to make considerable operational decisions is concentrated in the organization, and operational level managers are not included in decision-making process. In such organizations a sudden change in oil reservoir (e.g. unexpected fall of pressure in oil reservoir) may need consultation or specific equipment's to monitor the conditional changes (e.g. volumetric mapping, using seismic data). As illustrate in figure 7.3 in order for a reservoir manager to deal with such operational difficulties, a minimum of eight rounds of interaction could occur. First the reservoir manager fills in the order for the specific part or service needed. In the second stage the order is moved up the hierarchy and needs superior approval (i.e. head of operations). The order is then moved down to other internal departments that could affect the order requested. In this case it is passed through the finance and legal department and approved by the heads of each department respectfully (stage 3 and 4 of interaction). Based on this scenario it assumed that the same stages could also repeat itself in the suppliers company (figure 7.4). This lengthy processes enforced by the rigid OS (mechanistic) could therefore have a negative impact on supplier lead-time. The same could also apply to customer integration.

**To-be: Organization Structure with Supplier Integration**

Focal Firm Supplier Firm

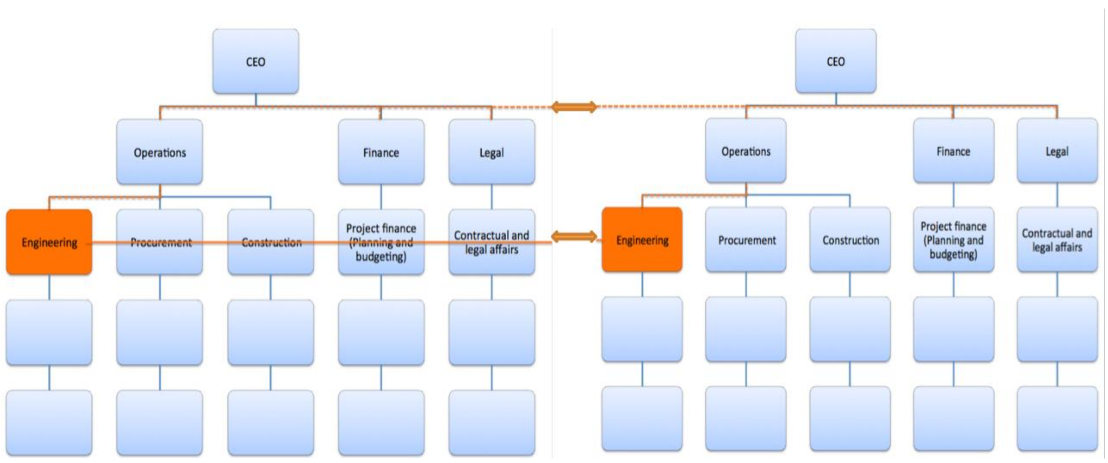



**Figure 7. 4: Relationship between Focal Firm and Supplier (with Supplier Integration)**

Figure 7.4 provides an illustration of how OS of an oil and gas company interacts with OS of suppliers. It shows an OS that could still have high levels of centralization, formalization and hierarchical relationship, however this time with the effect of supplier integration. It is argued that, as supplier integration is developed more flexibility is provided to existing rigid OS of oil and gas companies. These could happen by higher levels of information exchange through information networks, between the procurement manager and supplier counterpart. Through interaction such as stable procurement network with major supplier, the procurement managers (focal company) can develop higher expertise. Thus, such managers would require less supervision, and can be trusted with more operational decisions, which have been traditionally assigned to C-level management. For example, in such company if an oil and gas drilling disaster occurs, they could react more effectively by including drilling and well managers that have developed more expertise and know-hows through closer collaboration with suppliers. Thus, if an equipment was requested, the well manager would not need the higher departmental approval to interact with supplier. As illustrated in figure 7.4 this direct interaction with supplier could save the company valuable operation time. Furthermore such managers would have the best understanding on the spare parts cost, and can consequently advise and save operating cost (service and maintained cost). Compared to the pervious scenario it can be argued that, as supplier integration is introduced the negative effect of the mechanistic structure (higher centralization, formalization and hierarchical relationship) on operational performance (e.g. in this case supplier lead-time and operational cost) is diminished.

It has been argued throughout this study that OS have been associated to the environment in which they operate and also the strategy they adopt. In other words, the high level of industrial uncertainty could outline the OS adopted by the oil and gas company (e.g. mechanistic or organic). By examining OS as a continuum rather than a polarized construct, it is argued that oil and gas companies would need a certain degree of organicity to react faster to such uncertainties (e.g. faster decision-making processes). This implies that even though, oil and gas companies have rigid or mechanistic structure, it does not mean organic features are not included in the structures of such companies. By further classifying OS into "structural" and "structuring" this study illustrated that the structuring or the process associated to structure (i.e. centralization and formalization) had a greater negative impact on SCI and operational performance, compared to the structural or physical elements (hierarchical relationship). This could further clarify the confusion on OS and whether a more mechanistic or organic structure is needed. This study acknowledges that it may be a difficult task to for oil and gas companies to restructure their OS, however based on the illustrations above, they can mitigate the negative impact of highly mechanistic OS on operational performance, by investing in improving their internal, customer supplier integration (diminishing effects of high formalization, centralization and hierarchical relationship). Therefore, this study proposes the following hybrid OS, which still has the mechanistic features of OS, but also the enablers or the processing features associated to organic structures as a result of better SCI (doted red lines).

## 7.4 Proposed Hybrid Organization Structure

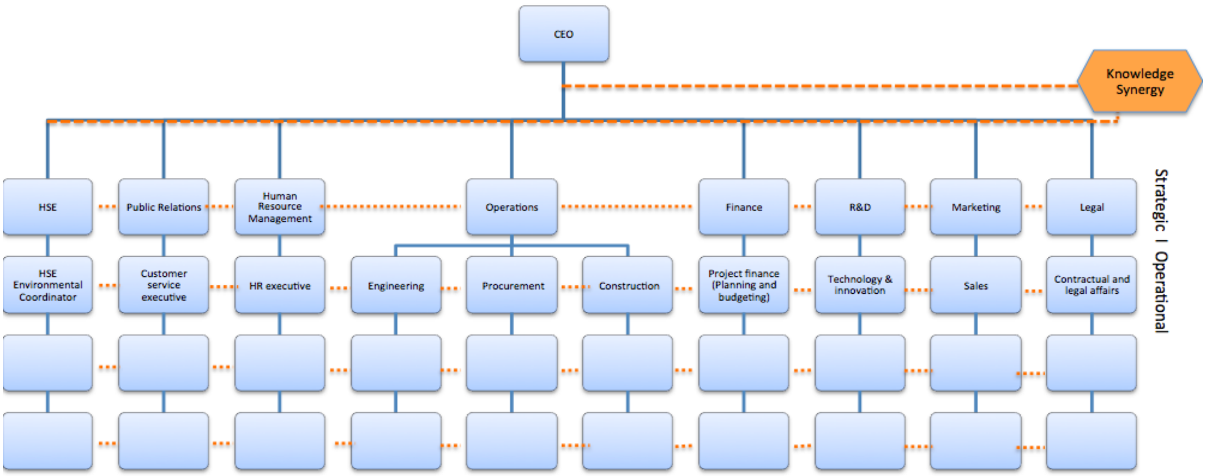



**Figure 7. 5: Proposed Hybrid Organization Structure**

In a traditional OS even with a good degree of SCI, differences in hierarchy between strategic and operational level could hinder comprehensive dynamic capability. This is because of the hierarchical gap existing that obstructs timely communication and information sharing. This is significant in the oil and gas industry where strategic decisions could have significant operational consequences.

Based on the above hybrid structure, it is argued that higher SCI at two levels of hierarchy, namely strategic and operational, will enable the organization to develop a unique cross-functional/border knowledge (know-how) that can be used as a competitive advantage. In such structure middle and operational level managers, have developed their own set of expertise (i.e. through higher internal, customer and supplier integration), and thus should be given autonomy (trusted) to carry out task and also participate in decision making processes (e.g. provide their operational experiences). Therefore based on the hybrid structure, C-level managers of each department should include operational managers (which they can vouch for and known for their expertise) in the weekly interdepartmental/cross functional meetings. This study defines such consolidate pool of operational and strategic managers as *knowledge synergy*, and is illustrated in figure 7.5; it is placed above the hierarchy of individual C-level managers in the OS. This is done in order to overcome potential conflicts on authority amongst departmental managers (C-level) on who gets to use resources. Thus, it is suggested that companies enabling such structure are considered more flexible in deploying or utilizing resource, in the uncertain and dynamic industry of the oil and gas.

## 7.5 Research Contribution

This study developed and tested the direct relationship for three key OS variables, namely centralization, formalization and hierarchical relationship on operational performance. It also examined the impact of internal, supplier and customer integration on operational performance. Furthermore the direct association between OS and SCI was also tested. Subsequently, the mediating impact of SCI – internal, supplier and customer, on the relationship between OS and operational performance was investigated. Under this study the strategic significance of SCI to the oil and gas supply chain performance has been explored. The research findings support and contribute to the contingency view of the firm.

### 7.5.1 Theoretical Implication

The findings as presented in chapter 6.4, offered fascinating answers to the four research questions developed under this research. This research included insights from the contingency theory to examine the mediating impact of three dimensions of SCI (i.e. internal, supplier and customer) on the relationship between OS (centralization, formalization and hierarchical relationship) and operational performance in oil and gas supply chains.

It was argued that during the past two decades, structural contingency theory has been the most used theoretical framework to examine the structure-performance and SCI-performance relationships (Boon-itt and Wong, 2011; Drazin and Van de Ven, 1985; Danese et al., 2013; Flynn et al., 2010; Gimenez et al., 2012; Lin and Germain, 2003; Olson et al., 2005; Stonebraker and Afifi, 2004; Thompson, 2011; Vickery et al., 1999a). Most of the conceptual models developed in the social sciences (especially the management field), have been shown to be complicated in nature, difficult to conceptualize, and dependent on many contingent factors (e.g. Flynn et al., 2010; Galbraith, 1982; Koufteros et al., 2007a,b; Ouchi, 1981; Pascale and Athos, 1981; Stonebraker and Afifi, 2004). This is because for a hypothesis to be valid, assumptions are to be made in relation to premises, system states, and the research boundary condition (Drazin and Van de Ven, 1985; Galbraith, 1973; Sutton and Staw, 1995).

Therefore instead of accepting the deterministic logic (e.g. all organizations need to decentralized) or an approach in which one believes “all cases differ”, the contingency theory enabled this study to view a middle ground in which the variances in OS and SCI, could be analyzed in an orderly way (Birkinshaw et al., 2002; Miller, 1996; Ruekert et al., 1985; Sinha and Van de Ven, 2005). Additionally by taking a contingency perspective in examining the mediating role of SCI, this study offers a systems view on the association between OS and operational performance. This approach is also in line with the objective of this research to examine both the direct, and mediating associations amongst these constructs. In other words, the contingency theory was used to provide a comprehensive explanation for the OS-SCI-operational performance associations, and develop mid-range theories of organizational fit in the context of the oil and gas supply chains. Since this study combines constructs from two different fields (organizational theory and operation management) and links them into one conceptual framework, the contingency theory provides a suitable research approach.

Therefore the findings under this research hold, in relation to the different contingent factors included (e.g. Oil and gas sector= upstream/downstream; type of the organization = public/private; Type of business activities = service provider, manufacturer; Respondent position = operational/strategic). In simpler terms, the outcomes of this study are in direct association to the contingent factors defined. By taking such a theoretical approach, this research was able to split the contingent factors into different groups and compare them using model invariance tests and thus, providing a better insight on the association of OS-SCI-operational performance of oil and gas supply chains (i.e. whether the region the oil and gas company was operating affected its operational performance). Other theoretical approaches such as the institutional theory would have also been useful, however the findings would have only been restricted to specific institutions and therefore it would be difficult to achieve a robust framework examining the OS-SCI-Operational performance. In other words, had this study taking another approach such as the institutional theory, the findings could have also been associated to other similar institutions to the oil and gas (e.g. such as the mining).

In carrying out the systematic literature review it was suggested that in fields of OS and SCI, evolving conceptualizations had resulted in mixed outcomes in both the association between OS-performance (e.g. Claver-Cortés et al., 2012; Cosh et al., 2012; Germain et al., 2007; Koufteros et al., 2007b) and SCI-performance (e.g. Danese and Romano, 2011; Devaraj et al., 2007; Koufteros et al., 2010). Furthermore a number of authors had suggested that in order to achieve a better level of organizational performance, companies would need to match their internal structures, strategies, and procedures with the external environment (e.g. Baum and Wally, 2003; Droge and Calantone, 1996; Flynn et al., 2010; Germain et al., 2007; Walker and Ruekert, 1987). Therefore, the structure-strategy-performance relationship has received significant attention. Although SCI strategy, features and its enablers have been researched quite extensively, no study investigated the mediating role of SCI on OS and operational performance. Furthermore it was argued that, while OS and SCI both impact operational performance (and explain the dynamics of communication, collaboration and information sharing within firms and across firm boundaries), very little was understood about the relationship between OS and SCI.

The uncertain and dynamic context of the oil and gas industry and the range internal (i.e. inter-departmental relationship) and external implications (i.e. relationship with suppliers and customers) provided this research with a suitable platform to progress knowledge and contribute to organizational theory, operations management and operational performance. Accordingly, this research empirically tested for the mediating impact of SCI on the relationship between OS and operational performance. By assessing the antecedents and ramification of OS and SCI in the dynamic environment of the oil and gas, this study theoretically contributes to both stream of organizational theory (e.g. Huang et al., 2010; Koufteros et al., 2007b; Lin and Germain, 2003; Marquis and Lee, 2013; Nahm et al., 2003), operations management (e.g. Flynn et al., 2010; Koufteros et al., 2005; Lau et al., 2010) in the following ways:

First by taking a contingency perspective to investigate the direct association between OS (centralization, formalization and hierarchical relationship), SCI (internal, supplier and customer) and operational performance, this research extended the current understanding of the individual impacts of OS on operational performance, and SCI on operational performance. It was found that as OS become more mechanistic (higher centralization, formalization and hierarchical relationship) this negatively impacts the operational performance of oil and gas supply chains. However it was found that higher levels of internal, customer and supplier integration improved operational performance. These revelations extend and contribute to the current knowledge in the domains of organizational theory and operations management.

Second, this research makes theoretical contributions to the organizational theory and operations management field by examining the direct association between three OS dimensions (centralization, formalization and hierarchical relationship), and three SCI dimensions (internal, supplier and customer). By doing so an attempt is made to bridge the gap between operations management and organizational theory literature. Utilizing a global sample from the oil and gas industry (181 C-level and operational managers), this research found that high levels of centralization, formalization and hierarchical relationship negatively impact the ability of an oil and gas company to achieve internal, customer and supplier integration.

Third prior research had focused on the relationships between OS- operational performance (e.g. Germain et al., 2007; Lin and Germain, 2003) and SCI-OP (e.g. Flynn et al., 2010; Prajogo and Olhager, 2012). By examining the mediating role of SCI, this research found that in the unpredictable and uncertain oil and gas industry, as companies developed SCI the negative impact of highly mechanistic structure on operational performance reduces. In other words, the more organic structures (lower level of centralization, formalization and hierarchical relationship) illustrated better levels of SCI and consequently higher levels of operational performance. This research therefore contributes directly to the organizational literature by extending the popular classification or taxonomy of organic and mechanistic structures, and also distinguishing between the “structuring” and “structural” dimensions of OS (see Campbell et al., 1974). Specifically this study found that that the two structuring dimensions of OS (centralization and formalization, the soft processes) had a more significant impact on SCI and operational performance, in comparison to physical and structural dimension (Hierarchical relationship) and therefore also contributing to the operations management field, by investigating the individual impacts of dimensions of OS on dimensions SCI.

Fourth, by conceptualizing SCI dimensions as internal, customer, and supplier integration, this study contributes to the field of operations management by providing a more comprehensive taxonomy of SCI. It was argued that the majority of existing study on SCI was categorized by developing explanations and dimensions. For example, authors such as He et al. (2014), Devaraj et al. (2007), and Danese and Romano (2011) have all conceptualized SCI as customer and supplier integration and did not contain internal integration. Additionally numerous authors have also referred to SCI as a single construct and did not break it down to internal and external integration (Huang et al., 2014; Kim, 2009; Lau et al., 2010; Liu et al., 2013; Vickery et al., 2003; Villena et al., 2009). Therefore, by viewing SCI as three distinct dimensions, this study developed a better understanding of the direct effects of SCI on operational performance, and also its mediating impact on the relationship between OS and operational performance.

Fifth the research findings also contribute and expand organizational theory and operations management literature, by demonstrating the association amongst, OS, SCI, and operational performance of oil and gas supply chains. It is argued that, despite the complexity and challenges associated to oil and gas supply chains, very little attention has been given to such a significant industry in both OS and SCI literature. Prior comparable research has been quite extensively directed at the manufacturing, retail and service sectors (e.g. Das et al., 2006; Droge et al., 2012; Flynn et al., 2010; Frohlich and Westbrook, 2001; Swink et al., 2007; Narasimhan and Kim, 2002; Vickery et al., 2003; Zhao et al., 2011).

### 7.5.2 Practical Implication

Whilst this research makes significant contributions to OS and SCI literature, it also has significance in practice for oil and gas managers. By investigating the direct impact of OS-operational performance, SCI- operational performance, OS-SCI, and also the mediating impact of SCI on the relationship between OS and operational performance in the uncertain and dynamic oil and gas industry, the following recommendations are made for practitioners:

This research argued that, the oil and gas industry as the main source of energy supply is considered as the lifeblood of the world economy, making it an essential input in the processes of producing almost all products and services around the globe. Nevertheless high levels of uncertainty and the dynamic nature of the oil and gas industry have resulted in enormous challenges and created rigid supply chain linkages throughout the industry. Such challenges have made the need for effectively managing the flow of information across both upstream and downstream oil and gas, an essential task. Therefore, it was suggested that operational managers would require better strategic data and information sharing; higher collaboration and better flow of communication; and integrated process management systems internally and within their supply chains (across customers and suppliers), which have been associated to higher levels of SCI. For example, through cross-functional data integration the engineers and purchasing employees are better able to communicate and collaborate (i.e. understand each other's language). This would resolve potential issues such as, staff from purchasing not understanding the technical engineering specs of the orders they need to process. Furthermore it was also noted that SCI could improve process and new product development. For instance, a closer coordination and collaboration between the construction manager, R&D and supplier, could enable technological advancement, which is needed for the more unconventional reserves (e.g. oil sands, shale gas and coalbed methane).

Furthermore despite highlighting the importance of SCI for oil and gas companies, this study also investigated organization's internal processes and structures, in order to view how it impacts the ability of an organization in achieving SCI and consequently better operational performance. Based on the findings it was argued that in the uncertain oil and gas environment, firms that were more mechanistic (higher levels of centralization, formalization and hierarchical relationship) were less likely to be internally and externally integrated and consequently had lower operational performance. This could become problematic in an industry in which external conditions evolve quickly (i.e. difficult to predict the future pattern of the external environment). Highly centralized structures would therefore affect the company's ability to effectively react to (unpredictable) operational alterations in projects (e.g. sudden change of oil price and/or demand affects every aspect of the oil and gas project). Furthermore such environments could comprise of many non-routine policies and procedures on a regular basis (e.g. environmental disastrous as a consequences of drilling failure). By essentially codifying the responsibility and closely supervising individual role, the oil and gas companies force their staff to be less motivated in taking initiatives where operational problems occur. For example, a breakdown in drilling equipment (e.g. rotary hose and water tanks) requires the sourcing manager to get approval from other departments and supervisors, before orders are made to suppliers (affecting supplier lead-time). Oil and gas companies with many different layers of hierarchy have been suggested to reduce the number of actors at each layer and thus, reducing customer/supplier contact points. In uncertain environments such as the oil and gas industry, many of the potential issues need to be mutually solved between the organization and its suppliers and/or customers. For example, offshore sits managers are the ones close to the actual oil exploration, however a large number of managing hierarchies could affect their ability to appropriately collaborate with key suppliers. Therefore, oil and gas companies with lower hierarchical relationship enable more access point to customer/suppliers at an operational level. This allows suppliers/customers to be in direct contact with operational and domain experts who understand them better, rather than interacting with systems and processes.

Nevertheless this research understands that from a practical point of view, it may be a difficult and daunting task for oil and gas companies to restructure and reform their OS (physical aspect), since this process might be timely and expensive to implement. However, based on the findings it was argued that such companies could mitigate the negative impact of highly mechanistic OS on operational performance (by investing in improving their internal and external integration). In other words it is argued that, oil and gas companies by investing in higher internal and external integration, create more inter and intra collaboration and communication which could ultimately encourage organizational restructuring and the move towards organic structures.

This study defines such consolidate pool of operational and strategic managers as *knowledge synergy*, and suggested it to be placed above the hierarchy of individual C-level managers in the OS. This is done in order to overcome potential conflicts on authority amongst departmental managers (C-level) on who gets to use resources. Such outcome has significant implications for oil and gas companies that operate in highly uncertain and dynamic conditions. It is suggested that oil and gas companies enabling such structure (through SCI strategies) are considered more flexible in deploying or utilizing resource, and could therefore better manage the risks that arise from such uncertain industry.

## 7.6 Conclusion

In the management and organization studies, many authors have attempted to eloquent what represents theoretical contribution (e.g. Bartunek and Rynes, 2010; Hambrick, 2007; Kilduff, 2006). However a lack of agreement on what actually constitutes theory has made it challenging for researchers to develop/contribute to the theory in management and organization studies (Sutton and Staw, 1995). This heterogeneous field of study (typically with many stakeholders) not only borrows from a variety of disciplines (e.g. economics, sociology, psychology), but also includes the practitioner's perspective as well (see Corley and Gioia, 2011). The mix of different perspective and background could result in misperception of what is knowledge contribution. This is more evident in the context of this research, which is attempting to establish a link between organization theory and operations management. Therefore, in order to clearly illustrate the knowledge contributions, this research made use of the 2x2 matrix introduced by Corley and Gioia (2011), categorizing contributions based on utility and originality (figure 7.6). In relation to utility (how useful the contribution is), the contributions are split into scientific and practical dimensions. On the other hand, research originality establishes whether contributions reveal something new (revelatory), or help develop or add to existing knowledge (incremental).

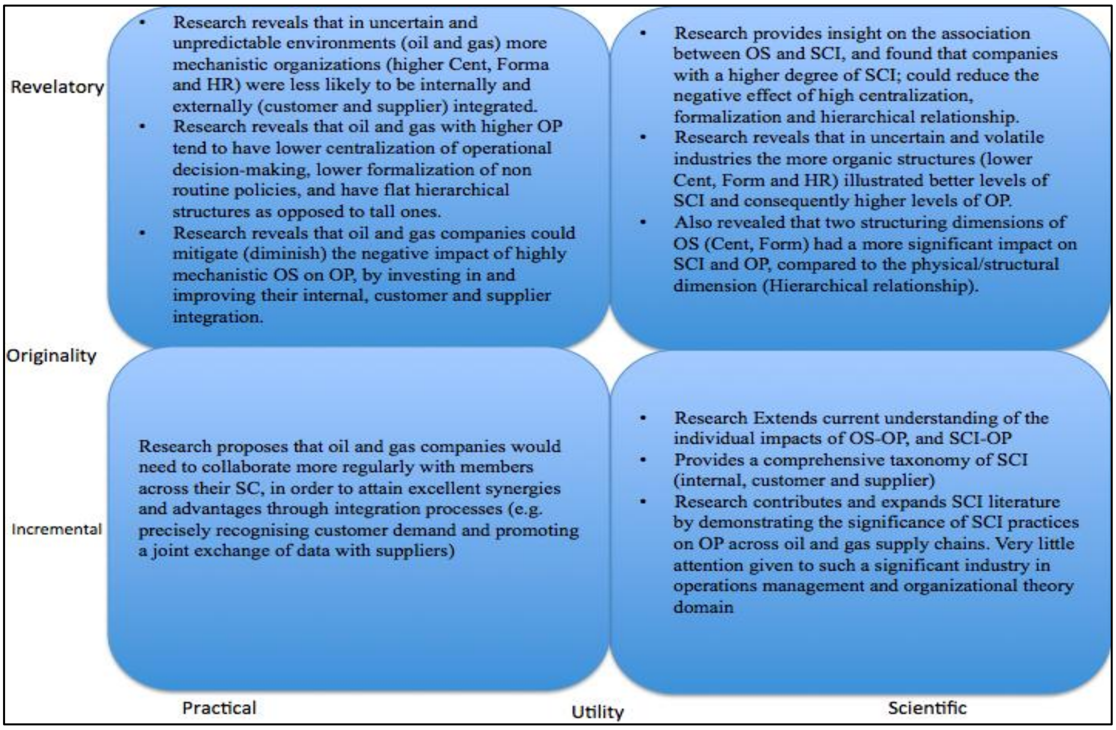



**Figure 7. 6: Research Theoretical and Practical Contributions 2x2 matrix (Corley and Gioia, 2011)**

## 7.7 Future Studies and Limitations

Although this research offers significant insights, a number of limitations and opportunities for future research still exist (e.g. research methodology, context and analysis). Such limitations provide the platform for other researchers to build and extend the understanding developed under this study. Therefore, further studies are needed to strengthen the findings of this research and extend the management understanding and academic knowledge in the important oil and gas industry. The research limitations under this study have been categorized as the following:

First although this research was carried out in the context of the oil and gas industry, the research concepts such as OS, SCI and operational performance are relevant to other settings as well (industry and companies). Nevertheless since the data were collected from a global sample of the oil and gas industry, it would be interesting to see if similar findings were to be found in other production (commodity) based industries (i.e. mining industry). Thus, a comparative research might be useful to precisely set generalizability limitations on the research outcomes.

Second it is typically understood that it may take some time for a focal company to develop a close integration with its customers and supplier. Therefore, it is suggested that it may be useful for future studies to investigate the impact of OS on SCI using a longitudinal surveys. This would help in clarifying how much long-term relationship and trust between the focal company and its suppliers/customers, affect their attitude and practices towards supplier/customer integration.

Third this research took a contingency perspective in investigation the mediating role of SCI on the relationship between OS and operational performance in the context of the oil and gas industry. As argued throughout this study, because of the dynamic and unpredictable nature of the oil and gas industry, one could argue other contingency exist that could be affecting the research outcomes. Therefore this research suggests that future studies look at other institutions resembling the oil and gas industry (to identify other contingencies), in examining the OS-SCI and operational performance relationship.

Lastly it would also be useful to examine the interaction effects between the SCI dimensions, Internal, customer, and supplier integration, and its impact on operational performance. This would help future researchers better understand how an increase, for example in internal integration, would impact the company's ability in achieving supplier and customer integration.

Nevertheless it is argued that the limitations stated above do not undervalue the overall significant original contribution from this study. In chapter 5 a number of strategies were presented in order to reinforce research reliability and validity. Additionally the research scope was clearly presented in order to outline how findings were generalized. Thus, this research has provided a novel framework in evolving more effective organizational structural types, in relation to improving the management of SCI and operational performance for oil and gas companies. Such an attempt to empirically examine the mediating impact of SCI on relationship between OS and operational performance should therefore be further researched. Lastly this research has emphasized on the importance of the oil and gas supply chain towards the global economy, this also warrants examination of such an industry across other management discipline.

## References


Adams, S. M., 1999, The development of strategic performance metrics.

Adler, P. S., and B. Borys, 1996, Two types of bureaucracy: Enabling and coercive: Administrative Science Quarterly, v. 41, p. 61-89.

Adler, P. S., and S. W. Kwon, 2002, Social capital: Prospects for a new concept: Academy of Management Review, v. 27, p. 17-40.

Ahire, S. L., D. Y. Golhar, and M. A. Waller, 1996, Development and validation of TQM implementation constructs: Decision sciences, v. 27, p. 23-56.

Aiken, M., and J. Hage, 1966, Organizational alienation: A comparative analysis: American Sociological Review, v. 31, p. 497-507.

Aiken, M., and J. Hage, 1968, Organizational interdependence and intra-organizational structure: American sociological review, v. 33, p. 912-930.

Aiken, M., and J. Hage, 1971, The organic organization and innovation: Sociology, v. 5, p. 63-82.

Al-Marri, K., A. Moneim M. Baheeg Ahmed, and M. Zairi, 2007, Excellence in service: an empirical study of the UAE banking sector: International Journal of Quality & Reliability Management, v. 24, p. 164-176.

Aldrich, H., 2007, Organizations and environments, Stanford University Press.

Alexander, J. A., 1991, Adaptive change in corporate control practices: Academy of Management Journal, v. 34, p. 162-193.

Alfalla-Luque, R., C. Medina-Lopez, and P. K. Dey, 2013, Supply chain integration framework using literature review: Production Planning & Control, v. 24, p. 800-817.

Allen, T. J., and S. I. Cohen, 1969, Information flow in research and development laboratories: Administrative Science Quarterly, v. 14, p. 12-19.

Allred, C. R., S. E. Fawcett, C. Wallin, and G. M. Magnan, 2011, A Dynamic Collaboration Capability as a Source of Competitive Advantage: Decision Sciences, v. 42, p. 129-161.

Altiok, T., and R. Ranjan, 1995, Multi-stage, pull-type production/inventory systems: IIE transactions, v. 27, p. 190-200.

Anderson, J. C., and D. W. Gerbing, 1988, Structural equation modeling in practice: A review and recommended two-step approach: Psychological bulletin, v. 103, p. 411.

Andrews, M. C., and K. M. Kacmar, 2001, Discriminating among organizational politics, justice, and support: Journal of Organizational Behavior, v. 22, p. 347-366.

Anseel, F., F. Lievens, E. Schollaert, and B. Choragwicka, 2010, Response rates in organizational science, 1995–2008: a meta-analytic review and guidelines for survey researchers: Journal of Business and Psychology, v. 25, p. 335-349.

Ansoff, H. I., 1991, Critique of Henry Mintzberg's 'The design school: reconsidering the basic premises of strategic management': Strategic management journal, v. 12, p. 449-461.

Antony, J., K. Leung, G. Knowles, and S. Gosh, 2002, Critical success factors of TQM implementation in Hong Kong industries: International Journal of Quality & Reliability Management, v. 19, p. 551-566.

Argyle, M., G. Gardner, and F. Cioffi, 1958, Supervisory methods related to productivity, absenteeism, and labour turnover: Human relations, v. 11, p. 23-40.

Argyris, C., 1972, The applicability of organizational sociology, CUP Archive.

Arlene, F., and S. L. Mark, 1995, How to measure survey reliability and validity, v. 7, Sage.
Arntzen, B. C., G. G. Brown, T. P. Harrison, and L. L. Trafton, 1995, Global supply chain management at Digital Equipment Corporation: Interfaces, v. 25, p. 69-93.
Artz, K. W., and P. M. Norman, 1998, Buyer-Supplier Performance: The Role of Asset Specificity, Reciprocal Investments and Relational Exchange, v. 1998, p. C1-C18.
Aryee, G., M. M. Naim, and C. Lalwani, 2008, Supply chain integration using a maturity scale: Journal of Manufacturing Technology Management, v. 19, p. 559-575.
Bagchi, P. K., B. Chun Ha, T. Skjoett-Larsen, and L. Boege Soerensen, 2005, Supply chain integration: a European survey: The International Journal of Logistics Management, v. 16, p. 275-294.
Baldridge, J. V., and R. A. Burnham, 1975, Organizational innovation: Individual, organizational, and environmental impacts: Administrative science quarterly, v. 20, p. 165-176.
Ballou, R. H., 1999, Business logistics management : planning, organizing, and controlling the supply chain: Upper Saddle River, NJ, Prentice-Hall International.
Bandalos, D. L., 2002, The effects of item parceling on goodness-of-fit and parameter estimate bias in structural equation modeling: Structural Equation Modeling, v. 9, p. 78-102.
Banks, R. L., and S. C. Wheelwright, 1979, Operatins vs Strategy-Trading Tomorrow for Today: Harvard Business Review, v. 57, p. 112-120.
Barnett, V., and T. Lewis, 1994, Outliers in statistical data: New York: Wiley.
Bartunek, J. M., and S. L. Rynes, 2010, The construction and contributions of “implications for practice”: what's in them and what might they offer?: Academy of management Learning & education, v. 9, p. 100-117.
Baruch, Y., and B. C. Holtom, 2008, Survey response rate levels and trends in organizational research: Human Relations, v. 61, p. 1139-1160.
Basnet, C., 2013, The measurement of internal supply chain integration: Management Research Review, v. 36, p. 153-172.
Baum, J. F., and S. A. Youngblood, 1975, Impact of an organizational control policy on absenteeism, performance, and satisfaction: Journal of Applied Psychology, v. 60, p. 688.
Baum, J. R., and S. Wally, 2003, Strategic decision speed and firm performance: Strategic Management Journal, v. 24, p. 1107-1129.
Beamon, B. M., 1998, Supply chain design and analysis:: Models and methods: International journal of production economics, v. 55, p. 281-294.
Beamon, B. M., 1999, Measuring supply chain performance: International Journal of Operations & Production Management, v. 19, p. 275-292.
Beamon, B. M., and V. C. P. Chen, 2001, Performance analysis of conjoined supply chains: International journal of production research, v. 39, p. 3195-3218.
Beck, E. M., and M. Betz, 1975, A comparative analysis of organizational conflict in schools: Sociology of Education, v. 48, p. 59-74.
Bedeian, A. G., 1984, Organizations: theory and analysis: text and cases, Dryden Pr.
Bell, E., and A. Bryman, 2007, The ethics of management research: an exploratory content analysis: British Journal of Management, v. 18, p. 63-77.
Bell, J., and S. Waters, 2014, Doing Your Research Project: A guide for first-time researchers, McGraw-Hill Education (UK).
Ben-Daya, M., and A. Raouf, 1994, Inventory models involving lead time as a decision variable: Journal of the Operational Research Society, v. 45, p. 579-582.

Bennett, R., and H. Gabriel, 1999, Organisational factors and knowledge management within large marketing departments: an empirical study: Journal of knowledge management, v. 3, p. 212-225.
Bentler, P. M., 1992, On the fit of models to covariances and methodology to the Bulletin: Psychological bulletin, v. 112, p. 400.
Berger, C. J., and L. L. Cummings, 1979, Organizational structure, attitudes and behaviors. Institute for research in the behavioral, economic, and management sciences.
Berman, S. L., J. Down, and C. W. L. Hill, 2002, Tacit knowledge as a source of competitive advantage in the National Basketball Association: Academy of Management Journal, v. 45, p. 13-31.
Bernon, M., J. Upperton, M. Bastl, and J. Cullen, 2013, An exploration of supply chain integration in the retail product returns process: International Journal of Physical Distribution & Logistics Management, v. 43, p. 586-608.
Bertrand, J. W. M., 2003, Supply chain design: flexibility considerations: Handbooks in Operations Research and Management Science, v. 11, p. 133-198.
Bhagwat, R., and M. K. Sharma, 2007, Performance measurement of supply chain management: A balanced scorecard approach: Computers & Industrial Engineering, v. 53, p. 43-62.
Bidwell, C. E., and J. D. Kasarda, 1975, School district organization and student achievement: American Sociological Review, v. 40, p. 55-70.
Birkinshaw, J., R. Nobel, and J. Ridderstråle, 2002, Knowledge as a contingency variable: do the characteristics of knowledge predict organization structure?: Organization science, v. 13, p. 274-289.
Black, S. A., and L. J. Porter, 1996, Identification of the Critical Factors of TQM*: Decision sciences, v. 27, p. 1-21.
Blau, P. M., 1968, The hierarchy of authority in organizations: American Journal of Sociology, v. 73, p. 453-467.
Blau, P. M., 1970, A formal theory of differentiation in organizations: American sociological review, v. 35, p. 201-218.
Blau, P. M., 1972, Interdependence and hierarchy in organizations: Social Science Research, v. 1, p. 1-24.
Blau, P. M., 1994, The organization of academic work, Transaction Publishers.
Blau, P. M., W. V. Heydebrand, and R. E. Stauffer, 1966, The structure of small bureaucracies: American Sociological Review, v. 31, p. 179-191.
Blau, P. M., and R. A. Schoenherr, 1971, The structure of organisations, Basic Books New York.
Blau, P. M., and W. R. Scott, 1962, "Formal organizations: a comparative approach.", Oxford, England: Chandler.
Blauner, R., 1964, Alienation and freedom: The factory worker and his industry.
Bollen, K. A., and J. S. Long, 1993, Testing structural equation models, v. 154, Sage.
Boon-itt, S., and C. Y. Wong, 2011, The moderating effects of technological and demand uncertainties on the relationship between supply chain integration and customer delivery performance: International Journal of Physical Distribution & Logistics Management, v. 41, p. 253-276.
Bowersox, D. J., D. J. Closs, and T. P. Stank, 1999, 21st Century Logistics: Making supply chain integration a reality: The Council of Logistics Management, Oak Brook, IL.

Boyer, K. K., and M. W. Lewis, 2002, Competitive priorities: investigating the need for trade-offs in operations strategy. Production and Operations Management, v. 11, p. 9-20.
BP Statistical Review of World Energy ,2014. [online] Available from: http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf [Accessed 05 November 2014].
Bourgeois, L. J., D. W. McAllister, and T. R. Mitchell, 1978, The effects of different organizational environments upon decisions about organizational structure: Academy of Management Journal, v. 21, p. 508-514.
Bowers, D. G., 1964, Organizational control in an insurance company: Sociometry, v. 27, p. 230-244.
Brah, S. A., J. Li Wong, and B. Madhu Rao, 2000, TQM and business performance in the service sector: a Singapore study: International Journal of Operations & Production Management, v. 20, p. 1293-1312.
Brass, D. J., 1984, Being in the right place: A structural analysis of individual influence in an organization: Administrative science quarterly, v. 29, p. 518-539.
Bridge, G., 2001, Resource triumphalism: postindustrial narratives of primary commodity production: Environment and Planning A, v. 33, p. 2149-2174.
Briner, R. B., D. Denyer, and D. M. Rousseau, 2009, Evidence-based management: concept cleanup time?: The Academy of Management Perspectives, v. 23, p. 19-32.
Bromwich, M., and A. Bhimani, 1989, Management accounting: evolution not revolution, Chartered Institute of Management Accountants London.
Bryman, A., and E. Bell, 2011, Business research methods 3e, Oxford university press.
Burns, T. E., and G. M. Stalker, 1961, The management of innovation: University of Illinois at Urbana-Champaign's Academy for Entrepreneurial Leadership Historical Research Reference in Entrepreneurship.
Byrne, B. M., 2013, Structural equation modeling with AMOS: Basic concepts, applications, and programming, Routledge.
Cagliano, R., F. Caniato, and G. Spina, 2006, The linkage between supply chain integration and manufacturing improvement programmes: International Journal of Operations & Production Management, v. 26, p. 282-299.
Cai, S., M. Jun, and Z. Yang, 2010, Implementing supply chain information integration in China: The role of institutional forces and trust: Journal of Operations Management, v. 28, p. 257-268.
Campbell, J. P., D. A. Bownas, N. G. Peterson, and M. D. Dunnette, 1974, The measurement of organizational effectiveness: A review of relevant research and opinion: Personnel Decisions Research INST Minneapolis MN.
Cao, M., M. A. Vonderembse, Q. Zhang, and T. S. Ragu-Nathan, 2010, Supply chain collaboration: conceptualisation and instrument development: International Journal of Production Research, v. 48, p. 6613-6635.
Cao, M., and Q. Zhang, 2011, Supply chain collaboration: Impact on collaborative advantage and firm performance: Journal of Operations Management, v. 29, p. 163-180.
Cao, Z., B. Huo, Y. Li, & X. Zhao, 2015. The impact of organizational culture on supply chain integration: a contingency and configuration approach. Supply Chain Management: An International Journal, v. 20, p. 24-41.

Carr, A. S., H. Kaynak, and S. Muthusamy, 2008, The cross-functional coordination between operations, marketing, purchasing and engineering and the impact on performance: International Journal of manufacturing technology and management, v. 13, p. 55-77.
Carr, A. S., and L. R. Smeltzer, 1997, An empirically based operational definition of strategic purchasing: European Journal of Purchasing & Supply Management, v. 3, p. 199-207.
Caruana, A., M. H. Morris, and A. J. Vella, 1998, The effect of centralization and formalization on entrepreneurship in export firms: Journal of Small Business Management, v. 36, p. 16-29.
Carzo Jr, R., and J. N. Yanouzas, 1969, Effects of flat and tall organization structure: Administrative science quarterly, v. 14, p. 178-191.
Cattell, R. B., 1966, The scree test for the number of factors: Multivariate behavioral research, v. 1, p. 245-276.
Cavana, R., B. L. Delahaye, and U. Sekeran, 2001, Applied business research: Qualitative and quantitative methods, John Wiley & Sons Australia.
Champion, D. J., 1975, The sociology of organizations, McGraw-Hill Companies.
Chan, F. T. S., 2003, Performance measurement in a supply chain: The international journal of advanced manufacturing technology, v. 21, p. 534-548.
Chan, F. T. S., and H. J. Qi, 2003, An innovative performance measurement method for supply chain management: Supply chain management: An international Journal, v. 8, p. 209-223.
Chandler, A. D., 1962, Strategy and structure: The history of American industrial enterprise: MIT Press, Cambridge, Mass.(1977) The Visible Hand, Harvard University Press, Cambridge, Mass.(1980) The Growth of the Transnational Industrial Firm in the United States and the United Kingdom: a Comparative Analysis', Economic History Review, v. 33, p. 396-410.
Channon, D. F., 1973, The strategy and structure of British enterprise, Harvard Business School Pr.
Checkland, P., 1999, Systems thinking, systems practice: includes a 30-year retrospective.
Chen, H., D. D. Mattioda, and P. J. Daugherty, 2007, Firm-wide integration and firm performance: The International Journal of Logistics Management, v. 18, p. 5-21.
Chen, I. J., and A. Paulraj, 2004, Understanding supply chain management: critical research and a theoretical framework: International Journal of Production Research, v. 42, p. 131-163.
Child, J., 1972, Organizational structure, environment and performance: The role of strategic choice: Sociology, v. 6, p. 1-22.
Child, J., 1973a, Predicting and understanding organization structure: Administrative Science Quarterly, v. 18, p. 168-185.
Child, J., 1973b, Strategies of control and organizational behavior: Administrative Science Quarterly, v. 18, p. 1-17.
Child, J., 1974, Managerial and organizational factors associated with company performance part I: Journal of Management studies, v. 11, p. 175-189.
Child, J., and R. Mansfield, 1972, Technology, size, and organization structure: Sociology, v. 6, p. 369-393.
Childerhouse, P., and R. Towill, 2011, Arcs of supply chain integration: International Journal of Production Research, v. 49, p. 7441-7468.

Chima, C. M., 2011, Supply-chain management issues in the oil and gas industry: Journal of Business & Economics Research (JBER), v. 5, p. 27-36.

Chin, K. S., K. F. Pun, Y. Xu, and J. S. F. Chan, 2002, An AHP based study of critical factors for TQM implementation in Shanghai manufacturing industries: Technovation, v. 22, p. 707-715.

Chow, G., L. E. Henrikssen, and T. D. Heaver, 1995, Strategy, structure and performance: a framework for logistics research: Logistics and Transportation Review, v. 31, p. 199-285.

Chuang, B.-R., L.-Y. Ouyang, and Y.-J. Lin, 2004, A minimax distribution free procedure for mixed inventory model with backorder discounts and variable lead time: Journal of Statistics and Management Systems, v. 7, p. 65-76.

Chung, Y.-C., S.-W. Tien, C.-H. Hsieh, and C.-H. Tsai, 2008, A study of the business value of Total Quality Management: Total Quality Management, v. 19, p. 367-379.

Clark, K. B., 1989, Project scope and project performance: the effect of parts strategy and supplier involvement on product development: Management science, v. 35, p. 1247-1263.

Claver-Cortés, E., E. M. Pertusa-Ortega, and J. F. Molina-Azorín, 2012, Characteristics of organizational structure relating to hybrid competitive strategy: Implications for performance. Journal of Business Research, v. 65, p. 993-1002.

Clercq, D. D., D. Dimov, and N. T. Thongpapanl, 2013, Organizational social capital, formalization, and internal knowledge sharing in entrepreneurial orientation formation: Entrepreneurship Theory and Practice, v. 37, p. 505-537.

Clifford D, C., and T. P. Stank, 2005, Applying the strategy-structure-performance paradigm to the supply chain environment: The International Journal of Logistics Management, v. 16, p. 28-50.

Cohen, M. A., and H. L. Lee, 1989, Resource deployment analysis of global manufacturing and distribution networks: Journal of manufacturing and operations management, v. 2, p. 81-104.

Coia, A., 1999, Integrating oil's supply chain: Traffic World, v. 259.

Cole, R. E., and W. R. Scott, 2000, The quality movement & organization theory, Sage Publications, Inc.

Collis, J., and R. Hussey, 2009, Business research: a practical guide for undergraduate and postgraduate students.

Collis, J., and R. Hussey, 2013, Business research, Citeseer.

Collis, J., R. Hussey, D. Crowther, G. Lancaster, M. Saunders, P. Lewis, A. Thornhill, A. Bryman, E. Bell, and J. Gill, 2003, Business research methods, Palgrave Macmillan, New York.

Colquitt, J. A., and C. P. Zapata-Phelan, 2007, Trends in theory building and theory testing: A five-decade study of the Academy of Management Journal: Academy of Management Journal, v. 50, p. 1281-1303.

Connor, P. E., 1980, Organizations, theory and design, Science Research Associates.

Cook, T. D., and D. T. Campbell, 1976, The design and conduct of quasi-experiments and true experiments in field settings: Handbook of industrial and organizational psychology, v. 223, p. 336.

Cooper, M. C., D. M. Lambert, and J. D. Pagh, 1997, Supply chain management: more than a new name for logistics: The International Journal of Logistics Management, v. 8 , p. 1-14.

Cooper, D. R., and P. S. Schindler, 2003, Business research methods.

Cooper, R., 1987, The two-stage procedure in cost accounting–part one: Journal of Cost Management, v. 1, p. 43-51.
Cooper, R., 1989a, The Rise of Activity-based Costing: How Many Cost Drivers Do You Need, and how Do You Select Them?, Journal of Cost Management, p. pp. 34-46.
Cooper, R., 1989b, You need a new cost system when: Harvard Business Review, v. 67, p. 77-82.
Cooper, R., and R. S. Kaplan, 1988, Measure costs right: make the right decisions: Harvard business review, v. 66, p. 96-103.
Corbett, C. J., M. J. Montes-Sancho, and D. A. Kirsch, 2005, The financial impact of ISO 9000 certification in the United States: An empirical analysis: Management science, v. 51, p. 1046-1059.
Corley, K. G., and D. A. Gioia, 2011, Building Theory about Theory Building: What Constitutes a Theoretical Contribution?: Academy of Management Review, v. 36, p. 12-32.
Corwin, R. G., 1970, Militant professionalism: A study of organizational conflict in high schools, Ardent Media.
Cosh, A., X. Fu, and A. Hughes, 2012, Organisation structure and innovation performance in different environments: Small Business Economics, v. 39, p. 301-317.
Cousins, P. D., and B. Menguc, 2006, The implications of socialization and integration in supply chain management: Journal of Operations Management, v. 24, p. 604-620.
Covin, J. G., K. M. Green, and D. P. Slevin, 2006, Strategic process effects on the entrepreneurial orientation–sales growth rate relationship: Entrepreneurship Theory and Practice, v. 30, p. 57-81.
Creswell, J. W., 2013, Research design: Qualitative, quantitative, and mixed methods approaches: Sage publications.
Croom, S., P. Romano, and M. Giannakis, 2000, Supply chain management: an analytical framework for critical literature review: European journal of purchasing & supply management, v. 6, p. 67-83.
Cropanzano, R., J. C. Howes, A. A. Grandey, and P. Toth, 1997, The relationship of organizational politics and support to work behaviors, attitudes, and stress: Journal of Organizational Behavior, v. 18, p. 159-180.
Crotty, M., 1998, The foundations of social research: Meaning and perspective in the research process, Sage.
Crozier, M., 2009, The bureaucratic phenomenon, v. 280, Transaction Publishers.
Csaszar, F. A., 2012, Organizational structure as a determinant of performance: Evidence from mutual funds: Strategic Management Journal, v.33, p. 611-632.
Cua, K. O., K. E. McKone, and R. G. Schroeder, 2001, Relationships between implementation of TQM, JIT, and TPM and manufacturing performance: Journal of Operations Management, v. 19, p. 675-694.
D'Aunno, T., and R. I. Sutton, 1992, The responses of drug abuse treatment organizations to financial adversity: A partial test of the threat-rigidity thesis: Journal of Management, v. 18, p. 117-131.
Daft, R., 2006, Organization theory and design, Cengage learning.
Daft, R. L., and R. H. Lengel, 1986, Organizational information requirements, media richness and structural design: Management science, v. 32, p. 554-571.
Dalton, D. R., W. D. Todor, M. J. Spendolini, G. J. Fielding, and L. W. Porter, 1980, Organization structure and performance: a critical review: Academy of Management Review, v. 5, p. 49-64.

Damanpour, F., 1987, The adoption of technological, administrative, and ancillary innovations: Impact of organizational factors: Journal of management, v. 13, p. 675-688.

Damanpour, F., 1988, Innovation type, radicalness, and the adoption process: Communication research, v. 15, p. 545-567.

Damanpour, F., 1991, Organizational innovation: A meta-analysis of effects of determinants and moderators: Academy of management journal, v. 34, p. 555-590.

Danese, P., 2013, Supplier integration and company performance: A configurational view: Omega-International Journal of Management Science, v. 41, p. 1029-1041.

Danese, P., and P. Romano, 2011, Supply chain integration and efficiency performance: a study on the interactions between customer and supplier integration: Supply Chain Management-an International Journal, v. 16, p. 220-230.

Danese, P., and P. Romano, 2012, Relationship between downstream integration, performance measurement systems and supply network efficiency: International Journal of Production Research, v. 50, p. 2002-2013.

Danese, P., and P. Romano, 2013, The moderating role of supply network structure on the customer integration-efficiency relationship: International Journal of Operations & Production Management, v. 33, p. 372-393.

Danese, P., P. Romano, and M. Formentini, 2013, The impact of supply chain integration on responsiveness: The moderating effect of using an international supplier network: Transportation Research Part E: Logistics and Transportation Review, v. 49, p. 125-140.

Das, A., R. Narasimhan, and S. Talluri, 2006, Supplier integration - Finding an optimal configuration: Journal of Operations Management, v. 24, p. 563-582.

Daugherty, P. J., H. Chen, and B. G. Ferrin, 2011, Organizational structure and logistics service innovation: The International Journal of Logistics Management, v. 22, p. 26-51.

Daugherty, P. J., M. B. Myers, and C. W. Autry, 1999, Automatic replenishment programs: an empirical examination: Journal of Business Logistics, v. 20, p. 63-82.

Davenport, T. H., and N. Nohria, 2012, Case management and the integration of labor: Sloan Management Review.

Davis, T., 1993, Effective supply chain management: Sloan management review, v. 34, p. 35-35.

De Toni, A., G. Nassimbeni, 1999, Buyer-supplier operational practices, sourcing policies and plant performances: results of an empirical research: International Journal of Production Research, v. 37, p. 597-619.

De Toni, A., and S. Tonchia, 2001, Performance measurement systems-models, characteristics and measures: International Journal of Operations & Production Management, v. 21, p. 46-71.

De Vaus, D. A., 2002, Surveys in social research, Psychology Press.

Dean, J. W., and D. E. Bowen, 1994, Management theory and total quality: improving research and practice through theory development: Academy of management review, v. 19, p. 392-418.

Deming, W. E., 1982, Quality, productivity, and competitive position, Massachusetts Institute of Technology Center for Advanced En.

Deming, W. E., 1986, Out of the crisis, Massachusetts Institute of Technology: Center for advanced engineering study, Cambridge, MA, v. 510.

Demirbag, M., E. Tatoglu, M. Tekinkus, and S. Zaim, 2006, An analysis of the relationship between TQM implementation and organizational performance: evidence from Turkish SMEs: Journal of Manufacturing Technology Management, v. 17, p. 829-847.

Denyer, D., and D. Tranfield, 2009, Producing a systematic review.

Devaraj, S., L. Krajewski, and J. C. Wei, 2007, Impact of eBusiness technologies on operational performance: The role of production information integration in the supply chain: Journal of Operations Management, v. 25, p. 1199-1216.

Dewar, R., and J. Werbel, 1979, Univesrsalistic and contingency predictions of employee satisfaction and conflict: Administrative Science Quarterly, v. 24, p. 426-448.

Dick, G. P. M., I. Heras, and M. Casadesús, 2008, Shedding light on causation between ISO 9001 and improved business performance: International Journal of Operations & Production Management, v. 28, p. 687-708.

Dixon, J. R., 1990, The new performance challenge: Measuring operations for world-class competition, Irwin Professional Pub.

Doll, W. J., and M. A. Vonderembse, 1991, The evolution of manufacturing systems: towards the post-industrial enterprise: Omega, v. 19, p. 401-411.

Donaldson, L., 2001, The contingency theory of organizations, Sage.

Donaldson, L., and M. Warner, 1974, Bureaucratic and electoral control in occupational interest associations: Sociology, v. 8, p. 47-57.

Drazin, R., and A. H. Van de Ven, 1985, Alternative forms of fit in contingency theory: Administrative science quarterly, v. 30, p. 514-539.

Droge, C., and R. Calantone, 1996, New product strategy, structure, and performance in two environments: Industrial Marketing Management, v. 25, p. 555-566.

Droge, C., J. Jayaram, and S. K. Vickery, 2004, The effects of internal versus external integration practices on time-based performance and overall firm performance: Journal of Operations Management, v. 22, p. 557-573.

Droge, C., S. K. Vickery, and M. A. Jacobs, 2012, Does supply chain integration mediate the relationships between product/process strategy and service performance? An empirical study: International Journal of Production Economics, v. 137, p. 250-262.

Duclos, L. K., R. J. Vokurka, and R. R. Lummus, 2003, A conceptual model of supply chain flexibility: Industrial Management & Data Systems, v. 103, p. 446-456.

Duhaime, I. M., and C. R. Schwenk, 1985, Conjectures on cognitive simplification in acquisition and divestment decision making: Academy of Management Review, v. 10, p. 287-295.

Duncan, R. B., 1972, Characteristics of organizational environments and perceived environmental uncertainty: Administrative science quarterly, v. 17, p. 313-327.

Dwyer, F. R., and S. Oh, 1987, Output sector munificence effects on the internal political economy of marketing channels: Journal of Marketing Research, v. 24, p. 347-358.

Dwyer, F. R., and S. Oh, 1988, A transaction cost perspective on vertical contractual structure and interchannel competitive strategies: The Journal of Marketing, v. 52, p. 21-34.

Dwyer, F. R., P. H. Schurr, and S. Oh, 1987, Developing buyer-seller relationships: The Journal of marketing, v. 51, p. 11-27.

Dwyer, F. R., and M. A. Welsh, 1985, Environmental relationships of the internal political economy of marketing channels: Journal of Marketing Research, v. 22, p. 397-414.

Dyas, G. P., and H. T. Thanheiser, 1976, The emerging european enterprise: Strategy and structure in French and German industry: Macmillian, London.
Easton, G. S., and S. L. Jarrell, 1998, The Effects of Total Quality Management on Corporate Performance: An Empirical Investigation*: The Journal of Business, v. 71, p. 253-307.
Egelhoff, W.G., 1988, Strategy and structure in multinational-corporations – a revision of the Stopford and Wells model: Strategic Management Journal, v. 9, p. 1-14.
Egelhoff, W. G., 1991, Information-processing theory and the multinational enterprise: Journal of international business studies, v. 22, p. 341-368.
EIA-Annual Energy Outlook 2014 with projections to 2040 [online] Available from: http://www.eia.gov/forecasts/aeo/pdf/0383(2014).pdf [Accessed 14 September 2014].
Eisenhardt, K. M., 1989, Making fast strategic decisions in high-velocity environments: Academy of Management Journal, v. 32, p. 543-576.
Ellinger, A. E., 2000, Improving marketing/logistics cross-functional collaboration in the supply chain: Industrial marketing management, v. 29, p. 85-96.
Ellram, L. M., 1995, Total cost of ownership: an analysis approach for purchasing: International Journal of Physical Distribution & Logistics Management, v. 25, p. 4-23.
Ettlie, J. E., W. P. Bridges, and R. D. O'Keefe, 1984, Organization strategy and structural differences for radical versus incremental innovation: Management science, v. 30, p. 682-695.
Etzicni, A., 1964, Modern organizations, Englewood : Prentice-Hall.
EU, 2050. Energy strategy [online] Available from https://ec.europa.eu/energy/en/topics/energy-strategy/2050-energy-strategy [Acccessed 18 February 2015].
Evan, W. M., and G. Black, 1967, Innovation in business organizations: some factors associated with success or failure of staff proposals: Journal of business, v. 40, p. 519-530.
Evans, J. R., and W. M. Lindsay, 2005, The management and control of quality, South-Western Mason, OH.
Fabbe-Costes, N., and M. Jahre, 2008, Supply chain integration and performance: a review of the evidence: International Journal of Logistics Management, v. 19, p. 130-154.
Fabbe-Costes, N., and M. Jahre, 2007, Supply chain integration improves performance: the Emperor's new suit?: International Journal of Physical Distribution & Logistics Management, v. 37, p. 835-855.
Fawcett, S. E., and G. M. Magnan, 2002, The rhetoric and reality of supply chain integration: International Journal of Physical Distribution & Logistics Management, v. 32, p. 339-361.
Fawcett, S. E., G. M. Magnan, and M.W. McCarter, 2008, Benefits, barriers, and bridges to effective supply chain management: Supply Chain Management: An International Journal, v. 13, p. 35-48.
Ferdows, K., M. A. Lewis, and J. A. D. Machuca, 2004, Rapid-fire fulfillment: Harvard business review, v. 82, p. 104-117.
Ferrell, O. C., and S. J. Skinner, 1988, Ethical behavior and bureaucratic structure in marketing research organizations: Journal of Marketing Research, v. 25, p. 103-109.

Ferris, G. R., and K. M. Kacmar, 1992, Perceptions of organizational politics: Journal of management, v. 18, p. 93-116.
Ferris, G. R., G. S. Russ, and P. M. Fandt, 1989, Politics in organizations, *in* R. A. G. P. Rosenfeld, ed., Impression management in the organization: Hillsdale, NJ, England, Lawrence Erlbaum Associates, Inc, p. 143-170.
Fiedler, F. E., and M. W. Gillo, 1974, Correlates of performance in community colleges: The Journal of Higher Education, v. 45, p. 672-681.
Fiol, C. M., and M. A. Lyles, 1985, Organizational learning: Academy of management review, v. 10, p. 803-813.
Fisher, M. L., 1997, What is the right supply chain for your product?: Harvard business review, v. 75, p. 105-117.
Fisher, M. L., J. H. Hammond, W. R. Obermeyer, and A. Raman, 1994, Making supply meet demand in an uncertain world, Graduate School of Business Administration, Harvard University.
Fiske, S. T., 1992, Thinking is for doing: portraits of social cognition from daguerreotype to laserphoto: Journal of personality and social psychology, v. 63, p. 877.
Floyd, S. W., and B. Wooldridge, 1992, Managing strategic consensus: the foundation of effective implementation: The Executive, v. 6, p. 27-39.
Flynn, B. B., B. Huo, and X. Zhao, 2010, The impact of supply chain integration on performance: A contingency and configuration approach: Journal of Operations Management, v. 28, p. 58-71.
Flynn, B. B., S. Sakakibara, R. G. Schroeder, K. A. Bates, and E. J. Flynn, 1990, Empirical research methods in operations management: Journal of Operations Management, v. 9, p. 250-284.
Flynn, B. B., R. G. Schroeder, and S. Sakakibara, 1995, The impact of quality management practices on performance and competitive advantage: Decision Sciences, v. 26, p. 659-691.
Flynn*, B. B., and E. J. Flynn, 2005, Synergies between supply chain management and quality management: emerging implications: International Journal of Production Research, v. 43, p. 3421-3436.
Ford, J. D., and J. W. Slocum, 1977, Size, technology, environment and the structure of organizations: Academy of Management Review, v. 2, p. 561-575.
Forehand, G. A., and G. Von Haller, 1964, Environmental variation in studies of organizational behavior: Psychological bulletin, v. 62, p. 361.
Fornell, C., and D. F. Larcker, 1981, Evaluating structural equation models with unobservable variables and measurement error: Journal of marketing research, v. 18, p. 39-50.
Forza, C., 2002, Survey research in operations management: a process-based perspective: International journal of operations & production management, v. 22, p. 152-194.
Forza, C., F. Salvador, and A. Rungtusanatham, 2005, Coordinating product design, process design, and supply chain design decisions - Part B. Coordinating approaches, tradeoffs, and future research directions: Journal of Operations Management, v. 23, p. 319-324.
Foss, N. J., J. Lyngsie, and S. A. Zahra, 2014, Organizational design correlates of entrepreneurship: The roles of decentralization and formalization for opportunity discovery and realization: Strategic Organization, v. 13, p. 32-60.
Foster, S. T., 2008, Towards an understanding of supply chain quality management: Journal of Operations Management, v. 26, p. 461-467.

Fotopoulos, C. B., and E. L. Psomas, 2009, The impact of “soft” and “hard” TQM elements on quality management results: International Journal of Quality & Reliability Management, v. 26, p. 150-163.
Fredericks, E., 2005, Infusing flexibility into business-to-business firms: A contingency theory and resource-based view perspective and practical implications: Industrial Marketing Management, v. 34, p. 555-565.
Fredrickson, J. W., 1986, The strategic decision process and organizational structure: Academy of management review, v. 11, p. 280-297.
Fredrickson, J. W., and A. L. Iaquinto, 1989, Inertia and creeping rationality in strategic decision processes: Academy of Management Journal, v. 32, p. 516-542.
Fredriksson, P., and L.-E. Gadde, 2005, Flexibility and rigidity in customization and build-to-order production: Industrial Marketing Management, v. 34, p. 695-705.
Fritz, M. S., A. B. Taylor, and D. P. MacKinnon, 2012, Explanation of Two Anomalous Results in Statistical Mediation Analysis: Multivariate Behavioral Research, v. 47, p. 61-87.
Frohlich, M. T., and R. Westbrook, 2001, Arcs of integration: an international study of supply chain strategies: Journal of Operations Management, v. 19, p. 185-200.
Frohlich, M. T., and R. Westbrook, 2002, Demand chain management in manufacturing and services: web-based integration, drivers and performance: Journal of Operations Management, v. 20, p. 729-745.
Fry, L. W., and D. Schellenberg, 1984, Congruence, contingency and theory building: An integrative perspective: Unpublished manuscript, University of Washington, Seattle.
Fry, L. W., and J. W. Slocum, 1984, Technology, structure, and workgroup effectiveness: A test of a contingency model: Academy of Management Journal, v. 27, p. 221-246.
Gadenne, D., and B. Sharma, 2009, An investigation of the hard and soft quality management factors of Australian SMEs and their association with firm performance: International Journal of Quality & Reliability Management, v. 26, p. 865-880.
Galbraith, J. R., 1973, Designing complex organizations, Addison-Wesley Longman Publishing Co., Inc.
Galbraith, J. R., 1977, Organization design: An information processing view: Organizational Effectiveness Center and School, v. 21.
Galbraith, J. R., 1982, Designing the innovating organization: Organizational Dynamics, v. 10, p. 5-25.
Galbraith, J. R., 1994, Competing with flexible lateral organizations, Addison-Wesley Reading, MA.
Galbraith, J. R., and D. A. Nathanson, 1978, Strategy implementation: The role of structure and process, West Publishing Company St. Paul, MN.
Galbraith, J. R., R. K. Kazanjian, 1986, Strategy implementation: Structure, systems, and process: West Publishing Company, St Paul, MN.
Galunic, D. C., K. M. Eisenhardt, 1994, Renewing the strategy-structure-performance paradigm: Research in Organizational Behavior, v. 16, p. 215-55.
Gandz, J., and V. V. Murray, 1980, The experience of workplace politics: Academy of Management Journal, v. 23, p. 237-251.
Garavelli, A. C., 2003, Flexibility configurations for the supply chain management: International Journal of Production Economics, v. 85, p. 141-153.

Garner, S. P., 1976, Evolution of cost accounting to 1925, v. 1, University of Alabama Press.
Georgiou, I., 2013, A BLAST AT THE PAST: AN INQUIRY INTO HERBERT SIMON'S ARGUMENTS AGAINST THE PRINCIPLES: Public Administration, v. 91, p. 1015-1034.
Gerbing, D. W., and J. C. Anderson, 1992, Monte Carlo evaluations of goodness of fit indices for structural equation models: Sociological Methods & Research, v. 21, p. 132-160.
Germain, R., 1996, The role of context and structure in radical and incremental logistics innovation adoption: Journal of Business Research, v. 35, p. 117-127.
Germain, R., C. Claycomb, and C. Droge, 2008, Supply chain variability, organizational structure, and performance: The moderating effect of demand unpredictability: Journal of Operations Management, v. 26, p. 557-570.
Germain, R., C. Dröge, and P. J. Daugherty, 1994, The effect of just-in-time selling on organizational structure: an empirical investigation: Journal of Marketing Research, v. 31, p. 471-483.
Germain, R., and K. N. S. Iyer, 2006, The interaction of internal and downstream integration and its association with performance: Journal of Business Logistics, v. 27, p. 29-52.
Gerwin, D., 1987, An agenda for research on the flexibility of manufacturing processes: International Journal of Operations & Production Management, v. 7, p. 38-49.
Gerwin, D., 1993, Manufacturing flexibility: a strategic perspective: Management science, v. 39, p. 395-410.
Gerwin, D., and H. Kolodny, 1992, Management of advanced manufacturing technology: Strategy, organization, and innovation, Wiley-Interscience.
Gill, J., and P. Johnson, 2010, Research methods for managers, Sage.
Gimenez, C., T. van der Vaart, and D. Pieter van Donk, 2012, Supply chain integration and performance: the moderating effect of supply complexity: International Journal of Operations & Production Management, v. 32, p. 583-610.
Gimenez, C., and E. Ventura, 2005, Logistics-production, logistics-marketing and external integration: their impact on performance: International journal of operations & Production Management, v. 25, p. 20-38.
Globerson, S., 1985, Issues in developing a performance criteria system for an organization: International Journal of production research, v. 23, p. 639-646.
Gold, A. H., and A. H. S. Arvind Malhotra, 2001, Knowledge management: An organizational capabilities perspective: Journal of management information systems, v. 18, p. 185-214.
Godfrey, P. C., and C. W. Hill, 1995, The problem of unobservables in strategic management research: Strategic management journal, v. 16, p. 519-533.
Godfrey, P. C., and C. W. L, Hill, 2000, The Philosophy of Science and the Problem of Unobservables in Strategic Management Research: Public Administration and Public Policy, v. 79, p. 227-248.
Golden, W., and P. Powell, 1999, Exploring inter-organisational systems and flexibility in Ireland: a case of two value chains: International journal of agile management systems, v. 1, p. 169-176.
Goldhaber, G. M., and S. Shaner, 1993, Organizational communication, Brown & Benchmark Madison.
Goles, T., and R. Hirschheim, 2000, The paradigm is dead, the paradigm is dead… long live the paradigm: the legacy of Burrell and Morgan: Omega, v. 28, p. 249-268.

Gordon, L. A., and V. K. Narayanan, 1984, Management accounting systems, perceived environmental uncertainty and organization structure: an empirical investigation: Accounting, Organizations and Society, v. 9, p. 33-47.
Gosain, S., A. Malhotra, and O. A. El Sawy, 2004, Coordinating for flexibility in e-business supply chains: Journal of Management Information Systems, v. 21, p. 7-45.
Gouldner, A. W., 1954, Patterns of industrial bureaucracy.
Graham, T. S., P. J. Daugherty, and W. N. Dudley, 1994, The Long-Term Strategic Impact of Purchasing Partnerships: International Journal of Purchasing and Materials Management, v. 30, p. 12-13.
Grant, R. M., 1996, Toward a knowledge-based theory of the firm: Strategic Management Journal, v. 17, p. 109-122.
Graves, S. C., and B. T. Tomlin, 2003, Process flexibility in supply chains: Management Science, v. 49, p. 907-919.
Green, S. G., W. Blank, and R. C. Liden, 1983, Market and organizational influences on bank employees' work attitudes and behaviors: Journal of Applied Psychology, v. 68, p. 298.
Grinyer, P. H., and M. Yasai-Ardekani, 1981, Strategy, structure, size and bureaucracy: Academy of Management journal, v. 24, p. 471-486.
Grinyer, P. H., M. Yasai-Ardekani, and S. Al-Bazzaz, 1980, Strategy, structure, the environment, and financial performance in 48 United Kingdom companies: Academy of Management Journal, v. 23, p. 193-220.
Gross, E., 1953, Some functional consequences of primary controls in formal work organizations: American Sociological Review, v. 18, p. 368-373.
Guba, E. G., and Y. S. Lincoln, 1994, Competing paradigms in qualitative research: Handbook of qualitative research, v. 2.
Gulati, R., 1998, Alliances and networks: Strategic management journal, v. 19, p. 293-317.
Gulick, L., 1937. Notes on the Theory of Organization. In papers on the Science Administration, edited by Luther Gulick and Lanydall Urwick, 191-95. New York: Institute of Public Administration, Colombia University.
Gunasekaran, A., and R. E. McGaughey, 2003, TQM is suppy chain management: The TQM Magazine, v. 15, p. 361-363.
Gunasekaran, A., C. Patel, and R. E. McGaughey, 2004, A framework for supply chain performance measurement: International Journal of Production Economics, v. 87, p. 333-347.
Gunasekaran, A., C. Patel, and E. Tirtiroglu, 2001, Performance measures and metrics in a supply chain environment: International Journal of Operations & Production Management, v. 21, p. 71-87.
Gunasekaran, A., H. J. Williams, and R. E. McGaughey, 2005, Performance measurement and costing system in new enterprise: Technovation, v. 25, p. 523-533.
Göritz, A. S., and R. Crutzen, 2012, Reminders in Web-Based Data Collection Increasing Response at the Price of Retention?: American Journal of Evaluation, v. 33, p. 240-250.
Hackman, J. R., and E. E. Lawler, 1971, Employee reactions to job characteristics: Journal of applied psychology, v. 55, p. 259.
Hage, J., 1980, Theories of organizations: Form, process, and transformation, John Wiley & Sons.
Hage, J., and M. Aiken, 1967a, Program change and organizational properties a comparative analysis: American Journal of Sociology, v. 72, p. 503-519.

Hage, J., and M. Aiken, 1967b, Relationship of centralization to other structural properties: Administrative Science Quarterly, v. 12, p. 72-92.
Hage, J., and M. Aiken, 1969, Routine technology, social structure, and organization goals: Administrative science quarterly, v. 14, p. 366-376.
Hage, J., M. Aiken, and C. B. Marrett, 1971, Organization structure and communications: American Sociological Review, v. 36, p. 860-871.
Hage, J., and R. Dewar, 1973, Elite values versus organizational structure in predicting innovation: Administrative science quarterly, v. 18, p. 279-290.
Hair, J. F., W. C. Black, B. J. Babin, R. E. Anderson, and R. L. Tatham, 2006, Multivariate data analysis, v. 6, Pearson Prentice Hall Upper Saddle River, NJ.
Hair, J. F., C. M. Ringle, and M. Sarstedt, 2011, PLS-SEM: Indeed a silver bullet: The Journal of Marketing Theory and Practice, v. 19, p. 139-152.
Hall, R. H., 1962, Intraorganizational structural variation: application of the bureaucratic model: Administrative Science Quarterly, v. 7, p. 295-308.
Hall, R. H., 1963, The concept of bureaucracy: An empirical assessment: American Journal of Sociology, v. 63, p. 32-40.
Hall, R. H., 1996, Organizations: structures, processes, and outcomes.
Hall, R. H., N. J. Johnson, and J. E. Haas, 1967, Organizational size, complexity, and formalization: American Sociological Review, v. 32, p. 903-912.
Hambrick, D. C., 2007, The field of management's devotion to theory: Too much of a good thing?: Academy of Management Journal, v. 50, p. 1346-1352.
Hamilton, J. D., 1996, This is what happened to the oil price-macroeconomy relationship: Journal of Monetary Economics, v. 38, p. 215-220.
Hammond, T. H., 1990, In defense of Gulick,Luther notes on the theory of organization: Public Administration, v. 68, p. 143-173.
Handfield, R., K. Petersen, P. Cousins, and B. Lawson, 2009, An organizational entrepreneurship model of supply management integration and performance outcomes: International Journal of Operations & Production Management, v. 29, p. 100-126.
Hariga, M. A., 2000, Setup cost reduction in (Q, r) policy with lot size, setup time and lead-time interactions: Journal of the Operational Research Society, v. 51, p. 1340-1345.
Harland, C. M., N. D. Caldwell, P. Powell, and J. Zheng, 2007, Barriers to supply chain information integration: SMEs adrift of eLands: Journal of Operations Management, v. 25, p. 1234-1254.
Harland, C. M., R. C. Lamming, and P. D. Cousins, 1999, Developing the concept of supply strategy: International Journal of Operations & Production Management, v. 19, p. 650-674.
Harrison, F., 1974, The management of scientists: Determinants of perceived role performance: Academy of Management Journal, v. 17, p. 234-241.
Harzing, A.W. 2007, “Publish or Perish”, available from http://www.harzing.com/pop.htm
Hayes, A. F., and K. J. Preacher, 2013, Statistical mediation analysis with a multicategorical independent variable: British Journal of Mathematical and Statistical Psychology.
He, Y., and K. K. Lai, 2012, Supply chain integration and service oriented transformation: Evidence from Chinese equipment manufacturers: International Journal of Production Economics, v. 135, p. 791-799.

He, Y., K. K. Lai, H. Sun, and Y. Chen, 2014, The impact of supplier integration on customer integration and new product performance: The mediating role of manufacturing flexibility under trust theory: International Journal of Production Economics, v. 147, p. 260-270.
Hellsten, U., and B. Klefsjö, 2000, TQM as a management system consisting of values, techniques and tools: The TQM magazine, v. 12, p. 238-244.
Hempel, P. S., Z.X. Zhang, and Y. Han, 2012, Team empowerment and the organizational context decentralization and the contrasting effects of formalization: Journal of Management, v. 38, p. 475-501.
Hendricks, K. B., and V. R. Singhal, 1997, Does implementing an effective TQM program actually improve operating performance? Empirical evidence from firms that have won quality awards: Management science, v. 43, p. 1258-1274.
Heras-Saizarbitoria, I., and O. Boiral, 2013, ISO 9001 and ISO 14001: Towards a research agenda on management system standards*: International Journal of Management Reviews, v. 15, p. 47-65.
Herbert, S., 1976, Administrative behavior: The Macmfllan Company, New York.
Herbst, P. G., 1957, Measurement of behaviour structures by means of input-output data: Human Relations, v. 10, p. 335-346.
Hervani, A. A., M. M. Helms, and J. Sarkis, 2005, Performance measurement for green supply chain management: Benchmarking: An International Journal, v. 12, p. 330-353.
Hickson, D. J., D. S. Pugh, and D. C. Pheysey, 1969, Operations technology and organization structure: An empirical reappraisal: Administrative science quarterly, v. 14, p. 378-397.
Hieber, R., 2002, Supply chain management: a collaborative performance measurement approach, v. 12, vdf Hochschulverlag AG.
Hinings, C. R., and G. L. Lee, 1971, Dimensions of organization structure and their context: a replication: Sociology, v. 5, p. 83-93.
Hirsch, J. E., 2005, An index to quantify an individual's scientific research output: Proceedings of the National academy of Sciences of the United States of America, v. 102, p. 16569-16572.
Hirst, G., D. V. Knippenberg, C. H. Chen, and C. A. Sacramento, 2011, How does bureaucracy impact individual creativity? A cross-level investigation of team contextual influences on goal orientation–creativity relationships: Academy of Management Journal, v. 54, p. 624-641.
Ho, D. C. K., V. G. Duffy, and H. M. Shih, 2001, Total quality management: an empirical test for mediation effect: International Journal of Production Research, v. 39, p. 529-548.
Hofer, C. W., 1975, Toward a contingency theory of business strategy: Academy of Management Journal, v. 18, p. 784-810.
Holdaway, E. A., J. F. Newberry, D. J. Hickson, and R. P. Heron, 1975, Dimensions of organizations in complex societies: The educational sector: Administrative Science Quarterly, v. 20, p. 37-58.
Hoskisson, R. E., L. Eden, C. M. Lau, and M. Wright, 2000, Strategy in emerging economies: Academy of management journal, v. 43, p. 249-267.
Howes, J. C., M. Citera, and R. S. Cropanzano, 1995, Total quality teams: how organizational politics and support impact the effectiveness of quality improvement teams, Organizational politics, justice, and support: Managing the social climate of the workplace.

Hoyle, R. H., 1995, Structural equation modeling: Concepts, issues, and applications, Sage Publications.
Hrebiniak, L. G., 1974, Job technology, supervision, and work-group structure: Administrative Science Quarterly, v. 19, p. 395-410.
Hrebiniak, L. G., and J. A. Alutto, 1973, A comparative organizational study of performance and size correlates in impatient psychiatric departments: Administrative Science Quarterly, v. 18, p. 365-382.
Hrebiniak, L. G., and C. C. Snow, 1980, Research notes: Industry differences in environmental uncertainty and organizational characteristics related to uncertainty: Academy of Management Journal, v. 23, p. 750-759.
Hu, L. t., and P. M. Bentler, 1999, Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives: Structural Equation Modeling: A Multidisciplinary Journal, v. 6, p. 1-55.
Huang, M.-C., G.-F. Yen, and T.-C. Liu, 2014, Reexamining supply chain integration and the supplier's performance relationships under uncertainty: Supply Chain Management: An International Journal, v. 19, p. 64-78.
Huang, S. H., S. K. Sheoran, and G. Wang, 2004, A review and analysis of supply chain operations reference (SCOR) model: Supply Chain Management: An International Journal, v. 9, p. 23-29.
Huang, X., M. M. Kristal, and R. G. Schroeder, 2010, The Impact of Organizational Structure on Mass Customization Capability: A Contingency View: Production and Operations Management, v. 19, p. 515-530.
Huber, G. P., M. J. O'Connell, and L. L. Cummings, 1975, Perceived environmental uncertainty: Effects of information and structure: Academy of Management Journal, v. 18, p. 725-740.
Hulin, C. L., and M. R. Blood, 1968, Job enlargement, individual differences, and worker responses: Psychological Bulletin, v. 69, p. 41.
Hull, F., and J. Hage, 1982, Organizing for innovation: Beyond Burns and Stalker's organic type: Sociology, v. 16, p. 564-577.
Huo, B., 2012, The impact of supply chain integration on company performance: an organizational capability perspective: Supply Chain Management: An International Journal, v. 17, p. 596-610.
Huq, Z., and J. D. Stolen, 1998, Total quality management contrasts in manufacturing and service industries: International Journal of Quality & Reliability Management, v. 15, p. 138-161.
Iacobucci, D., 2009, Everything you always wanted to know about SEM (structural equations modeling) but were afraid to ask: Journal of Consumer Psychology, v. 19, p. 673-680.
IEA, 2014. Key World Energy Statistics" (PDF) [online] Avaliable from http://www.iea.org/publications/freepublications/. pp. 6,24,28. Archived from the [Accessed 09 January 2015].
Ikram, A., 2004, Supply chain management in the oil and gas sector: Supply Chain Update.
Indik, B. P., 1963, Some effects of organization size on member attitudes and behavior: Human Relations.
Inkson, J. H. K., D. S. Pugh, and D. J. Hickson, 1970a, Organization context and structure: An abbreviated replication: Administrative Science Quarterly, v. 15, p. 318-329.

Inkson, J. H. K., J. P. Schwitter, D. C. Pheysey, and D. J. Hickson, 1970b, A comparison of organization structure and managerial roles: Ohio, USA, and the Midlands, England: Journal of Management Studies, v. 7, p. 347-363.
Isenberg, D. J., 1986, Thinking and managing: A verbal protocol analysis of managerial problem solving: Academy of management Journal, v. 29, p. 775-788.
ISO 15663-2:, 2001, Petroleum and natural gas industries -- Life-cycle costing -- Part 2: Guidance on application of methodology and calculation methods. [ONLINE] Available at: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=28626. [Last Accessed 13 June 2013]
Ivancevich, J. M., and J. H. Donnelly Jr, 1975, Relation of organizational structure to job satisfaction, anxiety-stress, and performance: Administrative science quarterly, v. 20, p. 272-280.
Jablin, F. M., and K. J. Krone, 1985, Task/work relationships: A life-span perspective: Handbook of interpersonal communication, v. 2, p. 621-675.
Jack, E. P., and A. Raturi, 2002, Sources of volume flexibility and their impact on performance: Journal of operations management, v. 20, p. 519-548.
Jacobides, M. G., 2007, The inherent limits of organizational structure and the unfulfilled role of hierarchy: Lessons from a near-war: Organization Science, v. 18, p. 455-477.
James, L. R., and A. P. Jones, 1976, Organizational structure: A review of structural dimensions and their conceptual relationships with individual attitudes and behavior: Organizational behavior and human performance, v. 16, p. 74-113.
Jansen, J. J., Z. Simsek, and Q. Cao, 2012, Ambidexterity and performance in multiunit contexts: Cross-level moderating effects of structural and resource attributes: Strategic Management Journal, v. 33, p. 1286-1303.
Jauch, L. R., and K. L. Kraft, 1986, Strategic management of uncertainty: Academy of management review, v. 11, p. 777-790.
Jaworski, B. J., 1988, Toward a theory of marketing control: environmental context, control types, and consequences: The Journal of Marketing, v. 52, p. 23-39.
Jaworski, B. J., and A. K. Kohli, 1993, Market orientation: antecedents and consequences: The Journal of marketing, v. 57, p. 53-70.
Jayaram, J., K.-C. Tan, and S. P. Nachiappan, 2010, Examining the interrelationships between supply chain integration scope and supply chain management efforts: International Journal of Production Research, v. 48, p. 6837-6857.
Jayaram, J., S. K. Vickery, and C. Droge, 1999, An empirical study of time-based competition in the North American automotive supplier industry: International Journal of Operations & Production Management, v. 19, p. 1010-1034.
Jeans, M., and M. Morrow, 1989, The practicalities of using activity-based costing: Management Accounting, v. 67, p. 42-44.
Jemison, D. B., 1981, Organizational versus environmental sources of influence in strategic decision making: Strategic Management Journal, v. 2, p. 77-89.
Jenkins, G. P., and D. S. Wright, 1998, Managing inflexible supply chains: The International Journal of Logistics Management, v. 9, p. 83-90.
Ji, J., and P. Dimitratos, 2013, An empirical investigation into international entry mode decision-making effectiveness: International Business Review, v. 22, p. 994-1007.
Jin, Y. H., A. M. Fawcett, and S. E. Fawcett, 2013, Awareness is not enough Commitment and performance implications of supply chain integration: International Journal of Physical Distribution & Logistics Management, v. 43, p. 205-230.

John, G., 1984, An empirical investigation of some antecedents of opportunism in a marketing channel: Journal of marketing Research, v. 21, p. 278-289.
John, G., and J. Martin, 1984, Effects of organizational structure of marketing planning on credibility and utilization of plan output: Journal of Marketing Research, v. 21, p. 170-183.
Johnson, H. T., 1972, Early cost accounting for internal management control: Lyman Mills in the 1850's: Business History Review, v. 46, p. 466-474.
Johnson, H. T., 1981, Toward a new understanding of nineteenth-century cost accounting: Accounting Review, v. 56, p. 510-518.
Johnson, H. T., 1983, The search for gain in markets and firms: a review of the historical emergence of management accounting systems: Accounting, Organizations and Society, v. 8, p. 139-146.
Johnson, H. T., 1991, Relevance lost: the rise and fall of management accounting, Harvard Business Press.
Johnson, R. B., and A. J. Onwuegbuzie, 2004, Mixed methods research: A research paradigm whose time has come: Educational researcher, v. 33, p. 14-26.
Johnson, T. H., 1978, Management accounting in an early multidivisional organization: General Motors in the 1920s: Business History Review, v. 52, p. 490-517.
José Tarí, J., 2005, Components of successful total quality management: The TQM magazine, v. 17, p. 182-194.
Jung, D. I., and B. J. Avolio, 1999, Effects of leadership style and followers' cultural orientation on performance in group and individual task conditions: Academy of Management Journal, v. 42, p. 208-218.
Jung, J. Y., and Y. J. Wang, 2006, Relationship between total quality management (TQM) and continuous improvement of international project management (CIIPM): Technovation, v. 26, p. 716-722.
Juran, J. M., 1988, Juran on planning for quality, Free Press New York, NY.
Kacmar, K. M., D. P. Bozeman, D. S. Carlson, and W. P. Anthony, 1999, An examination of the perceptions of organizational politics model: Replication and extension: Human Relations, v. 52, p. 383-416.
Kahn, R. L., D. M. Wolfe, R. P. Quinn, J. D. Snoek, and R. A. Rosenthal, 1964, Organizational stress: Studies in role conflict and ambiguity, Oxford, England: John Wiley.
Kaiser, H. F., 1974, An index of factorial simplicity: Psychometrika, v. 39, p. 31-36.
Kanji, G. K., and W. Wallace, 2000, Business excellence through customer satisfaction: Total Quality Management, v. 11, p. 979-998.
Kannan, V. R., and K. C. Tan, 2010, Supply chain integration: cluster analysis of the impact of span of integration: Supply Chain Management-an International Journal, v. 15, p. 207-215.
Kaplan, R. S., 1990, Measures for manufacturing excellence: Harvard Business School Press, Boston, MA.
Kaplan, R. S., 1988, One cost system isn't enough, Harvard Business Review.
Kaplan, R. S., and D. P. Norton, 1995, Putting the balanced scorecard to work: Performance measurement, management, and appraisal sourcebook, v. 66.
Karmel, B., and D. M. Egan, 1976, Managerial performance: A new look at underlying dimensionality: Organizational Behavior and Human Performance, v. 15, p. 322-334.
Katzell, R. A., R. S. Barrett, and T. C. Parker, 1961, Job satisfaction, job performance, and situational characteristics: Journal of Applied Psychology, v. 45, p. 65.

Kaynak, H., 2003, The relationship between total quality management practices and their effects on firm performance: Journal of operations management, v. 21, p. 405-435.
Keegan, D. P., R. G. Eiler, and C. R. Jones, 1989, Are your performance measures obsolete: Management accounting, v. 70, p. 45-50.
Kelley, S. W., T. Longfellow, and J. Malehorn, 1996, Organizational determinants of service employees' exercise of routine, creative, and deviant discretion: Journal of Retailing, v. 72, p. 135-157.
Kennedy, A. M., 1983, The adoption and diffusion of new industrial products: a literature review: European Journal of Marketing, v. 17, p. 31-88.
Khamalah, J. N., and B. P. Lingaraj, 2007, TQM in the service sector: a survey of small businesses: Total quality management, v. 18, p. 973-982.
Khandwalla, P. N., 1973, Effect of competition on the structure of top management control: Academy of Management Journal, v. 16, p. 285-295.
Khandwalla, P. N., 1974, Mass output orientation of operations technology and organizational structure: Administrative Science Quarterly, v. 19, p. 74-97.
Khandwalla, P. N., 1977, The design of organizations.
Kilduff, M., 2006, Editor's comments: Publishing theory: Academy of Management Review, v. 31, p. 252-255.
Kim, D.-Y., 2013, Relationship between supply chain integration and performance: Operations Management Research, v. 6, p. 74-90.
Kim, D. Y., V. Kumar, and U. Kumar, 2012, Relationship between quality management practices and innovation: Journal of Operations Management, v. 30, p. 295-315.
Kim, J. S., and Miller, J. G. 1992. Building the value factory: a progress report for US manufacturing. Boston University Manufacturing Roundtable.
Kim, J. S., and W. C. Benton, 1995, Lot size dependent lead times in a Q, R inventory system: The International Journal of Production Research, v. 33, p. 41-58.
Kim, S. W., 2006, Effects of supply chain management practices, integration and competition capability on performance: Supply Chain Management: An International Journal, v. 11, p. 241-248.
Kim, S. W., 2009, An investigation on the direct and indirect effect of supply chain integration on firm performance: International Journal of Production Economics, v. 119, p. 328-346.
Kimberly, J. R., 1976, Organizational size and the structuralist perspective: A review, critique, and proposal: Administrative Science Quarterly, v. 21, p. 571-597.
Kish, L., 1965, Survey sampling: Oxford, England, Wiley.
Klatzky, S. R., 1970, Relationship of organizational size to complexity and coordination: Administrative Science Quarterly, v. 15, p. 428-438.
Klauss, R., 1982, Interpersonal communication in organizations, Academic Press.
Kline, R. B., 2005, Principles and Practice of Structural Equation Modeling. 2005: New York, NY: Guilford.
Kocaoğlu, B., B. Gülsün, and M. Tanyaş, 2013, A SCOR based approach for measuring a benchmarkable supply chain performance: Journal of Intelligent Manufacturing, v. 24, p. 113-132.
Koh, S. C., S. Saad, and S. Arunachalam, 2006, Competing in the 21st century supply chain through supply chain management and enterprise resource planning integration: International Journal of Physical Distribution & Logistics Management, v. 36, p. 455-465.

Koh, S. C. L., M. Demirbag, E. Bayraktar, E. Tatoglu, and S. Zaim, 2007, The impact of supply chain management practices on performance of SMEs: Industrial Management & Data Systems, v. 107, p. 103-124.

Kornhauser, W., and W. O. Hagstrom, 1962, Scientists in industry: Conflict and accommodation, v. 1, University of California Press Berkeley.

Kostova, T., and K. Roth, 2003, Social capital in multinational corporations and a micro-macro model of its formation: Academy of Management Review, v. 28, p. 297-317.

Koufteros, X., S. K. Vickery, and C. Dröge, 2012, The effects of strategic supplier selection on buyer competitive performance in matched domains: does supplier integration mediate the relationships?: Journal of Supply Chain Management, v. 48, p. 93-115.

Koufteros, X., M. Vonderembse, and J. Jayaram, 2005, Internal and external integration for product development: the contingency effects of uncertainty, equivocality, and platform strategy: Decision Sciences, v. 36, p. 97-133.

Koufteros, X. A., T. C. E. Cheng, and K.-H. Lai, 2007a, "Black-box" and "gray-box" supplier integration in product development: Antecedents, consequences and the moderating role of firm size: Journal of Operations Management, v. 25, p. 847-870.

Koufteros, X. A., A. Y. Nahm, T. C. E. Cheng, and K.-h. Lai, 2007b, An empirical assessment of a nomological network of organizational design constructs: From culture to structure to pull production to performance: International Journal of Production Economics, v. 106, p. 468-492.

Koufteros, X. A., G. E. Rawski, and R. Rupak, 2010, Organizational integration for product development: the effects on glitches, on-time execution of engineering change orders, and market success: Decision Sciences, v. 41, p. 49-80.

Koufteros, X. A., and M. A. Vonderembse, 1998, The impact of organizational structure on the level of JIT attainment: towards theory development: International Journal of Production Research, v. 36, p. 2863-2878.

Krajewski, L., J. C. Wei, and L.-L. Tang, 2005, Responding to schedule changes in build-to-order supply chains: Journal of Operations Management, v. 23, p. 452-469.

Kuei, C.-H., C. N. Madu, and C. Lin, 2001, The relationship between supply chain quality management practices and organizational performance: International Journal of Quality & Reliability Management, v. 18, p. 864-872.

Kumar, V., K. A. Fantazy, U. Kumar, and T. A. Boyle, 2006, Implementation and management framework for supply chain flexibility: Journal of Enterprise Information Management, v. 19, p. 303-319.

Lai, K.-h., C. W. Y. Wong, and Y. H. V. Lun, 2014, The role of customer integration in extended producer responsibility: A study of Chinese export manufacturers: International Journal of Production Economics, v. 147, p. 284-293.

Lakhal, L., F. Pasin, and M. Limam, 2006, Quality management practices and their impact on performance: International Journal of Quality & Reliability Management, v. 23, p. 625-646.

Lambert, D. M., and M. C. Cooper, 2000, Issues in supply chain management: Industrial Marketing Management, v. 29, p. 65-83.

Lambert, D. M., S. J. García-Dastugue, and K. L. Croxton, 2005, An evaluation of process-oriented supply chain management frameworks: Journal of business Logistics, v. 26, p. 25-51.

Lau, A. K. W., R. C. M. Yam, and E. P. Y. Tang, 2010, Supply chain integration and product modularity An empirical study of product performance for selected Hong Kong manufacturing industries: International Journal of Operations & Production Management, v. 30, p. 20-56.

Lau, R. S. M., 1996, Strategic flexibility: a new reality for world-class manufacturing: SAM Advanced Management Journal, v. 61, p. 11-15.

Lawrence, P. R., and J. W. Lorsch, 1967, Differentiation and integration in complex organizations: Administrative science quarterly, v. 12, p. 1-47.

Lawrence, P. R., J. W. Lorsch, and J. S. Garrison, 1967, Organization and environment: Managing differentiation and integration, Division of Research, Graduate School of Business Administration, Harvard University Boston, MA.

Lee, C. C., and V. Grover, 1999, Exploring mediation between environmental and structural attributes: The penetration of communication technologies in manufacturing organizations: Journal of Management Information Systems, v. 16, p. 187-217.

Lee, C. W., I.-W. G. Kwon, and D. Severance, 2007, Relationship between supply chain performance and degree of linkage among supplier, internal integration, and customer: Supply Chain Management-an International Journal, v. 12, p. 444-452.

Lee, H. L., and C. Billington, 1993, Material management in decentralized supply chains: Operations research, v. 41, p. 835-847.

Lee, H. L., and E. Feitzinger, 1995, Product configuration and postponement for supply chain efficiency, v. 4, p. 43-48.

Leifer, R., and G. P. Huber, 1977, Relations among perceived environmental uncertainty, organization structure, and boundary-spanning behavior: Administrative science quarterly, v. 22, p. 235-247.

Leuschner, R., D. S. Rogers, and F. F. Charvet, 2013, A Meta-Analysis of Supply Chain Integration and Firm Performance: Journal of Supply Chain Management, v. 49, p. 34-57.

Lewis, W. G., K. F. Pun, and T. R. M. Lalla, 2006, Exploring soft versus hard factors for TQM implementation in small and medium-sized enterprises: International Journal of Productivity and Performance Management, v. 55, p. 539-554.

Li, G., H. Yang, L. Sun, and A. S. Sohal, 2009, The impact of IT implementation on supply chain integration and performance: International Journal of Production Economics, v. 120, p. 125-138.

Li, S., S. S. Rao, T. S. Ragu-Nathan, and B. Ragu-Nathan, 2005, Development and validation of a measurement instrument for studying supply chain management practices: Journal of Operations Management, v. 23, p. 618-641.

Liao, C., S.-H. Chuang, and P.-L. To, 2011, How knowledge management mediates the relationship between environment and organizational structure: Journal of Business Research, v. 64, p. 728-736.

Liao, C.-J., and C.-H. Shyu, 1991, An analytical determination of lead time with normal demand: International Journal of Operations & Production Management, v. 11, p. 72-78.

Liu, H., Ke, W., Wei, K. K. & Hua, Z. 2013. Effects of supply chain integration and market orientation on firm performance: Evidence from China. International Journal of Operations and Production Management, v. 33, p. 322-346.

Liker, J. K., and T. Y. Choi, 2004, Building deep supplier relationships: Harvard business review, v. 82, p. 104-113.

Lin, X. H., and R. Germain, 2003, Organizational structure, context, customer orientation, and performance: Lessons from Chinese state-owned enterprises: Strategic Management Journal, v. 24, p. 1131-1151.
Linderman, K., R. G. Schroeder, S. Zaheer, C. Liedtke, and A. S. Choo, 2004, Integrating quality management practices with knowledge creation processes: Journal of Operations Management, v. 22, p. 589-607.
Liu, G., R. Shah, and R. G. Schroeder, 2012, The relationships among functional integration, mass customisation, and firm performance: International Journal of Production Research, v. 50, p. 677-690.
Liu, G. J., R. Shah, and R. G. Schroeder, 2006, Linking Work Design to Mass Customization: A Sociotechnical Systems Perspective*: Decision Sciences, v. 37, p. 519-545.
Lockamy, A., and K. McCormack, 2004, Linking SCOR planning practices to supply chain performance - An exploratory study: International Journal of Operations & Production Management, v. 24, p. 1192-1218.
Locke, E. A., and G. P. Latham, 1990, A theory of goal setting & task performance, Prentice-Hall, Inc.
Lockstrom, M., J. Schadel, N. Harrison, R. Moser, and M. K. Malhotra, 2010, Antecedents to supplier integration in the automotive industry: A multiple-case study of foreign subsidiaries in China: Journal of Operations Management, v. 28, p. 240-256.
Longwell, H. J., 2002, The future of the oil and gas industry: past approaches, new challenges: World Energy, v. 5, p. 100-104.
Lovie, A. D., and P. Lovie, 1986, The flat maximum effect and linear scoring models for prediction: Journal of Forecasting, v. 5,p. 159.
Lubatkin, M., and R. C. Rogers, 1989, Diversification, systematic risk, and shareholder return: A capital market extension of Rumelt's 1974 study: Academy of Management Journal, v. 32, p. 454-65.
Luft, Gal., 2004, U.S., China Are on Collision Course Over Oil. [online] Available from: http://articles.latimes.com/2004/feb/02/opinion/oe-luft2 [Accessed 09/05/2012].
Luke, R. A., P. Block, J. M. Davey, and V. R. Averch, 1973, A structural approach to organizational change: The Journal of applied behavioral science, v. 9, p. 611-635.
Lummus, R. R., L. K. Duclos, and R. J. Vokurka, 2003, Supply chain flexibility: building a new model: Global Journal of Flexible Systems Management, v. 4, p. 1-13.
Lysonski, S., M. Levas, and N. Lavenka, 1995, Environmental uncertainty and organizational structure: a product management perspective: Journal of Product & Brand Management, v. 4, p. 7-18.
MacDuffie, J. P., 1995, Human resource bundles and manufacturing performance: Organizational logic and flexible production systems in the world auto industry: Industrial & labor relations review, v. 48, p. 197-221.
MacLeod, L., J. JoScriven, and F. S. Wayne, 1992, Gender and management level differences in the oral communication patterns of bank managers: Journal of Business Communication, v. 29, p. 343-365.
Madison, D. L., R. W. Allen, L. W. Porter, P. A. Renwick, and B. T. Mayes, 1980, Organizational politics: An exploration of managers' perceptions: Human Relations, v. 33, p. 79-100.

Mahmoudi, H., and G. A. Miller, 1985, A causal model of hospital structure: Group & Organization Management, v. 10, p. 209-223.
Mahoney, T. A., P. Frost, N. F. Crandall, and W. Weitzel, 1972, The conditioning influence of organization size upon managerial practice: Organizational behavior and human performance, v. 8, p. 230-241.
Maloni, M. J., and W. C. Benton, 1997, Supply chain partnerships: opportunities for operations research: European Journal of Operational Research, v. 101, p. 419-429.
Manz, C. C., and H. P. Sims, 1990, Super-leadership, Berkley Publishing Group.
Marquis, C., and M. Lee, 2013, Who is governing whom? Executives, governance, and the structure of generosity in large US firms: Strategic Management Journal, v. 34, p. 483-497.
Maruyama, G. M., 1998, Basics of structural equation modeling.
Mason-Jones, R., and D. R. Towill, 1999, Total cycle time compression and the agile supply chain: International journal of production economics, v. 62, p. 61-73.
McCarthy-Byrne, T. M., and J. T. Mentzer, 2011, Integrating supply chain infrastructure and process to create joint value: International Journal of Physical Distribution & Logistics Management, v. 41, p. 135-161.
McGrath, J. E., 1981, Dilemmatics: The Study of Research Choices and Dilemmas: American Behavioral Scientist, v. 25, p. 179-210.
McIntosh, R. I., S. J. Culley, A. R. Mileham, and G. W. Owen, 2000, A critical evaluation of Shingo's' SMED'(Single Minute Exchange of Die) methodology: International Journal of Production Research, v. 38, p. 2377-2395.
McKelvey, B., 1975, Guidelines for the empirical classification of organizations: Administrative Science Quarterly, v. 20, p. 509-525.
McMahon, J. T., 1976, Participative and Power-Equalized Organizational Systems An Empirical Investigation and Theoretical Integration: Human relations, v. 29, p. 203-214.
McMahon, J. T., and J. M. Ivancevich, 1976, A study of control in a manufacturing organization: Managers and nonmanagers: Administrative Science Quarterly, p. 66-83.
McMahon, J. T., and G. W. Perritt, 1971, An Empirical Test of Three Organizational Control Hypotheses, p. 240-249.
McQuitty, S., 2004, Statistical power and structural equation models in business research: Journal of Business Research, v. 57, p. 175-183.
Meier, K. J., and J. Bohte, 2000, Ode to Luther Gulick - Span of control and organizational performance: Administration & Society, v. 32, p. 115-137.
Mentzer, J. T., W. DeWitt, J. S. Keebler, S. Min, N. W. Nix, C. D. Smith, and Z. G. Zacharia, 2001, Defining supply chain management: Journal of Business logistics, v. 22, p. 1-25.
Mentzer, J.T., 2001, Supply chain management: Sage, Thousand Oaks, CA.
Meredith, J. R., A. Raturi, K. Amoako-Gyampah, and B. Kaplan, 1989, Alternative research paradigms in operations: Journal of Operations Management, v. 8, p. 297-326.
Meyer, A. D., 1982, How ideologies supplant formal structures and shape responses to environments: Journal of Management Studies, v. 19, p. 45-61.
Meyer, M. W., 1968a, Automation and bureaucratic structure: American Journal of Sociology, v. 74, p. 256-264.
Meyer, M. W., 1968b, The Two Authority Structures of Bureaucratic Organizatino: Administrative Science Quarterly, v. 13, p. 211-228.

Meyer, M. W., 1971, Some constraints in analyzing data on organizational structures: A comment on Blau's paper: American Sociological Review, v. 36, p. 294-297.
Meyer, M. W., 1972, Size and the structure of organizations: A causal analysis: American Sociological Review, v. 37, p. 434-440.
Miles, R. E., C. C. Snow, A. D. Meyer, and H. J. Coleman, 1978, Organizational strategy, structure, and process: Academy of management review, v. 3, p. 546-562.
Miles, R. E., C. C. Snow, and J. Pfeffer, 1974, Organization-environment: concepts and issues: Industrial Relations: A Journal of Economy and Society, v. 13, p. 244-264.
Miller, C. C., W. H. Glick, and G. P. Huber, 1991, Understanding technology-structure relationships: Theory development and meta-analytic theory testing: Academy of Management Journal, v. 34, p. 370-399.
Miller, D., 1981, Toward a new contingency approach: The search for organizational gestalts: Journal of management studies, v. 18, p. 1-26.
Miller, D., 1996, Configurations revisited: Strategic management journal, v. 17, p. 505-512.
Miller, D., 1988, Relating Porter’s business strategies to environment and structure: Analysis and performance implications: Academy of Management Journal, v. 31, p. 280-308.
Miller, D., and C. Dröge, 1986, Psychological and traditional determinants of structure: Administrative science quarterly, v. 31, p. 539-560.
Miller, D., C. Dröge, and J.-M. Toulouse, 1988, Strategic process and content as mediators between organizational context and structure: Academy of Management Journal, v. 31, p. 544-569.
Miller, G. A., 1967, Professionals in bureaucracy: Alienation among industrial scientists and engineers: American Sociological Review, v. 32, p. 755-768.
Miller, J. G., and T. E. Vollmann, 1985, The hidden factory: Harvard business review, v. 63, p. 142-150.
Miller, R.-E., 1971, Innovation, organization and environment: a study of sixteen American and West European steel firms, Institut de recherche et de perfectionnement en administration.
Milner, J. M., and P. Kouvelis, 2005, Order quantity and timing flexibility in supply chains: The role of demand characteristics: Management Science, v. 51, p. 970-985.
Miner, J. B., 1982, Theories of organizational structure and process, Dryden Press.
Mingers, J., 2004, Real-izing information systems: critical realism as an underpinning philosophy for information systems: Information and organization, v. 14, p. 87-103.
Mintzberg, H., 1973, Strategy-Making in Three Modes: California management review, v. 16, p. pp. 44-58.
Mintzberg, H., 1979, The structuring of organization: A synthesis of the research, Prentice-Hall.
Mintzberg, H., 1983, Structure in fives: Designing effective organizations Prentice-Hall: Englewood Cliffs, NJ.
Mitchell, J., V. Marcel, and B. Mitchell, 2012, What next for the oil and gas industry?, Royal Institute of International Affairs.
Moch, M. K., 1976, Structure and organizational resource allocation: Administrative Science Quarterly, v. 21, p. 661-674.
Moch, M. K., and E. V. Morse, 1977, Size, centralization and organizational adoption of innovations: American Sociological Review, v. 42, p. 716-725.

Moenaert, R. K., W. E. Souder, A. D. Meyer, and D. Deschoolmeester, 1994, R&D–marketing integration mechanisms, communication flows, and innovation success: Journal of Product Innovation Management, v. 11, p. 31-45.
Mohr, L. B., 1971, Organizational technology and organizational structure: Administrative Science Quarterly, v. 16, p. 444-459.
Mollenkopf, D. A., A. Gibson, and L. Ozanne, 2000, The integration of marketing and logistics functions: an empirical examination of New Zealand firms: Journal of Business Logistics, v. 21, p. 89-112.
Montanari, J. R., 1978, Managerial discretion: An expanded model of organization choice: Academy of Management Review, v. 3, p. 231-241.
Moorman, C., R. Deshpande, and G. Zaltman, 1993, Factors affecting trust in market research relationships: the Journal of Marketing, v. 57, p. 81-101.
Morash, E. A., and S. R. Clinton, 1998, Supply chain integration: customer value through collaborative closeness versus operational excellence: Journal of Marketing Theory and Practice, v. 6, p. 104-120.
Morgan, G., and R. Ramirez, 1984, Action learning: A holographic metaphor for guiding social change: Human relations, v. 37, p. 1-27.
Morton, R., 2003, Good chemistry in the supply chain: Logistics Today.
Moyano-Fuentes, J., M. Sacristán-Díaz, and P. Martínez-Jurado, 2012, Cooperation in the supply chain and lean production adoption: International Journal of Operations & Production Management, v. 32, p. 1075-1096.
Muffatto, M., 1999, Introducing a platform strategy in product development: International journal of production economics, v. 60, p. 145-153.
Murphy, J. C., and S. L. Braund, 2000, Management accounting and new manufacturing technology.
Nahm, A. Y., M. A. Vonderembse, and X. A. Koufteros, 2003, The impact of organizational structure on time-based manufacturing and plant performance: Journal of Operations Management, v. 21, p. 281-306.
Nair, A., 2006, Meta-analysis of the relationship between quality management practices and firm performance—implications for quality management theory development: Journal of Operations Management, v. 24, p. 948-975.
Narasimhan, R., and A. Das, 2000, An empirical examination of sourcing's role in developing manufacturing flexibilities: International Journal of Production Research, v. 38, p. 875-893.
Narasimhan, R., and S. W. Kim, 2002, Effect of supply chain integration on the relationship between diversification and performance: evidence from Japanese and Korean firms: Journal of Operations Management, v. 20, p. 303-323.
Narasimhan, R., M. Swink, and S. Viswanathan, 2010, On decisions for integration implementation: An examination of complementarities between product-Process technology integration and supply chain integration: Decision Sciences, v. 41, p. 355-372.
Neely, A., M. Gregory, and K. Platts, 1995, Performance measurement system design - A literature review and research agenda: International Journal of Operations & Production Management, v. 15, p. 80-116.
Negandhi, A. R., and B. C. Reimann, 1972, A contingency theory of organization re-examined in the context of a developing country: Academy of Management Journal, v. 15, p. 137-146.

Nemetz, P. L., and L. W. Fry, 1988, Flexible manufacturing organizations: implications for strategy formulation and organization design: Academy of Management Review, v. 13, p. 627-639.

Nicoll, A. D., 1994, Integrating Logistics Strategies, p. 590-594.

Nidumolu, S. R., 1996, A comparison of the structural contingency and risk-based perspectives on coordination in software-development projects: Journal of Management Information Systems, v. 13, p. 77-113.

Nord, W. R., and S. Tucker, 1987, Implementing routine and radical innovations, Free Press.

NORSOK STANDARD, 1996, Life Cycle Cost For Production Facility - NORSOK:O-CR-001. [ONLINE] Available at: http://www.standard.no/pagefiles/1137/o-cr-002r1.pdf. [Accessed 14 June 2013].

Nunnally, J. C., 1979, Citation classic-psychometric theory: Current Contents/Social & Behavioral Sciences, v. 22, p. 12-12.

Nunnally, J. C., I. H. Bernstein, and J. M. F. t. Berge, 1967, Psychometric theory, v. 226, McGraw-Hill New York.

Obstfeld, M., and K. Rogoff, 2009, Global imbalances and the financial crisis: products of common causes: Journal of Economic Issues, v. 46, p. 353-362.

Oldham, G. R., and J. R. Hackman, 1981, Relationships between organizational structure and employee reactions: Comparing alternative frameworks: Administrative Science Quarterly, v. 26, p. 66-83.

Olhager, J., and D. I. Prajogo, 2012, The impact of manufacturing and supply chain improvement initiatives: A survey comparing make-to-order and make-to-stock firms: Omega, v. 40, p. 159-165.

Olhager, J., and B. M. West, 2002, The house of flexibility: using the QFD approach to deploy manufacturing flexibility: International Journal of Operations & Production Management, v. 22, p. 50-79.

Olson, E. M., S. F. Slater, and G. T. M. Hult, 2005, The performance implications of fit among business strategy, marketing organization structure, and strategic behavior: Journal of marketing, v. 69, p. 49-65.

Olson, E. M., O. C. Walker Jr, and R. W. Ruekert, 1995, Organizing for effective new product development: the moderating role of product innovativeness: The Journal of Marketing, v. 59, p. 48-62.

OPEC 2015 OPEC share of world crude oil [online] Available from http://www.opec.org/opec_web/en/data_graphs/330.htm [Acccessed 19 January 2015]

OPEC, 2012. World Oil Outlook [online] Available from http://www.opec.org/opec_web/static_files_project/media/downloads/publications/WOO2012.pdf [Acccessed 22 June 2014]

Osborne, J. W., and A. Overbay, 2004, The power of outliers (and why researchers should always check for them): Practical Assessment, Research & Evaluation, v. 9, p. 1-12.

Ouchi, W., 1981, Theory Z: How American business can meet the Japanese challenge: Business Horizons, v. 24, p. 82-83.

Ouyang, L.-Y., and H.-C. Chang, 2002, Lot size reorder point inventory model with controllable lead time and set-up cost: International Journal of Systems Science, v. 33, p. 635-642.

Ouyang, L.-Y., and K.-S. Wu, 1997, Mixture inventory model involving variable lead time with a service level constraint: Computers & Operations Research, v. 24, p. 875-882.
Ouyang, L.-Y., N.-C. Yeh, and K.-S. Wu, 1996, Mixture inventory model with backorders and lost sales for variable lead time: Journal of the Operational Research Society, v. 47, p. 829-832.
Ouyang, L. Y., C.-K. Chen, and H. C. Chang, 1999, Lead time and ordering cost reductions in continuous review inventory systems with partial backorders: Journal of the Operational Research Society, v. 50, p. 1272-1279.
Pagell, M., 2004, Understanding the factors that enable and inhibit the integration of operations, purchasing and logistics: Journal of Operations Management, v. 22, p. 459-487.
Pallant, J., 2010, A step by step guide to data analysis using the SPSS program: SPSS survival manual 4th ed, v. 494.
Palomero, S., and R. Chalmeta, 2014, A guide for supply chain integration in SMEs: Production Planning & Control, v. 25, p. 372-400.
Pan, J. C.-H., M.-C. Lo, and Y.-C. Hsiao, 2004, Optimal reorder point inventory models with variable lead time and backorder discount considerations: European Journal of Operational Research, v. 158, p. 488-505.
Pan, J. C.-H., and J.-S. Yang, 2002, A study of an integrated inventory with controllable lead time: International Journal of Production Research, v. 40, p. 1263-1273.
Parker, C. P., 1999, A test of alternative hierarchical models of psycho logical climate: Pcg, satisfaction, or common method variance?: Organizational Research Methods, v. 2, p. 257–274.
Parker, C. P., R. L. Dipboye, and S. L. Jackson, 1995, Perceptions of organizational politics: An investigation of antecedents and consequences: Journal of Management, v. 21, p. 891-912.
Parker, S. K., and C. M. Axtell, 2001, Seeing another viewpoint: Antecedents and outcomes of employee perspective taking: Academy of Management Journal, v. 44, p. 1085-1100.
Parsons, T., 1949, Essays in sociological theory; pure and applied.
Parthasarthy, R., and S. P. Sethi, 1992, The impact of flexible automation on business strategy and organizational structure: Academy of Management review, v. 17, p. 86-111.
Parthasarthy, R., and S. P. Sethi, 1993, Relating strategy and structure to flexible automation: a test of fit and performance implications: Strategic Management Journal, v. 14, p. 529-549.
Pascale, R. T., and A. G. Athos, 1981, The art of Japanese management: Business Horizons, v. 24, p. 83-85.
Paswan, A. K., R. P. Dant, and J. R. Lumpkin, 1998, An empirical investigation of the linkages among relationalism, environmental uncertainty, and bureaucratization: Journal of Business Research, v. 43, p. 125-140.
Patomäki, H., and C. Wight, 2000, After postpositivism? The promises of critical realism: International Studies Quarterly, v. 44, p. 213-237.
Paullay, I. M., G. M. Alliger, and E. F. Stone-Romero, 1994, Construct validation of two instruments designed to measure job involvement and work centrality: Journal of Applied Psychology, v. 79, p. 224.

Payne, R. L., and R. Mansfield, 1973, Relationships of perceptions of organizational climate to organizational structure, context, and hierarchical position: Administrative Science Quarterly, v. 18, p. 515-526.
Pearl, J., 2011, The Causal Foundations of Structural Equation Modeling: Department of Statistics, UCLA.
Peng, D. X., A. Verghese, R. Shah, and R. G. Schroeder, 2013, The relationships between external integration and plant improvement and innovation capabilities: The moderation effect of product clockspeed: Journal of Supply Chain Management, v. 49, p. 3-24.
Pennings, J. M., 1976, Dimensions of organizational influence and their effectiveness correlates: Administrative Science Quarterly, v. 21, p. 688-699.
Perren, L., and M. Ram, 2004, Case-study method in small business and entrepreneurial research mapping boundaries and perspectives: International Small Business Journal, v. 22, p. 83-101.
Petersen, K. J., R. B. Handfield, and G. L. Ragatz, 2005, Supplier integration into new product development: coordinating product, process and supply chain design: Journal of Operations Management, v. 23, p. 371-388.
Pfeffer, J., 1981, Power in organizations, v. 33, Marshfield, MA: Pitman.
Pfeffer, J., 1995, Competitive advantage through people: Unleashing the power of the work force, Harvard Business Press.
Phan, P. H. C., 2000, Taking back the boardroom: Better directing for the new millennium, McGraw-Hill.
Pierce, J. L., and A. L. Delbecq, 1977, Organization structure, individual attitudes and innovation: Academy of management review, v. 2, p. 27-37.
Pierce, J. L., R. B. Dunham, and R. S. Blackburn, 1979, Social systems structure, job design, and growth need strength: A test of a congruency model: Academy of Management Journal, v. 22, p. 223-240.
Piper, J. A., and P. Walley, 1990, Testing ABC logic: Management Accounting, v. 68, p. 37.
Piper, J. A., and P. Walley, 1991, ABC relevance not found: Management Accounting, v. 54, p. 42-44.
Pittaway, L., M. Robertson, K. Munir, D. Denyer, and A. Neely, 2004, Networking and innovation: a systematic review of the evidence: International Journal of Management Reviews, v. 5, p. 137-168.
Podsakoff, P. M., S. B. MacKenzie, J.-Y. Lee, and N. P. Podsakoff, 2003, Common method biases in behavioral research: a critical review of the literature and recommended remedies: Journal of applied psychology, v. 88, p. 879.
Pondy, L. R., 1969, Varieties of organizational conflict: Administrative Science Quarterly, v. 14, p. 499-505.
Porter, L. W., and E. E. Lawler, 1965, Properties of organization structure in relation to job attitudes and job behavior: Psychological bulletin, v. 64, p. 23.
Porter, M. E., 1979, How competitive forces shape strategy.
Porter, M. E., 1985, Competitive advantage: The Free Press, New York, NY.
Powell, T. C., 1995, Total quality management as competitive advantage: a review and empirical study: Strategic management journal, v. 16, p. 15-37.
Power, D., 2005, Supply chain management integration and implementation: a literature review: Supply Chain Management-an International Journal, v. 10, p. 252-263.
Prajogo, D., M. Chowdhury, A. C. L. Yeung, and T. C. E. Cheng, 2012, The relationship between supplier management and firm's operational performance: A multi-

dimensional perspective: International Journal of Production Economics, v. 136, p. 123-130.
Prajogo, D., and J. Olhager, 2012, Supply chain integration and performance: The effects of long-term relationships, information technology and sharing, and logistics integration: International Journal of Production Economics, v. 135, p. 514-522.
Pugh, D. S., D. J. Hickson, and C. R. Hinings, 1969a, An empirical taxonomy of structures of work organizations: Administrative Science Quarterly, v. 14, p. 115-126.
Pugh, D. S., D. J. Hickson, C. R. Hinings, K. M. Macdonald, C. Turner, and T. Lupton, 1963, A conceptual scheme for organizational analysis: Administrative Science Quarterly, v. 8, p. 289-315.
Pugh, D. S., D. J. Hickson, C. R. Hinings, and C. Turner, 1968, Dimensions of organization structure: Administrative science quarterly, v. 13, p. 65-105.
Pugh, D. S., D. J. Hickson, C. R. Hinings, and C. Turner, 1969b, The context of organization structures: Administrative Science Quarterly, v. 14, p. 91-114.
Punch, K., 2006, Developing Effective Research Proposals, SAGE.
Pérez, M. P., and A. M. Sánchez, 2001, Supplier relations and flexibility in the Spanish automotive industry: Supply chain management: an international journal, v. 6, p. 29-38.
Quazi, H. A., J. Jemangin, L. W. Kit, and C. L. Kian, 1998, Critical factors in quality management and guidelines for self-assessment: the case of Singapore: Total quality management, v. 9, p. 35-55.
Ragatz, G. L., R. B. Handfield, and K. J. Petersen, 2002, Benefits associated with supplier integration into new product development under conditions of technology uncertainty: Journal of Business Research, v. 55, p. 389-400.
Rahman, S.-U., 2004, The future of TQM is past. Can TQM be resurrected?: Total Quality Management & Business Excellence, v. 15, p. 411-422.
Rahman, S. U., and P. Bullock, 2005, Soft TQM, hard TQM, and organisational performance relationships: an empirical investigation: Omega-International Journal of Management Science, v. 33, p. 73-83.
Ramanathan, R., 2007, Supplier selection problem: integrating DEA with the approaches of total cost of ownership and AHP: Supply Chain Management: an international journal, v. 12, p. 258-261.
Rapert, M. I., and B. M. Wren, 1998, Reconsidering organizational structure: a dual perspective of frameworks and processes: Journal of Managerial Issues, v. 10, p. 287-302.
Raykov, T., 1997, Estimation of composite reliability for congeneric measures: Applied Psychological Measurement, v. 21, p. 173-184.
Reay, D., G. Crozier, and J. Clayton, 2009, 'Strangers in paradise'? Working-class students in elite universities: Sociology, v. 43, p. 1103-1121.
Reimann, B. C., 1973, On the dimensions of bureaucratic structure: An empirical reappraisal: Administrative Science Quarterly, v. 18, p. 462-476.
Reimann, B. C., 1974, Dimensions of structure in effective organizations: some empirical evidence: Academy of Management Journal, v. 17, p. 693-708.
Reimann, B. C., 1975, Organizational effectiveness and management's public valúes: A canonical analysis: Academy of Management Journal, v. 18, p. 224-241.
Reimann, B. C., and A. R. Negandhi, 1976, Organization structure and effectiveness: A canonical analysis: The management of organization design, v. 2, p. 191-210.
Revans, R. W., 1958, Human relations, management and size: Human relations and modern management, p. 177-220.

Richey, R. G., Jr., H. Chen, R. Upreti, S. E. Fawcett, and F. G. Adams, 2009, The moderating role of barriers on the relationship between drivers to supply chain integration and firm performance: International Journal of Physical Distribution & Logistics Management, v. 39, p. 826-840.
Riordan, C. M., and R. J. Vandenberg, 1994, A central question in cross-cultural research: Do employees of different cultures interpret work-related measures in an equivalent manner?: Journal of Management, v. 20, p. 643-671.
Rizzo, J. R., R. J. House, and S. I. Lirtzman, 1970, Role conflict and ambiguity in complex organizations: Administrative science quarterly, v. 15, p. 150-163.
Robbins, S. P., 1990, Organization Theory: Structures, Designs, And Applications, 3/e, Pearson Education India.
Roberts, K. H., C. L. Hulin, and D. M. Rousseau, 1978, Developing an interdisciplinary science of organizations.
Rodrigues, A. M., T. P. Stank, and D. Lynch, 2004, Linking strategy, structure, process and performance in integrated logistics: Journal of Business Logistics, v. 25 p. 65-94.
Rogers, D. L., and J. Molnar, 1976, Organizational antecedents of role conflict and ambiguity in top-level administrators: Administrative Science Quarterly, v. 24, p. 598-610.
Rosenzweig, E. D., A. V. Roth, and J. W. Dean, 2003, The influence of an integration strategy on competitive capabilities and business performance: an exploratory study of consumer products manufacturers: Journal of operations management, v. 21, p. 437-456.
Rousseau, D. M., 1978, Characteristics of departments, positions, and individuals: Contexts for attitudes and behavior: Administrative Science Quarterly, v. 23, p. 521-540.
Rousseau, R., and K. U. Leuven, 2008, Reflections on recent developments of the h-index and h-type indices: CollentJournal of Scientometrics and Information Management, v. 2, p. 1-8.
Rowley, J., and F. Slack, 2004, Conducting a literature review: Management Research News, v. 27, p. 31-39.
Ruekert, R. W., O. C. Walker Jr, and K. J. Roering, 1985, The organization of marketing activities: a contingency theory of structure and performance: The Journal of Marketing, v. 49, p. 13-25.
Rumelt, R. P., 1974, Strategy, structure, and economic performance: Harvard University Press, Cambridge, MA.
Sabri, E. H., and B. M. Beamon, B. M, 2000, A multi-objective approach to simultaneous strategic and operational planning in supply chain design: Omega, v. 28, p. 581-598.
Sackett, P. R., and J. R. Larson Jr, 1990, Research strategies and tactics in industrial and organizational psychology, *in* M. D. D. L. M. Hough, ed., Handbook of industrial and organizational psychology, Vol. 1 (2nd ed.): Palo Alto, CA, US, Consulting Psychologists Press, p. 419-489.
Saeed, K. A., M. K. Malhotra, and V. Grover, 2005, Examining the impact of interorganizational systems on process efficiency and sourcing leverage in buyer-supplier dyads: Decision Sciences, v. 36, p. 365-396.
Saeed, K. A., M. K. Malhotra, and V. Grover, 2011, Interorganizational System Characteristics and Supply Chain Integration: An Empirical Assessment*: Decision Sciences, v. 42, p. 7-42.

Sahin, F., and E. P. Robinson, 2005, Information sharing and coordination in make-to-order supply chains: Journal of operations management, v. 23, p. 579-598.

Sakakibara, S., B. B. Flynn, R. G. Schroeder, and W. T. Morris, 1997, The impact of just-in-time manufacturing and its infrastructure on manufacturing performance: Management Science, v. 43, p. 1246-1257.

Samat, N., T. Ramayah, and N. Mat Saad, 2006, TQM practices, service quality, and market orientation: Some empirical evidence from a developing country: Management Research News, v. 29, p. 713-728.

Samson, D., and M. Terziovski, 1999, The relationship between total quality management practices and operational performance: Journal of operations management, v. 17, p. 393-409.

Sanchez, A. M., and M. Perez, 2005, Supply chain flexibility and firm performance - A conceptual model and empirical study in the automotive industry: International Journal of Operations & Production Management, v. 25, p. 681-700.

Sánchez-Fernández, J., F. Muñoz-Leiva, and F. J. Montoro-Ríos, 2012, Improving retention rate and response quality in Web-based surveys: Computers in Human Behavior, v. 28, p. 507-514.

Sanders, N. R., 2007, An empirical study of the impact of e-business technologies on organizational collaboration and performance: Journal of Operations Management, v. 25, p. 1332-1347.

Sanders, N. R., 2008, Pattern of information technology use: The impact on buyer-suppler coordination and performance: Journal of Operations Management, v. 26, p. 349-367.

Sanders, N. R., and R. Premus, 2002, IT applications in supply chain organizations: A link between competitive priorities and organizational benefits: Journal of Business Logistics, v. 23, p. 65-83.

Saraph, J. V., P. G. Benson, and R. G. Schroeder, 1989, An instrument for measuring the critical factors of quality management: Decision sciences, v. 20, p. 810-829.

Saunders, M. N. K., M. Saunders, P. Lewis, and A. Thornhill, 2011, Research methods for business students, 5/e, Pearson Education India.

Scandura, T. A., and E. A. Williams, 2000, Research methodology in management: Current practices, trends, and implications for future research: Academy of Management journal, v. 43, p. 1248-1264.

Schmenner, R. W., and M. V. Tatikonda, 2005, Manufacturing process flexibility revisited: International Journal of Operations & Production Management, v. 25, p. 1183-1189.

Schminke, M., M. L. Ambrose, and R. S. Cropanzano, 2000, The effect of organizational structure on perceptions of procedural fairness: Journal of Applied Psychology, v. 85, p. 294-304.

Schoenherr, T., and M. Swink, 2012, Revisiting the arcs of integration: Cross-validations and extensions: Journal of Operations Management, v. 30, p. 99-115.

Schonberger, R. J.,1982, The transfer of Japanese manufacturing management approaches to US industry: Academy of Management Review, v. 7 , p. 479-87.

Schoonhoven, C. B., 1981, Problems with contingency theory: testing assumptions hidden within the language of contingency" theory": Administrative science quarterly, v. 26, p. 349-377.

Schreiber, J. B., A. Nora, F. K. Stage, E. A. Barlow, and J. King, 2006, Reporting structural equation modeling and confirmatory factor analysis results: A review: The Journal of Educational Research, v. 99, p. 323-338.

Schuler, R. S., 1975, Role perceptions, satisfaction, and performance: A partial reconciliation: Journal of Applied Psychology, v. 60, p. 683.
Schwab, D. P., 1978, Construct validity in organizational behavior: Graduate School of Business, University of Wisconsin-Madison, v. 2, p. 3-44.
Schwartz, R., 2000, The crude supply chain: Transportation & Distribution.
Schwenk, C. R., and C. B. Shrader, 1993, Effects of formal strategic planning on financial performance in small firms: A meta-analysis.: Entrepreneurship Theory and Practice, v. 17, p. 53-53.
Schönsleben, P., 2003, Integral logistics management: planning and control of comprehensive supply chains, CRC Press.
Scullen, S. E., 1999, Using confirmatory factor analysis of correlated uniquenesses to estimate method variance in multitrait–multimethod matrices: Organizational Research Methods, v. 2, p. 275–292.
Sekaran, U., 2006, Research methods for business: A skill building approach, John Wiley & Sons.
Sethi, S. P., H. Yan, and H. Zhang, 2004, Quantity Flexibility Contracts: Optimal Decisions with Information Updates*: Decision Sciences, v. 35, p. 691-712.
Sezen, B., 2008, Relative effects of design, integration and information sharing on supply chain performance: Supply Chain Management-an International Journal, v. 13, p. 233-240.
Shah, R., and S. M. Goldstein, 2006, Use of structural equation modeling in operations management research: Looking back and forward: Journal of Operations Management, v. 24, p. 148-169.
Shepherd, C., and H. Günter, 2006, Measuring supply chain performance: current research and future directions: International Journal of Productivity and Performance Management, v. 55, p. 242-258.
Shepherd, C., and H. Günter, 2011, Measuring supply chain performance: current research and future directions, Behavioral Operations in Planning and Scheduling, Springer, p. 105-121.
Shrout, P. E., and N. Bolger, 2002, Mediation in experimental and nonexperimental studies: new procedures and recommendations: Psychological methods, v. 7, p. 422.
Shub, A. N., and P. W. Stonebraker, 2009, The human impact on supply chains: evaluating the importance of "soft" areas on integration and performance: Supply Chain Management: An International Journal, v. 14, p. 31-40.
Sila, I., 2007, Examining the effects of contextual factors on TQM and performance through the lens of organizational theories: An empirical study: Journal of Operations management, v. 25, p. 83-109.
Sila, I., and M. Ebrahimpour, 2002, An investigation of the total quality management survey based research published between 1989 and 2000: A literature review: International Journal of Quality & Reliability Management, v. 19, p. 902-970.
Silver, E., D. F. Pyke, and R. Peterson, 1998, Inventory management and production planning and scheduling.
Simon, H. A., 1946, The proverbs of administration: Public Administration Review, v. 6, p. 53-67.
Sims, H. P., 1996, Businesses Without Bosses, Wiley: New York.
Singh, P. J., M. Feng, and A. Smith, 2006, ISO 9000 series of standards: comparison of manufacturing and service organisations: International Journal of Quality & Reliability Management, v. 23, p. 122-142.

Sinha, K. K., and A. H. Van de Ven, 2005, Designing work within and between organizations: Organization Science, v. 16, p. 389-408.
Sink, D. S., and T. C. Tuttle, 1990, The performance management question in the organization of the future: Industrial Management, v. 32, p. 4-12.
Sivadas, E., and F. R. Dwyer, 2000, An examination of organizational factors influencing new product success in internal and alliance-based processes: Journal of Marketing, v. 64, p. 31-49.
Sivo, S. A., X. Fan, E. L. Witta, and J. T. Willse, 2006, The search for" optimal" cutoff properties: Fit index criteria in structural equation modeling: The Journal of Experimental Education, v. 74, p. 267-288.
Skivington, J. E., and R. L. Daft, 1991, A study of organizational framework and process modelites for the implementation of business-level strategic decisions: Journal of Management Studies, v. 28, p. 45-68.
Slack, N., 1983, Flexibility as a manufacturing objective: International Journal of Operations & Production Management, v. 3, p. 4-13.
Slack, N., 1987, The flexibility of manufacturing systems: International Journal of Operations & Production Management, v. 7, p. 35-45.
Smith, M., 2011, Research Methods in Accounting, SAGE.
Snow, C. C., and R. E. Miles, 1992, Causes for failure in network organizations: California management review, v. 34, p. 53-57.
Snow, C. C., and J. B. Thomas, 1994, Field research methods in strategic management: Contributions to theory buliding and testing *: Journal of management studies, v. 31, p. 457-480.
Sorensen Jr, P. F., and B. H. Baum, 1975, Organizational control and effectiveness in a voluntary association: The Journal of Social Psychology, v. 95, p. 125-126.
Spekman, R. E., and L. W. Stern, 1979, Environmental uncertainty and buying group structure: an empirical investigation: The Journal of Marketing, v. 43, p. 54-64.
Sperka, M., 1997, Zur Entwicklung eines „Fragebogens zur Erfassung der Kommunikation in Organisationen "(KomminO): Zeitschrift für Arbeits-und Organisationspsychologie, v. 41, p. 182-190.
Spreitzer, G. M., M. A. Kizilos, and S. W. Nason, 1997, A dimensional analysis of the relationship between psychological empowerment and effectiveness satisfaction, and strain: Journal of management, v. 23, p. 679-704.
Stank, T. P., S. B. Keller, and D. J. Closs, 2001a, Performance benefits of supply chain logistical integration: Transportation Journal, v. 41, p. 32-46.
Stank, T. P., S. B. Keller, and P. J. Daugherty, 2001b, Supply chain collaboration and logistical service performance: Journal of Business logistics, v. 22, p. 29-48.
Staw, B. M., L. E. Sandelands, and J. E. Dutton, 1981, Threat rigidity effects in organizational behavior: A multilevel analysis: Administrative science quarterly, v. 26, p. 501-524.
Steiger, J. H., 1990, Structural model evaluation and modification: An interval estimation approach: Multivariate behavioral research, v. 25, p. 173-180.
Stephens, S., 2001, Supply chain operations reference model version 5.0: a new tool to improve supply chain efficiency and achieve best practice: Information Systems Frontiers, v. 3, p. 471-476.
Stevenson, W. B., 1990, Formal structure and networks of interaction within organizations. Social Science Research, v. 19, p. 113-131.

Stevenson, M., and M. Spring, 2007, Flexibility from a supply chain perspective: definition and review: International Journal of Operations & Production Management, v. 27, p. 685-713.
Stewart, G, 1997, Supply-chain operations reference model (SCOR): the first cross-industry framework for integrated supply-chain management. Logistics information management, v. 102, 62-6.7
Stimpert, J. L., and L. M. Duhaime, 1997, Seeing the big picture: The influence of industry, diversification, and business strategy on performance: Academy of Management Journal, v. 40, p. 560-83.
Stock, G. N., N. P. Greis, and J. D. Kasarda, 2000, Enterprise logistics and supply chain structure: the role of fit: Journal of Operations Management, v. 18, p. 531-547.
Stone-Romero, E. F., 1994, Construct validity issues in organizational behavior research: Organizational behavior: The state of the science, v. 155, p. 179.
Stonebraker, P. W., and J. Liao, 2006, Supply chain integration: exploring product and environmental contingencies: Supply Chain Management: An International Journal, v. 11, p. 34-43.
Stonebraker, P. W., and R. Afifi, 2004, Toward a contingency theory of supply chains: Management Decision, v. 42, p. 1131-1144.
Suarez, F. F., M. A. Cusumano, and C. H. Fine, 1996, An empirical study of manufacturing flexibility in printed circuit board assembly: Operations research, v. 44, p. 223-240.
Sussmann, M., and D. U. Robertson, 1986, The validity of validity: An analysis of validation study designs: Journal of Applied Psychology, v. 71, p. 461.
Sutton, R. I., and B. M. Staw, 1995, What theory is not: Administrative science quarterly, v. 40, p. 371-384.
Swamidass, P. M., and W. T. Newell, 1987, Manufacturing strategy, environmental uncertainty and performance: a path analytic model: Management science, v. 33, p. 509-524.
Swink, M., R. Narasimhan, and C. Wang, 2007, Managing beyond the factory walls: Effects of four types of strategic integration on manufacturing plant performance: Journal of Operations Management, v. 25, p. 148-164.
Tabachnick, B. G., and L. S. Fidell, 2007, Profile analysis: the multivariate approach to repeated measures: Using multivariate statistics. Boston (MA): Pearson Education, Inc, p. 311-74.
Talib, F., and Z. Rahman, 2010, Critical success factors of TQM in service organizations: a proposed model: Services Marketing Quarterly, v. 31, p. 363-380.
Tam, M. C., and V. R. Tummala, 2001, An application of the AHP in vendor selection of a telecommunications system: Omega, v. 29, p. 171-182.
Tanaka, J. S., 1993, Multifaceted conceptions of fit in structural equation models: Sage focus editions, v. 154, p. 10-10.
Tannenbaum, A. S., 1961, Control and effectiveness in a voluntary organization: American Journal of Sociology, v. 67, p. 33-46.
Terjesen, S., P. C. Patel, and N. R. Sanders, 2012, Managing Differentiation-Integration Duality in Supply Chain Integration*: Decision Sciences, v. 43, p. 303-339.
Tersine, R. J., 1994, Principles of inventory and materials management: Prentice-Hall Englewood Cliffs, NJ.
Tersine, R. J., and E. A. Hummingbird, 1995, Lead-time reduction: the search for competitive advantage: International Journal of Operations & Production Management, v. 15, p. 8-18.

Terziovski, M., D. Power, and A. S. Sohal, 2003, The longitudinal effects of the ISO 9000 certification process on business performance: European Journal of operational research, v. 146, p. 580-595.

The World Factbook, 2015b, Venezuela . [online] Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/ve.html. [Accessed 05 January 2015].

The World Factbook, 2015a, Kuwait. [online] Available at: https://www.cia.gov/library/publications/the-world-factbook/geos/ku.html. [Accessed 05 January 2015]

Thietart, R.-A., 2001, Doing management research: a comprehensive guide, Sage.

Thomas, E. J., 1959, Role conceptions and organizational size: American Sociological Review, v. 24, p. 30-37.

Thomas, J., and A. Harden, 2008, Methods for the thematic synthesis of qualitative research in systematic reviews: BMC medical research methodology, v. 8, p. 45.

Thompson, J. D., 2011, Organizations in action: Social science bases of administrative theory, v. 1, Transaction publishers.

Thompson, V. A., 1965, Bureaucracy and innovation: Administrative science quarterly, v. 10, p. 1-20.

Tordo, S., Tracy, C., Arfaa, N., 2011, National Oil Companies and Value Creation. World Bank Working Paper 218 [ONLINE] Available at: http://siteresources.worldbank.org/INTOGMC/Resources/9780821388310.pdf. [Last Accessed 23 October 2014].

Thun, J. H., 2010, Angles of integration: an empirical analysis of the alignment of internet-based information technology and global supply chain integration: Journal of Supply Chain Management, v. 46, p. 30-44.

Tranfield, D., D. Denyer, and P. Smart, 2003, Towards a methodology for developing evidence-informed management knowledge by means of systematic review: British journal of management, v. 14, p. 207-222.

Trovinger, S. C., and R. E. Bohn, 2005, Setup Time Reduction for Electronics Assembly: Combining Simple (SMED) and IT-Based Methods: Production and operations management, v. 14, p. 205-217.

Troxel, R. B., and M. G. Weber, 1990, The evolution of activity-based costing: Journal of Cost Management, v. 4, p. 14-22.

Tsay, A. A., 1999, The quantity flexibility contract and supplier-customer incentives: Management science, v. 45, p. 1339-1358.

Tsay, A. A., and W. S. Lovejoy, 1999, Quantity flexibility contracts and supply chain performance: Manufacturing & Service Operations Management, v. 1, p. 89-111.

Tung, R. L., 1979, Dimensions of organizational environments: An exploratory study of their impact on organization structure: Academy of Management Journal, v. 22, p. 672-693.

Turkulainen, V., and M. Ketokivi, 2012, Cross-functional integration and performance: what are the real benefits?: International Journal of Operations & Production Management, v. 32, p. 447-467.

Tushman, M. L., 1977, Special boundary roles in the innovation process: Administrative science quarterly, v. 22, p. 587-605.

Tushman, M. L., and T. J. Scanlan, 1981, Boundary spanning individuals: Their role in information transfer and their antecedents: Academy of Management Journal, v. 24, p. 289-305.

Ueno, A., 2008, Which management practices are contributory to service quality?: International Journal of Quality & Reliability Management, v. 25, p. 585-603.

Upton, D., 1995, What really makes factories flexible?: Harvard business review, v. 73, p. 74-84.

Vachon, S., and R. D. Klassen, 2006, Extending green practices across the supply chain - The impact of upstream and downstream integration: International Journal of Operations & Production Management, v. 26, p. 795-821.

Vachon, S., and R. D. Klassen, 2007, Supply chain management and environmental technologies: the role of integration: International Journal of Production Research, v. 45, p. 401-423.

Vallet-Bellmunt, T., and P. Rivera-Torres, 2013, Integration: attitudes, patterns and practices: Supply Chain Management: An International Journal, v. 18, p. 308-323.

Van de Ven, A. H., 1976, A framework for organization assessment: Academy of Management Review, v. 1, p. 64-78.

Van de Ven, A. H., and A. L. Delbecq, 1974, A task contingent model of work-unit structure: Administrative Science Quarterly, v. 19, p. 183-197.

Van de Ven, A. H., A. L. Delbecq, and R. Koenig Jr, 1976, Determinants of coordination modes within organizations: American sociological review, v. 41, p. 322-338.

Van de Ven, A. H., and R. Drazin, 1984, The Concept of Fit in Contingency Theory, Minnestoa Univ Minneapolis Strategic Management Research Centre, DTIC Document.

Van de Ven, A. H., and D. L. Ferry, 1980, Measuring and assessing organizations, John Wiley & Sons.

Van de Ven, A. H., and G. Walker, 1984, The dynamics of interorganizational coordination: Administrative science quarterly, v. 29, p. 598-621.

van der Vaart, T., and D. P. van Donk, 2008, A critical review of survey-based research in supply chain integration: International Journal of Production Economics, v. 111, p. 42-55.

Van der Vorst, J. G. A. J., and A. J. M. Beulens, 2002, Identifying sources of uncertainty to generate supply chain redesign strategies: International Journal of Physical Distribution & Logistics Management, v. 32, p. 409-430.

Van Hoek, R. L., A. Harrison, and M. Christopher, 2001, Measuring agile capabilities in the supply chain: International Journal of Operations & Production Management, v. 21, p. 126-148.

Van Kasteren, J. M. N., and A. P. Nisworo, 2007, A process model to estimate the cost of industrial scale biodiesel production from waste cooking oil by supercritical transesterification: Resources, Conservation and Recycling, v. 50, p. 442-458.

Vanichchinchai, A., and B. Igel, 2009, Total quality management and supply chain management: similarities and differences: The TQM Journal, v. 21, p. 249-260.

Vanichchinchai, A., and B. Igel, 2011, The impact of total quality management on supply chain management and firm's supply performance: International Journal of Production Research, v. 49, p. 3405-3424.

Venkatraman, N., 1989, The concept of fit in strategy research: toward verbal and statistical correspondence: Academy of management review, v. 14, p. 423-444.

Vereecke, A., and S. Muylle, 2006, Performance improvement through supply chain collaboration in Europe: International journal of operations & production management, v. 26, p. 1176-1198.

Vickery, S., C. Droge, and R. Germain, 1999a, The relationship between product customization and organizational structure: Journal of Operations Management, v. 17, p. 377-391.
Vickery, S. K., J. Jayaram, C. Droge, and R. Calantone, 2003, The effects of an integrative supply chain strategy on customer service and financial performance: an analysis of direct versus indirect relationships: Journal of Operations Management, v. 21, p. 523-539.
Vickery, S. n., R. Calantone, and C. Dröge, 1999b, Supply Chain Flexibility: An Empirical Study: Journal of Supply Chain Management, v. 35, p. 16-24.
Villena, V. H., L. R. Gomez-Mejia, and E. Revilla, 2009, The Decision of the Supply Chain Executive to Support or Impede Supply Chain Integration: A Multidisciplinary Behavioral Agency Perspective*: Decision Sciences, v. 40, p. 635-665.
Vinson, E., and M. Holloway, 1977, The effects of formalization on perceptions of discrimination, satisfaction, effort and performance: Journal of Vocational Behavior, v. 10, p. 302-315.
Vokurka, R. J., and S. W. O'Leary-Kelly, 2000, A review of empirical research on manufacturing flexibility: Journal of operations management, v. 18, p. 485-501.
Von Bertalanffy, L., 1969, General system theory: foundations, development, applications (Revised Edition).
Vonderembse, M. A., T. S. Raghunathan, and S. S. Rao, 1997, A post-industrial paradigm: to integrate and automate manufacturing: International Journal of Production Research, v. 35, p. 2579-2599.
Vredenburgh, D. J., and J. A. Alutto, 1977, Perceived Structure in Relation to Individual Attitudes and Performance: Organization and Administrative Sciences.
Walker Jr, O. C., and R. W. Ruekert, 1987, Marketing's role in the implementation of business strategies: a critical review and conceptual framework: The Journal of Marketing, v. 51, p. 15-33.
Walker, O. C., and R. W. Ruekert, 1987, Marketing's role in the implementation of business strategies: a critical review and conceptual framework: The Journal of Marketing, v. 51, p. 15-33.
Wally, S., and J. R. Baum, 1994, Personal and structural determinants of the pace of strategic decision making: Academy of Management Journal, v. 37, p. 932-956.
Walton, R. E., 1984, From Control to Commitment: Transforming Work Force Management in the United States:[executive Summary], Division of Research, Harvard Business School.
Waternaux, C. M., 1976, Asymptotic distribution of the sample roots for a nonnormal population: Biometrika, v. 63, p. 639-645.
Webb, Malcolm (2015). North Sea oil summit to hear pleas for action. [online] Available from: http://www.bbc.co.uk/news/uk-scotland-scotland-business-31073640. [Accessed 01 February 2015].
Weber, M., 1947, The theory of economic and social organization: Trans. AM Henderson and Talcott Parsons. New York: Oxford University Press.
Weick, K. E., and C. A. Kiesler, 1979, The social psychology of organizing, v. 2, Random House New York.
White, A., E. M. Daniel, and M. Mohdzain, 2005, The role of emergent information technologies and systems in enabling supply chain agility: International journal of information management, v. 25, p. 396-410.

Wilden, R., S. P. Gudergan, B. B. Nielsen, and L. Lings, 2013, Dynamic capabilities and performance: strategy, structure and environment: Long Range Planning, v. 46, p. 72-96.
Wilkinson, A. J., T. Redman, E. Snape, and M. Marchington, 2008, Managing with total quality management: theory and practice.
Willem, A., and M. Buelens, 2009, Knowledge sharing in inter-unit cooperative episodes: The impact of organizational structure dimensions: International Journal of Information Management, v. 29, p. 151-160.
Williams, B. D., J. Roh, T. Tokar, and M. Swink, 2013, Leveraging supply chain visibility for responsiveness: the moderating role of internal integration: Journal of Operations Management, v. 31, p. 543-554.
Williamson, O. E., 1967, Hierarchical control and optimum firm size: The Journal of Political Economy, v. 75, p. 123-138.
Windischer, A., and G. Grote, 2003, Success factors for collaborative planning: Strategy and organziation in supply chains, p. 131-146.
Wong, C. W. Y., 2013, Leveraging environmental information integration to enable environmental management capability and performance: Journal of Supply Chain Management, v. 49, p. 114-136.
Wong, C. W. Y., C. Y. Wong, and S. Boon-itt, 2013, The combined effects of internal and external supply chain integration on product innovation: International Journal of Production Economics, v. 146, p. 566-574.
Wong, E. M., M. E. Ormiston, and P. H. Tetlock, 2011a, The effects of top management team integrative complexity and decentralized decision making on corporate social performance: Academy of Management Journal, v. 54, p. 1207-1228.
Wong, C. Y., S. Boon-itt, and C. W. Y. Wong, 2011b , The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance: Journal of Operations Management, v. 29, p. 604-615.
Woodward, J., S. Dawson, and D. Wedderburn, 1965, Industrial organization: Theory and practice, v. 3, Oxford University Press London.
World Economic Forum, 2012. Energy for Economic Growth Energy Vision Update 2012. [online] Available from: http://www3.weforum.org/docs/WEF_EN_EnergyEconomicGrowth_IndustryAgenda_2012.pdf [Accessed 20 April 2014].
Woon, K. C., 2000, TQM implementation: comparing Singapore's service and manufacturing leaders: Managing Service Quality: An International Journal, v. 10, p. 318-331.
Workman, J. P., C. Homburg, and K. Gruner, 1998, Marketing organization: An integrative framework of dimensions and determinants: Journal of Marketing, v. 62, p. 21-41.
World Economic Outlook, 2014. [online] Available from http://www.imf.org/external/pubs/ft/weo/2014/02/ [Acccessed 15 February 2015].
Worthy, J. C., 1950, Organizational structure and employe morale: American Sociological Review, v. 15, p. 169-179.
Wu, Z., T. Y. Choi, and M. J. Rungtusanatham, 2010, Supplier-supplier relationships in buyer-supplier-supplier triads: Implications for supplier performance: Journal of Operations Management, v. 28, p. 115-123.

Yang, Z., X. Zhou, and P. Zhang, 2014, Centralization and innovation performance in an emerging economy: Testing the moderating effects: Asia Pacific Journal of Management, v. 32, p. 1-28.
Yasai-Ardekani, M., 1986, Structural adaptations to environments: Academy of Management Review, v. 11, p. 9-21.
Yergin, D., 2011, The prize: The epic quest for oil, money & power, Simon and Schuster.
Yin, R., 1994, Case study research: Design and methods . Beverly Hills, CA: Sage publishing.
York, K. M., and C. E. Miree, 2004, Causation or covariation: an empirical re-examination of the link between TQM and financial performance: Journal of Operations Management, v. 22, p. 291-311.
Zailani, S., and P. Rajagopal, 2005, Supply chain integration and performance: US versus East Asian companies: Supply Chain Management-an International Journal, v. 10, p. 379-393.
Zakuan, N. M., S. M. Yusof, T. Laosirihongthong, and A. M. Shaharoun, 2010, Proposed relationship of TQM and organisational performance using structured equation modelling: Total Quality Management, v. 21, p. 185-203.
Zaltman, G., 1979, Knowledge utilization as planned social change: Science Communication, v. 1, p. 82-105.
Zaltman, G., and R. Duncan, 1977, Strategies for planned change.
Zaltman, G., R. Duncan, and J. Holbek, 1973, Innovations and organizations, v. 1973, Wiley New York, NY.
Zammuto, R. F., and E. J. O'Connor, 1992, Gaining advanced manufacturing technologies' benefits: The roles of organization design and culture: Academy of Management Review, v. 17, p. 701-728.
Zey, M., and M. Zey-Ferrell, 1979, Dimensions of organizations: environment, context, structure, process, and performance, Santa Monica, Ca: Goodyear.
Zhang, Z., A. B. Waszink, and J. Wijngaard, 2000, An instrument for measuring TQM implementation for Chinese manufacturing companies: International Journal of Quality & Reliability Management, v. 17, p. 730-755.
Zhao, L., B. Huo, L. Sun, and X. Zhao, 2013, The impact of supply chain risk on supply chain integration and company performance: a global investigation: Supply Chain Management-an International Journal, v. 18, p. 115-131.
Zhao, X., B. Huo, B. B. Flynn, and J. H. Y. Yeung, 2008, The impact of power and relationship commitment on the integration between manufacturers and customers in a supply chain: Journal of Operations Management, v. 26, p. 368-388.
Zhao, X., B. Huo, W. Selen, and J. H. Y. Yeung, 2011, The impact of internal integration and relationship commitment on external integration: Journal of Operations Management, v. 29, p. 17-32.
Zheng, W., B. Yang, and G. N. McLean, 2010, Linking organizational culture, structure, strategy, and organizational effectiveness: Mediating role of knowledge management: Journal of Business Research, v. 63, p. 763-771.

# Appendix A
# From BP Statistical Review 2014
# Proved oil reserves

Oil

Proved reserves

| | At end 1993 Thousand million barrels | At end 2003 Thousand million barrels | At end 2012 Thousand million barrels | At end 2013 Thousand million tonnes | At end 2013 Thousand million barrels | At end 2013 Share of total | At end 2013 R/P ratio |
|---|---|---|---|---|---|---|---|
| US | 30.2 | 29.4 | 44.2 | **5.4** | **44.2** | 2.6% | 12.1 |
| Canada | 39.5 | 180.4 | 174.3 | **28.1** | **174.3** | 10.3% | * |
| Mexico | 50.8 | 16.0 | 11.4 | **1.5** | **11.1** | 0.7% | 10.6 |
| Total North America | 120.5 | 225.8 | 229.9 | **35.0** | **229.6** | 13.6% | 37.4 |
| Argentina | 2.2 | 2.7 | 2.4 | **0.3** | **2.4** | 0.1% | 9.8 |
| Brazil | 5.0 | 10.6 | 15.3 | **2.3** | **15.6** | 0.9% | 20.2 |
| Colombia | 3.2 | 1.5 | 2.2 | **0.3** | **2.4** | 0.1% | 6.5 |
| Ecuador | 3.7 | 5.1 | 8.4 | **1.2** | **8.2** | 0.5% | 42.6 |
| Peru | 0.8 | 0.9 | 1.4 | **0.2** | **1.4** | 0.1% | 37.5 |
| Trinidad & Tobago | 0.6 | 0.9 | 0.8 | **0.1** | **0.8** | • | 19.2 |
| Venezuela | 64.4 | 77.2 | 297.6 | **46.6** | **298.3** | 17.7% | * |
| Other S. & Cent. America | 0.9 | 1.5 | 0.5 | **0.1** | **0.5** | • | 9.6 |
| Total S. & Cent. America | 80.7 | 100.4 | 328.6 | **51.1** | **329.6** | 19.5% | * |
| Azerbaijan | n/a | 7.0 | 7.0 | **1.0** | **7.0** | 0.4% | 21.9 |
| Denmark | 0.7 | 1.3 | 0.7 | **0.1** | **0.7** | • | 10.3 |
| Italy | 0.6 | 0.8 | 1.4 | **0.2** | **1.4** | 0.1% | 32.7 |
| Kazakhstan | n/a | 9.0 | 30.0 | **3.9** | **30.0** | 1.8% | 46.0 |
| Norway | 9.6 | 10.1 | 9.2 | **1.0** | **8.7** | 0.5% | 12.9 |
| Romania | 1.0 | 0.5 | 0.6 | **0.1** | **0.6** | • | 19.0 |
| Russian Federation | n/a | 79.0 | 92.1 | **12.7** | **93.0** | 5.5% | 23.6 |
| Turkmenistan | n/a | 0.5 | 0.6 | **0.1** | **0.6** | • | 7.1 |
| United Kingdom | 4.5 | 4.3 | 3.0 | **0.4** | **3.0** | 0.2% | 9.6 |
| Uzbekistan | n/a | 0.6 | 0.6 | **0.1** | **0.6** | • | 25.9 |
| Other Europe & Eurasia | 61.8 | 2.3 | 2.1 | **0.3** | **2.2** | 0.1% | 15.1 |
| Total Europe & Eurasia | 78.3 | 115.5 | 147.4 | **19.9** | **147.8** | 8.8% | 23.5 |
| Iran | 92.9 | 133.3 | 157.0 | **21.6** | **157.0** | 9.3% | * |
| Iraq | 100.0 | 115.0 | 150.0 | **20.2** | **150.0** | 8.9% | * |
| Kuwait | 96.5 | 99.0 | 101.5 | **14.0** | **101.5** | 6.0% | 89.0 |
| Oman | 5.0 | 5.6 | 5.5 | **0.7** | **5.5** | 0.3% | 16.0 |
| Qatar | 3.1 | 27.0 | 25.2 | **2.6** | **25.1** | 1.5% | 34.4 |
| Saudi Arabia | 261.4 | 262.7 | 265.9 | **36.5** | **265.9** | 15.8% | 63.2 |
| Syria | 3.0 | 2.4 | 2.5 | **0.3** | **2.5** | 0.1% | * |
| United Arab Emirates | 98.1 | 97.8 | 97.8 | **13.0** | **97.8** | 5.8% | 73.5 |
| Yemen | 2.0 | 2.8 | 3.0 | **0.4** | **3.0** | 0.2% | 51.2 |
| Other Middle East | 0.1 | 0.1 | 0.3 | **†** | **0.3** | • | 3.4 |
| Total Middle East | 661.9 | 745.7 | 808.7 | **109.4** | **808.5** | 47.9% | 78.1 |
| Algeria | 9.2 | 11.8 | 12.2 | **1.5** | **12.2** | 0.7% | 21.2 |
| Angola | 1.9 | 8.8 | 12.7 | **1.7** | **12.7** | 0.8% | 19.3 |
| Chad | – | 0.9 | 1.5 | **0.2** | **1.5** | 0.1% | 43.5 |
| Republic of Congo (Brazzaville) | 0.7 | 1.5 | 1.6 | **0.2** | **1.6** | 0.1% | 15.6 |
| Egypt | 3.4 | 3.5 | 4.2 | **0.5** | **3.9** | 0.2% | 15.0 |
| Equatorial Guinea | 0.3 | 1.3 | 1.7 | **0.2** | **1.7** | 0.1% | 15.0 |
| Gabon | 0.7 | 2.3 | 2.0 | **0.3** | **2.0** | 0.1% | 23.1 |
| Libya | 22.8 | 39.1 | 48.5 | **6.3** | **48.5** | 2.9% | * |
| Nigeria | 21.0 | 35.3 | 37.1 | **5.0** | **37.1** | 2.2% | 43.8 |
| South Sudan | – | – | 3.5 | **0.5** | **3.5** | 0.2% | 96.9 |
| Sudan | 0.3 | 0.6 | 1.5 | **0.2** | **1.5** | 0.1% | 33.7 |
| Tunisia | 0.4 | 0.6 | 0.4 | **0.1** | **0.4** | • | 18.7 |
| Other Africa | 0.6 | 0.6 | 3.7 | **0.5** | **3.7** | 0.2% | 47.7 |
| Total Africa | 61.2 | 106.2 | 130.6 | **17.3** | **130.3** | 7.7% | 40.5 |
| Australia | 3.3 | 3.7 | 3.9 | **0.4** | **4.0** | 0.2% | 26.1 |
| Brunei | 1.3 | 1.0 | 1.1 | **0.1** | **1.1** | 0.1% | 22.3 |
| China | 16.4 | 15.5 | 18.1 | **2.5** | **18.1** | 1.1% | 11.9 |
| India | 5.9 | 5.7 | 5.7 | **0.8** | **5.7** | 0.3% | 17.5 |
| Indonesia | 5.2 | 4.7 | 3.7 | **0.5** | **3.7** | 0.2% | 11.6 |
| Malaysia | 5.0 | 4.8 | 3.7 | **0.5** | **3.7** | 0.2% | 15.3 |
| Thailand | 0.2 | 0.5 | 0.4 | **0.1** | **0.4** | • | 2.5 |
| Vietnam | 0.6 | 3.0 | 4.4 | **0.6** | **4.4** | 0.3% | 34.5 |
| Other Asia Pacific | 1.1 | 1.4 | 1.1 | **0.1** | **1.1** | 0.1% | 11.2 |
| Total Asia Pacific | 38.8 | 40.5 | 42.1 | **5.6** | **42.1** | 2.5% | 14.0 |
| **Total World** | **1041.4** | **1334.1** | **1687.3** | **238.2** | **1687.9** | **100.0%** | **53.3** |
| of which: OECD | 140.8 | 247.5 | 249.6 | **37.3** | **248.8** | 14.7% | 33.2 |
| Non-OECD | 900.6 | 1086.6 | 1437.7 | **200.9** | **1439.1** | 85.3% | 59.5 |
| OPEC | 774.9 | 912.1 | 1213.8 | **170.2** | **1214.2** | 71.9% | 90.3 |
| Non-OPEC‡ | 206.3 | 325.2 | 342.6 | **50.1** | **341.9** | 20.3% | 26.0 |
| European Union# | 8.1 | 8.0 | 6.8 | **0.9** | **6.8** | 0.4% | 13.0 |
| Former Soviet Union | 60.1 | 96.8 | 130.9 | **17.9** | **131.8** | 7.8% | 26.0 |
| Canadian oil sands: Total | 32.3 | 174.4 | 167.8 | **27.3** | **167.8** | | |
| of which: Under active development | 2.9 | 10.8 | 25.9 | **4.2** | **25.9** | | |
| Venezuela: Orinoco Belt | – | – | 220.0 | **35.4** | **220.5** | | |

# Oil production

**Production***

| Thousand barrels daily | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Change 2013 over 2012 | 2013 share of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 7362 | 7244 | 6903 | 6828 | 6862 | 6783 | 7263 | 7552 | 7868 | 8892 | **10003** | 13.5% | 10.8% |
| Canada | 3003 | 3080 | 3041 | 3208 | 3290 | 3207 | 3202 | 3332 | 3515 | 3740 | **3948** | 6.0% | 4.7% |
| Mexico | 3795 | 3830 | 3766 | 3689 | 3479 | 3165 | 2978 | 2959 | 2940 | 2911 | **2875** | -1.1% | 3.4% |
| Total North America | 14160 | 14154 | 13709 | 13725 | 13631 | 13156 | 13444 | 13843 | 14323 | 15543 | **16826** | 8.7% | 18.9% |
| Argentina | 900 | 868 | 839 | 838 | 813 | 772 | 743 | 722 | 687 | 665 | **656** | -1.5% | 0.7% |
| Brazil | 1548 | 1537 | 1699 | 1804 | 1833 | 1895 | 2024 | 2137 | 2193 | 2149 | **2114** | -1.7% | 2.7% |
| Colombia | 541 | 528 | 526 | 529 | 531 | 588 | 671 | 786 | 915 | 944 | **1004** | 6.3% | 1.3% |
| Ecuador | 420 | 528 | 534 | 538 | 513 | 507 | 488 | 488 | 501 | 505 | **527** | 4.5% | 0.7% |
| Peru | 89 | 86 | 92 | 97 | 96 | 99 | 107 | 113 | 110 | 107 | **104** | -4.0% | 0.1% |
| Trinidad & Tobago | 175 | 165 | 181 | 193 | 166 | 174 | 153 | 148 | 140 | 120 | **118** | -1.2% | 0.1% |
| Venezuela | 2868 | 3305 | 3308 | 3336 | 3230 | 3222 | 3033 | 2838 | 2766 | 2643 | **2623** | -0.8% | 3.3% |
| Other S. & Cent. America | 149 | 144 | 146 | 140 | 139 | 138 | 129 | 134 | 137 | 140 | **146** | 3.0% | 0.2% |
| Total S. & Cent. America | 6691 | 7161 | 7325 | 7474 | 7322 | 7394 | 7348 | 7367 | 7448 | 7274 | **7293** | 0.2% | 9.1% |
| Azerbaijan | 308 | 309 | 445 | 646 | 856 | 895 | 1014 | 1023 | 919 | 872 | **877** | 0.4% | 1.1% |
| Denmark | 368 | 390 | 377 | 342 | 311 | 287 | 265 | 249 | 225 | 204 | **178** | -12.8% | 0.2% |
| Italy | 116 | 113 | 127 | 120 | 122 | 108 | 95 | 106 | 110 | 112 | **116** | 3.3% | 0.1% |
| Kazakhstan | 1111 | 1283 | 1330 | 1403 | 1453 | 1526 | 1664 | 1740 | 1758 | 1724 | **1785** | 3.5% | 2.0% |
| Norway | 3264 | 3180 | 2961 | 2772 | 2551 | 2466 | 2349 | 2136 | 2040 | 1917 | **1837** | -4.4% | 2.0% |
| Romania | 124 | 120 | 114 | 105 | 100 | 99 | 94 | 90 | 89 | 83 | **87** | 4.0% | 0.1% |
| Russian Federation | 8602 | 9335 | 9598 | 9818 | 10044 | 9950 | 10139 | 10365 | 10510 | 10643 | **10788** | 1.3% | 12.9% |
| Turkmenistan | 203 | 194 | 193 | 187 | 199 | 208 | 211 | 217 | 217 | 222 | **231** | 4.1% | 0.3% |
| United Kingdom | 2296 | 2064 | 1843 | 1666 | 1659 | 1555 | 1477 | 1361 | 1116 | 949 | **866** | -8.6% | 1.0% |
| Uzbekistan | 151 | 138 | 115 | 114 | 104 | 102 | 95 | 78 | 77 | 68 | **63** | -7.1% | 0.1% |
| Other Europe & Eurasia | 495 | 482 | 454 | 445 | 442 | 420 | 409 | 394 | 394 | 390 | **398** | 2.4% | 0.5% |
| Total Europe & Eurasia | 17037 | 17608 | 17557 | 17619 | 17840 | 17617 | 17812 | 17759 | 17452 | 17184 | **17226** | 0.2% | 20.2% |
| Iran | 4002 | 4201 | 4184 | 4260 | 4303 | 4396 | 4249 | 4356 | 4358 | 3751 | **3558** | -6.0% | 4.0% |
| Iraq | 1344 | 2030 | 1833 | 1999 | 2143 | 2428 | 2452 | 2490 | 2801 | 3116 | **3141** | 0.8% | 3.7% |
| Kuwait | 2370 | 2523 | 2668 | 2737 | 2663 | 2786 | 2511 | 2536 | 2880 | 3165 | **3126** | -1.3% | 3.7% |
| Oman | 822 | 783 | 777 | 738 | 710 | 757 | 813 | 865 | 885 | 918 | **942** | 2.7% | 1.1% |
| Qatar | 949 | 1082 | 1149 | 1241 | 1279 | 1449 | 1416 | 1676 | 1836 | 1966 | **1995** | 1.3% | 2.0% |
| Saudi Arabia | 10141 | 10458 | 10931 | 10671 | 10268 | 10663 | 9663 | 10075 | 11144 | 11635 | **11525** | -1.1% | 13.1% |
| Syria | 652 | 487 | 448 | 421 | 404 | 406 | 401 | 385 | 327 | 171 | **56** | -67.3% | 0.1% |
| United Arab Emirates | 2722 | 2836 | 2922 | 3099 | 3001 | 3026 | 2723 | 2895 | 3319 | 3399 | **3646** | 7.4% | 4.0% |
| Yemen | 451 | 424 | 421 | 387 | 341 | 315 | 306 | 291 | 228 | 180 | **161** | -11.5% | 0.2% |
| Other Middle East | 48 | 48 | 185 | 182 | 194 | 192 | 192 | 192 | 201 | 183 | **208** | 13.5% | 0.2% |
| Total Middle East | 23501 | 24873 | 25518 | 25734 | 25305 | 26417 | 24726 | 25761 | 27980 | 28484 | **28358** | -0.7% | 32.2% |
| Algeria | 1826 | 1921 | 1990 | 1979 | 1992 | 1969 | 1775 | 1689 | 1642 | 1537 | **1575** | 2.7% | 1.7% |
| Angola | 870 | 1103 | 1404 | 1421 | 1684 | 1901 | 1804 | 1863 | 1726 | 1784 | **1801** | 0.8% | 2.1% |
| Chad | 24 | 168 | 173 | 153 | 144 | 127 | 118 | 122 | 114 | 101 | **94** | -6.3% | 0.1% |
| Republic of Congo (Brazzaville) | 208 | 217 | 239 | 271 | 221 | 235 | 269 | 294 | 302 | 289 | **281** | -2.9% | 0.4% |
| Egypt | 750 | 701 | 672 | 704 | 698 | 715 | 730 | 725 | 714 | 715 | **714** | -0.3% | 0.8% |
| Equatorial Guinea | 291 | 399 | 429 | 417 | 430 | 412 | 366 | 326 | 298 | 316 | **311** | -1.8% | 0.4% |
| Gabon | 274 | 273 | 270 | 242 | 246 | 240 | 241 | 255 | 254 | 245 | **237** | -3.3% | 0.3% |
| Libya | 1485 | 1623 | 1745 | 1816 | 1820 | 1820 | 1652 | 1658 | 479 | 1509 | **988** | -34.5% | 1.1% |
| Nigeria | 2233 | 2430 | 2502 | 2392 | 2265 | 2113 | 2211 | 2523 | 2460 | 2417 | **2322** | -4.0% | 2.7% |
| South Sudan | – | – | – | – | – | – | – | – | – | 31 | **99** | 219.4% | 0.1% |
| Sudan | 262 | 291 | 294 | 356 | 483 | 457 | 475 | 462 | 291 | 103 | **122** | 18.3% | 0.1% |
| Tunisia | 68 | 71 | 73 | 70 | 97 | 89 | 83 | 80 | 68 | 67 | **62** | -7.2% | 0.1% |
| Other Africa | 141 | 165 | 172 | 224 | 193 | 190 | 183 | 167 | 232 | 233 | **211** | -10.0% | 0.3% |
| Total Africa | 8431 | 9361 | 9962 | 10045 | 10274 | 10268 | 9908 | 10163 | 8580 | 9349 | **8818** | -5.7% | 10.1% |
| Australia | 664 | 582 | 580 | 542 | 559 | 547 | 512 | 560 | 500 | 489 | **416** | -16.8% | 0.4% |
| Brunei | 214 | 210 | 206 | 221 | 194 | 175 | 168 | 172 | 165 | 159 | **135** | -15.3% | 0.2% |
| China | 3406 | 3486 | 3642 | 3711 | 3742 | 3814 | 3805 | 4077 | 4074 | 4155 | **4180** | 0.6% | 5.0% |
| India | 802 | 816 | 785 | 809 | 809 | 809 | 796 | 873 | 903 | 894 | **894** | 0.1% | 1.0% |
| Indonesia | 1176 | 1130 | 1096 | 1018 | 972 | 1006 | 994 | 1003 | 952 | 918 | **882** | -4.0% | 1.0% |
| Malaysia | 760 | 776 | 757 | 713 | 742 | 741 | 701 | 703 | 640 | 670 | **657** | -2.2% | 0.7% |
| Thailand | 244 | 241 | 297 | 325 | 341 | 362 | 376 | 388 | 414 | 450 | **459** | 1.8% | 0.4% |
| Vietnam | 361 | 424 | 389 | 355 | 334 | 311 | 342 | 312 | 317 | 348 | **350** | 0.4% | 0.4% |
| Other Asia Pacific | 192 | 233 | 284 | 303 | 318 | 338 | 330 | 315 | 300 | 285 | **260** | -8.5% | 0.3% |
| Total Asia Pacific | 7819 | 7898 | 8035 | 7996 | 8011 | 8103 | 8025 | 8404 | 8266 | 8370 | **8232** | -1.7% | 9.5% |
| **Total World** | **77639** | **81054** | **82107** | **82593** | **82383** | **82955** | **81262** | **83296** | **84049** | **86204** | **86754** | **0.6%** | **100.0%** |
| of which: OECD | 21214 | 20813 | 19902 | 19465 | 19151 | 18440 | 18445 | 18547 | 18601 | 19492 | **20523** | 5.6% | 23.0% |
| Non-OECD | 56425 | 60241 | 62204 | 63129 | 63233 | 64515 | 62818 | 64750 | 65448 | 66712 | **66230** | -0.8% | 77.0% |
| OPEC | 31231 | 34040 | 35170 | 35489 | 35161 | 36279 | 33978 | 35088 | 35911 | 37427 | **36829** | -1.8% | 42.1% |
| Non-OPEC‡ | 35879 | 35601 | 35102 | 34786 | 34420 | 33852 | 34016 | 34650 | 34529 | 35122 | **36062** | 2.7% | 41.4% |
| European Union | 3185 | 2955 | 2708 | 2468 | 2425 | 2264 | 2127 | 1987 | 1724 | 1528 | **1437** | -5.8% | 1.7% |
| Former Soviet Union | 10530 | 11414 | 11835 | 12318 | 12803 | 12824 | 13269 | 13558 | 13609 | 13655 | **13863** | 1.4% | 16.4% |

**Oil consumption**

## Consumption*

| Thousand barrels daily | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | Change 2013 over 2012 | 2013 share of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 20033 | 20732 | 20802 | 20687 | 20680 | 19490 | 18771 | 19180 | 18882 | 18490 | **18887** | 2.0% | 19.9% |
| Canada | 2228 | 2309 | 2288 | 2295 | 2361 | 2315 | 2190 | 2316 | 2404 | 2394 | **2385** | -0.5% | 2.5% |
| Mexico | 1909 | 1983 | 2030 | 2019 | 2067 | 2054 | 1995 | 2014 | 2042 | 2063 | **2020** | -2.6% | 2.1% |
| Total North America | 24170 | 25023 | 25119 | 25002 | 25109 | 23860 | 22957 | 23510 | 23329 | 22948 | **23292** | 1.3% | 24.5% |
| Argentina | 405 | 425 | 449 | 471 | 523 | 535 | 525 | 571 | 585 | 613 | **636** | 3.6% | 0.7% |
| Brazil | 1973 | 2050 | 2097 | 2134 | 2286 | 2439 | 2467 | 2669 | 2730 | 2807 | **2973** | 5.8% | 3.2% |
| Chile | 228 | 244 | 250 | 278 | 358 | 372 | 367 | 329 | 355 | 368 | **377** | 2.0% | 0.4% |
| Colombia | 222 | 225 | 230 | 235 | 234 | 233 | 239 | 250 | 269 | 285 | **297** | 4.0% | 0.3% |
| Ecuador | 151 | 155 | 169 | 180 | 183 | 188 | 191 | 220 | 226 | 233 | **248** | 6.3% | 0.3% |
| Peru | 139 | 152 | 152 | 147 | 153 | 172 | 176 | 187 | 203 | 212 | **224** | 5.3% | 0.2% |
| Trinidad & Tobago | 24 | 25 | 26 | 29 | 34 | 37 | 35 | 39 | 35 | 35 | **38** | 6.3% | * |
| Venezuela | 506 | 545 | 606 | 633 | 640 | 716 | 727 | 691 | 689 | 712 | **777** | 10.2% | 0.9% |
| Other S. & Cent. America | 1224 | 1235 | 1221 | 1235 | 1250 | 1190 | 1186 | 1199 | 1212 | 1212 | **1206** | -1.0% | 1.4% |
| Total S. & Cent. America | 4872 | 5056 | 5200 | 5340 | 5661 | 5881 | 5913 | 6155 | 6306 | 6478 | **6775** | 4.4% | 7.4% |
| Austria | 292 | 283 | 287 | 291 | 276 | 274 | 264 | 276 | 258 | 258 | **259** | 0.6% | 0.3% |
| Azerbaijan | 84 | 88 | 106 | 96 | 91 | 74 | 73 | 71 | 89 | 92 | **101** | 9.8% | 0.1% |
| Belarus | 163 | 162 | 151 | 176 | 162 | 159 | 183 | 152 | 175 | 175 | **177** | 0.7% | 0.2% |
| Belgium | 688 | 680 | 679 | 671 | 676 | 747 | 650 | 672 | 662 | 631 | **654** | 2.5% | 0.7% |
| Bulgaria | 95 | 92 | 102 | 105 | 103 | 102 | 92 | 82 | 80 | 82 | **86** | 4.2% | 0.1% |
| Czech Republic | 184 | 202 | 210 | 207 | 205 | 209 | 204 | 195 | 193 | 191 | **184** | -3.9% | 0.2% |
| Denmark | 188 | 185 | 187 | 190 | 191 | 188 | 169 | 171 | 168 | 159 | **160** | 0.5% | 0.2% |
| Finland | 235 | 221 | 229 | 222 | 223 | 222 | 209 | 219 | 204 | 190 | **188** | -1.7% | 0.2% |
| France | 1952 | 1963 | 1946 | 1942 | 1911 | 1889 | 1822 | 1763 | 1742 | 1689 | **1683** | -0.6% | 1.9% |
| Germany | 2648 | 2619 | 2592 | 2609 | 2380 | 2502 | 2409 | 2445 | 2369 | 2356 | **2382** | 0.9% | 2.7% |
| Greece | 396 | 426 | 424 | 442 | 435 | 425 | 405 | 365 | 347 | 310 | **287** | -7.1% | 0.3% |
| Hungary | 131 | 136 | 158 | 168 | 168 | 164 | 154 | 146 | 140 | 128 | **131** | 1.6% | 0.1% |
| Republic of Ireland | 175 | 181 | 191 | 191 | 195 | 187 | 166 | 158 | 141 | 134 | **140** | 4.7% | 0.2% |
| Italy | 1900 | 1850 | 1798 | 1791 | 1740 | 1661 | 1563 | 1532 | 1475 | 1346 | **1308** | -3.6% | 1.5% |
| Kazakhstan | 183 | 196 | 204 | 210 | 233 | 229 | 188 | 196 | 256 | 274 | **287** | 5.9% | 0.3% |
| Lithuania | 50 | 53 | 57 | 58 | 58 | 63 | 54 | 55 | 53 | 55 | **55** | 1.4% | 0.1% |
| Netherlands | 946 | 983 | 1039 | 1047 | 1065 | 991 | 971 | 977 | 971 | 926 | **898** | -4.9% | 1.0% |
| Norway | 232 | 221 | 224 | 229 | 237 | 228 | 236 | 235 | 240 | 235 | **241** | 1.0% | 0.3% |
| Poland | 441 | 469 | 487 | 512 | 531 | 549 | 549 | 576 | 574 | 553 | **524** | -6.2% | 0.6% |
| Portugal | 311 | 315 | 324 | 294 | 296 | 278 | 263 | 259 | 240 | 226 | **228** | -0.8% | 0.3% |
| Romania | 194 | 224 | 218 | 214 | 218 | 216 | 195 | 184 | 191 | 191 | **188** | -1.7% | 0.2% |
| Russian Federation | 2679 | 2660 | 2679 | 2761 | 2777 | 2862 | 2772 | 2892 | 3089 | 3212 | **3313** | 3.1% | 3.7% |
| Slovakia | 70 | 67 | 80 | 72 | 76 | 82 | 79 | 82 | 81 | 74 | **73** | -1.3% | 0.1% |
| Spain | 1539 | 1575 | 1594 | 1592 | 1613 | 1557 | 1473 | 1394 | 1377 | 1285 | **1200** | -7.3% | 1.4% |
| Sweden | 367 | 362 | 358 | 358 | 357 | 350 | 323 | 336 | 311 | 309 | **305** | -2.0% | 0.3% |
| Switzerland | 257 | 255 | 260 | 266 | 241 | 256 | 260 | 242 | 235 | 238 | **249** | 5.0% | 0.3% |
| Turkey | 649 | 660 | 665 | 698 | 718 | 684 | 707 | 694 | 672 | 678 | **714** | 5.7% | 0.8% |
| Turkmenistan | 110 | 112 | 113 | 109 | 115 | 119 | 110 | 123 | 130 | 134 | **137** | 2.8% | 0.2% |
| Ukraine | 295 | 310 | 296 | 308 | 318 | 301 | 282 | 268 | 279 | 267 | **260** | -2.7% | 0.3% |
| United Kingdom | 1723 | 1766 | 1806 | 1788 | 1716 | 1683 | 1610 | 1588 | 1532 | 1520 | **1503** | -1.4% | 1.7% |
| Uzbekistan | 145 | 146 | 103 | 103 | 94 | 92 | 89 | 77 | 72 | 69 | **70** | 2.1% | 0.1% |
| Other Europe & Eurasia | 567 | 600 | 623 | 637 | 660 | 670 | 658 | 662 | 664 | 649 | **661** | 1.6% | 0.8% |
| Total Europe & Eurasia | 19888 | 20063 | 20187 | 20357 | 20082 | 20013 | 19181 | 19087 | 19009 | 18636 | **18645** | -0.4% | 21.0% |
| Iran | 1508 | 1548 | 1699 | 1843 | 1874 | 1959 | 2011 | 1873 | 1909 | 1927 | **2002** | 4.0% | 2.2% |
| Israel | 267 | 251 | 257 | 251 | 264 | 259 | 244 | 236 | 249 | 289 | **231** | -21.9% | 0.3% |
| Kuwait | 334 | 374 | 411 | 378 | 383 | 405 | 454 | 487 | 466 | 490 | **494** | 1.2% | 0.5% |
| Qatar | 95 | 106 | 120 | 135 | 153 | 173 | 172 | 193 | 237 | 248 | **267** | 7.1% | 0.2% |
| Saudi Arabia | 1780 | 1913 | 2012 | 2083 | 2201 | 2376 | 2592 | 2803 | 2847 | 2989 | **3075** | 3.1% | 3.2% |
| United Arab Emirates | 453 | 484 | 493 | 527 | 565 | 586 | 566 | 630 | 718 | 748 | **773** | 4.2% | 0.9% |
| Other Middle East | 1233 | 1265 | 1343 | 1238 | 1314 | 1448 | 1468 | 1546 | 1577 | 1661 | **1683** | 1.5% | 1.9% |
| Total Middle East | 5670 | 5941 | 6335 | 6456 | 6755 | 7206 | 7508 | 7767 | 8004 | 8353 | **8526** | 2.2% | 9.2% |
| Algeria | 230 | 239 | 250 | 258 | 286 | 309 | 327 | 327 | 345 | 368 | **386** | 5.0% | 0.4% |
| Egypt | 540 | 556 | 617 | 602 | 642 | 687 | 726 | 766 | 720 | 746 | **757** | 1.5% | 0.9% |
| South Africa | 497 | 513 | 518 | 528 | 556 | 536 | 510 | 559 | 577 | 572 | **570** | -0.1% | 0.7% |
| Other Africa | 1388 | 1464 | 1535 | 1539 | 1584 | 1704 | 1744 | 1827 | 1733 | 1833 | **1911** | 4.6% | 2.2% |
| Total Africa | 2654 | 2771 | 2920 | 2927 | 3068 | 3235 | 3306 | 3479 | 3374 | 3519 | **3624** | 3.2% | 4.1% |
| Australia | 854 | 865 | 897 | 930 | 937 | 950 | 937 | 953 | 1000 | 1027 | **1026** | -0.4% | 1.1% |
| Bangladesh | 83 | 86 | 89 | 89 | 86 | 86 | 77 | 88 | 113 | 118 | **116** | -1.7% | 0.1% |
| China | 5771 | 6740 | 6945 | 7500 | 7860 | 7994 | 8306 | 9317 | 9867 | 10367 | **10756** | 3.8% | 12.1% |
| China Hong Kong SAR | 269 | 313 | 285 | 305 | 324 | 293 | 334 | 362 | 363 | 347 | **354** | 2.6% | 0.4% |
| India | 2485 | 2556 | 2606 | 2737 | 2941 | 3077 | 3237 | 3319 | 3488 | 3685 | **3727** | 1.2% | 4.2% |
| Indonesia | 1222 | 1299 | 1285 | 1247 | 1299 | 1294 | 1334 | 1449 | 1572 | 1597 | **1623** | 1.1% | 1.8% |
| Japan | 5456 | 5308 | 5391 | 5210 | 5053 | 4882 | 4422 | 4474 | 4470 | 4709 | **4551** | -3.8% | 5.0% |
| Malaysia | 620 | 633 | 637 | 660 | 701 | 672 | 679 | 689 | 718 | 712 | **725** | 2.0% | 0.7% |
| New Zealand | 146 | 147 | 150 | 152 | 153 | 154 | 147 | 151 | 150 | 148 | **151** | 2.1% | 0.2% |
| Pakistan | 319 | 324 | 311 | 354 | 387 | 388 | 414 | 411 | 417 | 402 | **445** | 10.3% | 0.5% |
| Philippines | 329 | 336 | 314 | 284 | 301 | 266 | 283 | 285 | 281 | 283 | **298** | 5.5% | 0.3% |
| Singapore | 688 | 761 | 828 | 883 | 961 | 1013 | 1077 | 1190 | 1242 | 1239 | **1259** | 1.1% | 1.6% |
| South Korea | 2340 | 2294 | 2312 | 2320 | 2399 | 2308 | 2339 | 2370 | 2394 | 2458 | **2460** | * | 2.6% |
| Taiwan | 1012 | 1056 | 1054 | 1053 | 1111 | 1005 | 982 | 1011 | 946 | 934 | **977** | 3.9% | 1.0% |
| Thailand | 844 | 911 | 943 | 944 | 942 | 944 | 1024 | 1043 | 1119 | 1191 | **1211** | 2.0% | 1.2% |
| Vietnam | 220 | 263 | 258 | 254 | 283 | 300 | 313 | 337 | 366 | 371 | **378** | 2.0% | 0.4% |
| Other Asia Pacific | 304 | 309 | 325 | 323 | 342 | 324 | 342 | 352 | 406 | 409 | **412** | 0.8% | 0.5% |
| Total Asia Pacific | 22962 | 24202 | 24629 | 25244 | 26080 | 25952 | 26247 | 27802 | 28912 | 29997 | **30470** | 1.5% | 33.8% |
| **Total World** | **80216** | **83055** | **84389** | **85325** | **86754** | **86147** | **85111** | **87801** | **88934** | **89931** | **91331** | **1.4%** | **100.0%** |
| of which: OECD | 48934 | 49713 | 50078 | 49888 | 49690 | 48085 | 46057 | 46509 | 46040 | 45545 | **45558** | -0.4% | 49.2% |
| Non-OECD | 31282 | 33342 | 34311 | 35437 | 37064 | 38062 | 39054 | 41292 | 42894 | 44386 | **45773** | 3.1% | 50.8% |
| European Union | 14866 | 15002 | 15123 | 15122 | 14802 | 14710 | 13977 | 13827 | 13455 | 12946 | **12770** | -1.9% | 14.5% |
| Former Soviet Union | 3814 | 3840 | 3829 | 3943 | 3993 | 4040 | 3887 | 3984 | 4293 | 4434 | **4559** | 2.8% | 5.1% |

**Proved natural gas**

# Natural gas

## Proved reserves

| | At end 1993 Trillion cubic metres | At end 2003 Trillion cubic metres | At end 2012 Trillion cubic metres | At end 2013 Trillion cubic feet | At end 2013 Trillion cubic metres | At end 2013 Share of total | At end 2013 R/P ratio |
|---|---|---|---|---|---|---|---|
| US | 4.6 | 5.4 | 8.7 | **330.0** | **9.3** | 5.0% | 13.6 |
| Canada | 2.2 | 1.6 | 2.0 | **71.4** | **2.0** | 1.1% | 13.1 |
| Mexico | 2.0 | 0.4 | 0.4 | **12.3** | **0.3** | 0.2% | 6.1 |
| Total North America | 8.8 | 7.4 | 11.1 | **413.7** | **11.7** | 6.3% | 13.0 |
| Argentina | 0.5 | 0.6 | 0.3 | **11.1** | **0.3** | 0.2% | 8.9 |
| Bolivia | 0.1 | 0.8 | 0.3 | **11.2** | **0.3** | 0.2% | 15.2 |
| Brazil | 0.1 | 0.2 | 0.5 | **15.9** | **0.5** | 0.2% | 21.2 |
| Colombia | 0.2 | 0.1 | 0.2 | **5.7** | **0.2** | 0.1% | 12.8 |
| Peru | 0.3 | 0.2 | 0.4 | **15.4** | **0.4** | 0.2% | 35.7 |
| Trinidad & Tobago | 0.2 | 0.5 | 0.4 | **12.4** | **0.4** | 0.2% | 8.2 |
| Venezuela | 3.7 | 4.2 | 5.6 | **196.8** | **5.6** | 3.0% | * |
| Other S. & Cent. America | 0.2 | 0.1 | 0.1 | **2.2** | **0.1** | • | 24.9 |
| Total S. & Cent. America | 5.4 | 6.8 | 7.7 | **270.9** | **7.7** | 4.1% | 43.5 |
| Azerbaijan | n/a | 0.9 | 0.9 | **31.0** | **0.9** | 0.5% | 54.3 |
| Denmark | 0.1 | 0.1 | † | **1.2** | **†** | • | 7.0 |
| Germany | 0.2 | 0.2 | 0.1 | **1.7** | **†** | • | 5.9 |
| Italy | 0.3 | 0.1 | 0.1 | **1.8** | **0.1** | • | 7.3 |
| Kazakhstan | n/a | 1.3 | 1.5 | **53.9** | **1.5** | 0.8% | 82.5 |
| Netherlands | 1.7 | 1.4 | 0.9 | **30.1** | **0.9** | 0.5% | 12.4 |
| Norway | 1.4 | 2.5 | 2.1 | **72.4** | **2.0** | 1.1% | 18.8 |
| Poland | 0.2 | 0.1 | 0.1 | **4.1** | **0.1** | 0.1% | 27.5 |
| Romania | 0.4 | 0.3 | 0.1 | **4.1** | **0.1** | 0.1% | 10.6 |
| Russian Federation | n/a | 30.4 | 31.0 | **1103.6** | **31.3** | 16.8% | 51.7 |
| Turkmenistan | n/a | 2.3 | 17.5 | **617.3** | **17.5** | 9.4% | * |
| Ukraine | n/a | 0.7 | 0.6 | **22.7** | **0.6** | 0.3% | 33.4 |
| United Kingdom | 0.6 | 0.9 | 0.2 | **8.6** | **0.2** | 0.1% | 6.7 |
| Uzbekistan | n/a | 1.2 | 1.1 | **38.3** | **1.1** | 0.6% | 19.7 |
| Other Europe & Eurasia | 35.6 | 0.4 | 0.3 | **8.8** | **0.2** | 0.1% | 33.4 |
| Total Europe & Eurasia | 40.5 | 42.7 | 56.5 | **1999.5** | **56.6** | 30.5% | 54.8 |
| Bahrain | 0.2 | 0.1 | 0.2 | **6.7** | **0.2** | 0.1% | 12.1 |
| Iran | 20.7 | 27.6 | 33.6 | **1192.9** | **33.8** | 18.2% | * |
| Iraq | 3.1 | 3.2 | 3.6 | **126.7** | **3.6** | 1.9% | * |
| Kuwait | 1.5 | 1.6 | 1.8 | **63.0** | **1.8** | 1.0% | * |
| Oman | 0.2 | 1.0 | 0.9 | **33.5** | **0.9** | 0.5% | 30.7 |
| Qatar | 7.1 | 25.3 | 24.9 | **871.5** | **24.7** | 13.3% | * |
| Saudi Arabia | 5.2 | 6.8 | 8.2 | **290.8** | **8.2** | 4.4% | 79.9 |
| Syria | 0.2 | 0.3 | 0.3 | **10.1** | **0.3** | 0.2% | 63.9 |
| United Arab Emirates | 5.8 | 6.0 | 6.1 | **215.1** | **6.1** | 3.3% | * |
| Yemen | 0.4 | 0.5 | 0.5 | **16.9** | **0.5** | 0.3% | 46.3 |
| Other Middle East | † | 0.1 | 0.2 | **8.1** | **0.2** | 0.1% | 35.3 |
| Total Middle East | 44.4 | 72.4 | 80.3 | **2835.4** | **80.3** | 43.2% | * |
| Algeria | 3.7 | 4.5 | 4.5 | **159.1** | **4.5** | 2.4% | 57.3 |
| Egypt | 0.6 | 1.7 | 2.0 | **65.2** | **1.8** | 1.0% | 32.9 |
| Libya | 1.3 | 1.5 | 1.5 | **54.7** | **1.5** | 0.8% | * |
| Nigeria | 3.7 | 5.1 | 5.1 | **179.4** | **5.1** | 2.7% | * |
| Other Africa | 0.7 | 1.0 | 1.2 | **43.3** | **1.2** | 0.7% | 56.9 |
| Total Africa | 10.0 | 13.9 | 14.4 | **501.7** | **14.2** | 7.6% | 69.5 |
| Australia | 1.0 | 2.4 | 3.8 | **129.9** | **3.7** | 2.0% | 85.8 |
| Bangladesh | 0.3 | 0.4 | 0.3 | **9.7** | **0.3** | 0.1% | 12.6 |
| Brunei | 0.4 | 0.3 | 0.3 | **10.2** | **0.3** | 0.2% | 23.6 |
| China | 1.7 | 1.3 | 3.3 | **115.6** | **3.3** | 1.8% | 28.0 |
| India | 0.7 | 0.9 | 1.3 | **47.8** | **1.4** | 0.7% | 40.2 |
| Indonesia | 1.8 | 2.6 | 2.9 | **103.3** | **2.9** | 1.6% | 41.6 |
| Malaysia | 1.8 | 2.5 | 1.1 | **38.5** | **1.1** | 0.6% | 15.8 |
| Myanmar | 0.3 | 0.4 | 0.3 | **10.0** | **0.3** | 0.2% | 21.6 |
| Pakistan | 0.7 | 0.8 | 0.6 | **22.7** | **0.6** | 0.3% | 16.7 |
| Papua New Guinea | † | † | 0.2 | **5.5** | **0.2** | 0.1% | * |
| Thailand | 0.2 | 0.4 | 0.3 | **10.1** | **0.3** | 0.2% | 6.8 |
| Vietnam | 0.1 | 0.2 | 0.6 | **21.8** | **0.6** | 0.3% | 63.3 |
| Other Asia Pacific | 0.3 | 0.5 | 0.3 | **11.5** | **0.3** | 0.2% | 17.5 |
| Total Asia Pacific | 9.3 | 12.7 | 15.2 | **536.6** | **15.2** | 8.2% | 31.1 |
| **Total World** | **118.4** | **155.7** | **185.3** | **6557.8** | **185.7** | **100.0%** | **55.1** |
| of which: OECD | 14.6 | 15.3 | 18.7 | **678.3** | **19.2** | 10.3% | 16.0 |
| Non-OECD | 103.8 | 140.4 | 166.6 | **5879.5** | **166.5** | 89.7% | 76.7 |
| European Union | 3.7 | 3.2 | 1.6 | **55.6** | **1.6** | 0.8% | 10.7 |
| Former Soviet Union | 35.3 | 36.9 | 52.8 | **1869.5** | **52.9** | 28.5% | 68.2 |

## Natural gas production

**Production***

| Billion cubic metres | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | **2013** | Change 2013 over 2012 | 2013 share of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 540.8 | 526.4 | 511.1 | 524.0 | 545.6 | 570.8 | 584.0 | 603.6 | 648.5 | 681.2 | **687.6** | 1.3% | 20.6% |
| Canada | 184.7 | 183.7 | 187.1 | 188.4 | 182.7 | 176.6 | 164.0 | 159.9 | 159.7 | 156.0 | **154.8** | -0.5% | 4.6% |
| Mexico | 41.7 | 43.4 | 52.3 | 57.3 | 53.7 | 53.4 | 59.4 | 57.6 | 58.3 | 56.9 | **56.6** | -0.2% | 1.7% |
| Total North America | 767.2 | 753.6 | 750.6 | 769.7 | 781.9 | 800.8 | 807.4 | 821.1 | 866.5 | 894.2 | **899.1** | 0.9% | 26.9% |
| Argentina | 41.0 | 44.9 | 45.6 | 46.1 | 44.8 | 44.1 | 41.4 | 40.1 | 38.8 | 37.7 | **35.5** | -5.6% | 1.1% |
| Bolivia | 6.4 | 9.8 | 11.9 | 12.9 | 13.8 | 14.3 | 12.3 | 14.2 | 16.0 | 18.3 | **20.8** | 14.4% | 0.6% |
| Brazil | 10.0 | 11.0 | 10.9 | 11.2 | 11.2 | 14.0 | 11.9 | 14.6 | 16.7 | 19.3 | **21.3** | 11.0% | 0.6% |
| Colombia | 6.1 | 6.4 | 6.7 | 7.0 | 7.5 | 9.1 | 10.5 | 11.3 | 11.0 | 12.0 | **12.6** | 5.8% | 0.4% |
| Peru | 0.5 | 0.9 | 1.5 | 1.8 | 2.7 | 3.4 | 3.5 | 7.2 | 11.3 | 11.9 | **12.2** | 3.1% | 0.4% |
| Trinidad & Tobago | 27.0 | 30.2 | 33.0 | 40.1 | 42.2 | 42.0 | 43.6 | 44.8 | 42.9 | 42.7 | **42.8** | 0.5% | 1.3% |
| Venezuela | 25.2 | 28.4 | 27.4 | 31.5 | 36.1 | 32.8 | 31.0 | 27.4 | 27.6 | 29.5 | **28.4** | -3.2% | 0.8% |
| Other S. & Cent. America | 3.1 | 3.1 | 3.4 | 3.8 | 3.9 | 3.7 | 4.2 | 3.6 | 3.1 | 2.9 | **2.5** | -13.4% | 0.1% |
| Total S. & Cent. America | 119.4 | 134.7 | 140.5 | 154.3 | 162.3 | 163.2 | 158.5 | 163.2 | 167.4 | 174.3 | **176.4** | 1.5% | 5.2% |
| Azerbaijan | 4.6 | 4.5 | 5.2 | 6.1 | 9.8 | 14.8 | 14.8 | 15.1 | 14.8 | 15.6 | **16.2** | 3.8% | 0.5% |
| Denmark | 8.0 | 9.4 | 10.4 | 10.4 | 9.2 | 10.1 | 8.4 | 8.2 | 6.6 | 5.8 | **4.8** | -15.6% | 0.1% |
| Germany | 17.7 | 16.4 | 15.8 | 15.6 | 14.3 | 13.0 | 12.2 | 10.6 | 10.0 | 9.0 | **8.2** | -8.8% | 0.2% |
| Italy | 12.7 | 11.9 | 11.1 | 10.1 | 8.9 | 8.5 | 7.3 | 7.7 | 7.7 | 7.9 | **7.1** | -9.9% | 0.2% |
| Kazakhstan | 11.1 | 12.3 | 12.7 | 13.0 | 15.1 | 16.9 | 16.4 | 15.9 | 17.5 | 18.4 | **18.5** | 0.8% | 0.5% |
| Netherlands | 58.1 | 68.5 | 62.5 | 61.6 | 60.5 | 66.6 | 62.7 | 70.5 | 64.2 | 63.9 | **68.7** | 7.9% | 2.0% |
| Norway | 73.1 | 79.2 | 85.8 | 88.7 | 90.3 | 100.1 | 104.4 | 107.3 | 101.3 | 114.7 | **108.7** | -5.0% | 3.2% |
| Poland | 4.0 | 4.4 | 4.3 | 4.3 | 4.3 | 4.1 | 4.1 | 4.1 | 4.3 | 4.3 | **4.2** | -1.4% | 0.1% |
| Romania | 13.0 | 12.8 | 12.4 | 11.9 | 11.5 | 11.4 | 11.3 | 10.9 | 10.9 | 10.9 | **11.0** | 0.6% | 0.3% |
| Russian Federation | 561.6 | 573.3 | 580.1 | 595.2 | 592.1 | 601.8 | 527.7 | 588.9 | 607.0 | 592.3 | **604.8** | 2.4% | 17.9% |
| Turkmenistan | 53.5 | 52.8 | 57.0 | 60.4 | 65.4 | 66.1 | 36.4 | 42.4 | 59.5 | 62.3 | **62.3** | 0.4% | 1.8% |
| Ukraine | 17.6 | 18.4 | 18.6 | 18.7 | 18.7 | 19.0 | 19.3 | 18.5 | 18.7 | 18.6 | **19.3** | 4.0% | 0.6% |
| United Kingdom | 102.9 | 96.4 | 88.2 | 80.0 | 72.1 | 69.6 | 59.7 | 57.1 | 45.2 | 38.9 | **36.5** | -5.9% | 1.1% |
| Uzbekistan | 52.0 | 54.2 | 54.0 | 54.5 | 59.1 | 62.2 | 60.0 | 59.6 | 57.0 | 56.9 | **55.2** | -2.8% | 1.6% |
| Other Europe & Eurasia | 10.6 | 11.0 | 10.7 | 10.5 | 10.7 | 10.2 | 10.2 | 10.1 | 9.5 | 8.7 | **7.5** | -13.8% | 0.2% |
| Total Europe & Eurasia | 1000.5 | 1025.3 | 1028.8 | 1040.9 | 1042.1 | 1074.4 | 954.8 | 1026.9 | 1034.2 | 1028.1 | **1032.9** | 0.7% | 30.6% |
| Bahrain | 9.6 | 9.8 | 10.7 | 11.3 | 11.8 | 12.7 | 12.8 | 13.1 | 13.3 | 13.7 | **15.8** | 15.2% | 0.5% |
| Iran | 82.7 | 96.4 | 102.3 | 111.5 | 125.0 | 132.4 | 144.2 | 152.4 | 159.9 | 165.6 | **166.6** | 0.8% | 4.9% |
| Iraq | 1.6 | 1.0 | 1.5 | 1.5 | 1.5 | 1.9 | 1.2 | 1.3 | 0.9 | 0.7 | **0.6** | -4.4% | * |
| Kuwait | 11.0 | 11.9 | 12.2 | 12.5 | 12.1 | 12.8 | 11.5 | 11.7 | 13.5 | 15.5 | **15.6** | 0.7% | 0.5% |
| Oman | 16.5 | 18.5 | 19.8 | 23.7 | 24.0 | 24.1 | 24.8 | 27.1 | 26.5 | 30.0 | **30.9** | 3.3% | 0.9% |
| Qatar | 31.4 | 39.2 | 45.8 | 50.7 | 63.2 | 77.0 | 89.3 | 116.7 | 145.3 | 150.8 | **158.5** | 5.4% | 4.7% |
| Saudi Arabia | 60.1 | 65.7 | 71.2 | 73.5 | 74.4 | 80.4 | 78.5 | 87.7 | 92.3 | 99.3 | **103.0** | 4.0% | 3.0% |
| Syria | 6.2 | 6.4 | 5.5 | 5.6 | 5.6 | 5.3 | 5.6 | 8.0 | 7.1 | 5.3 | **4.5** | -15.2% | 0.1% |
| United Arab Emirates | 44.8 | 46.3 | 47.8 | 49.0 | 50.3 | 50.2 | 48.8 | 51.3 | 52.3 | 54.3 | **56.0** | 3.3% | 1.7% |
| Yemen | – | – | – | – | – | – | 0.8 | 6.2 | 9.4 | 7.6 | **10.3** | 36.5% | 0.3% |
| Other Middle East | 0.3 | 1.5 | 1.9 | 2.6 | 3.0 | 3.6 | 3.0 | 3.4 | 4.4 | 2.6 | **6.5** | 148.5% | 0.2% |
| Total Middle East | 264.1 | 296.6 | 318.7 | 341.9 | 370.9 | 400.3 | 420.3 | 478.9 | 524.8 | 545.5 | **568.2** | 4.5% | 16.8% |
| Algeria | 82.8 | 82.0 | 88.2 | 84.5 | 84.8 | 85.8 | 79.6 | 80.4 | 82.7 | 81.5 | **78.6** | -3.3% | 2.3% |
| Egypt | 30.1 | 33.0 | 42.5 | 54.7 | 55.7 | 59.0 | 62.7 | 61.3 | 61.4 | 60.9 | **56.1** | -7.7% | 1.7% |
| Libya | 5.5 | 8.1 | 11.3 | 13.2 | 15.3 | 15.9 | 15.9 | 16.8 | 7.9 | 12.2 | **12.0** | -1.5% | 0.4% |
| Nigeria | 22.6 | 24.4 | 25.1 | 29.6 | 36.9 | 36.2 | 26.0 | 37.3 | 40.6 | 43.3 | **36.1** | -16.4% | 1.1% |
| Other Africa | 7.2 | 8.9 | 9.9 | 10.4 | 12.3 | 15.8 | 16.3 | 18.4 | 18.6 | 18.5 | **21.6** | 17.2% | 0.6% |
| Total Africa | 148.2 | 156.4 | 177.0 | 192.4 | 205.0 | 212.6 | 200.4 | 214.3 | 211.2 | 216.3 | **204.3** | -5.3% | 6.0% |
| Australia | 33.2 | 35.3 | 37.1 | 38.9 | 40.0 | 38.3 | 42.3 | 45.2 | 44.9 | 43.4 | **42.9** | -0.9% | 1.3% |
| Bangladesh | 12.3 | 12.8 | 13.8 | 15.1 | 15.9 | 17.0 | 18.5 | 19.9 | 20.1 | 21.1 | **21.9** | 4.2% | 0.6% |
| Brunei | 12.4 | 12.2 | 12.0 | 12.6 | 12.3 | 12.2 | 11.4 | 12.3 | 12.8 | 12.6 | **12.2** | -2.6% | 0.4% |
| China | 35.0 | 41.5 | 49.3 | 58.6 | 69.2 | 80.3 | 85.3 | 94.8 | 102.7 | 107.2 | **117.1** | 9.5% | 3.5% |
| India | 29.5 | 29.2 | 29.6 | 29.3 | 30.1 | 30.5 | 39.2 | 50.8 | 46.1 | 40.3 | **33.7** | -16.3% | 1.0% |
| Indonesia | 73.2 | 70.3 | 71.2 | 70.3 | 67.6 | 69.7 | 71.9 | 82.0 | 75.9 | 71.1 | **70.4** | -0.7% | 2.1% |
| Malaysia | 51.8 | 53.9 | 61.1 | 63.3 | 64.6 | 64.7 | 63.4 | 65.3 | 65.3 | 66.5 | **69.1** | 4.2% | 2.0% |
| Myanmar | 9.6 | 10.2 | 12.2 | 12.6 | 13.5 | 12.4 | 11.6 | 12.4 | 12.8 | 12.7 | **13.1** | 3.1% | 0.4% |
| Pakistan | 30.4 | 34.5 | 35.5 | 36.1 | 36.8 | 37.5 | 38.4 | 39.6 | 39.2 | 41.2 | **38.6** | -6.2% | 1.1% |
| Thailand | 21.5 | 22.4 | 23.7 | 24.3 | 26.0 | 28.8 | 30.9 | 36.3 | 37.0 | 41.4 | **41.8** | 1.2% | 1.2% |
| Vietnam | 2.4 | 4.2 | 6.4 | 7.0 | 7.1 | 7.5 | 8.0 | 9.4 | 8.5 | 9.4 | **9.8** | 4.5% | 0.3% |
| Other Asia Pacific | 10.6 | 10.0 | 11.0 | 14.6 | 17.4 | 18.3 | 18.6 | 18.2 | 18.4 | 18.2 | **18.7** | 3.3% | 0.6% |
| Total Asia Pacific | 322.0 | 336.4 | 363.0 | 382.6 | 400.5 | 417.1 | 439.6 | 486.4 | 483.5 | 484.9 | **489.0** | 1.1% | 14.5% |
| **Total World** | **2621.3** | **2702.8** | **2778.6** | **2881.8** | **2962.7** | **3068.5** | **2981.0** | **3190.8** | **3287.7** | **3343.3** | **3369.9** | **1.1%** | **100.0%** |
| of which: OECD | 1093.9 | 1092.8 | 1084.3 | 1097.4 | 1101.2 | 1131.0 | 1128.7 | 1151.9 | 1170.0 | 1199.3 | **1200.0** | 0.4% | 35.8% |
| Non-OECD | 1527.4 | 1610.0 | 1694.3 | 1784.4 | 1861.5 | 1937.5 | 1852.3 | 2038.9 | 2117.7 | 2144.0 | **2169.8** | 1.5% | 64.2% |
| European Union | 225.8 | 229.5 | 214.1 | 203.0 | 190.2 | 192.1 | 174.7 | 178.0 | 157.0 | 147.9 | **146.8** | -0.5% | 4.3% |
| Former Soviet Union | 700.7 | 715.8 | 727.9 | 748.2 | 760.5 | 781.0 | 674.8 | 740.7 | 774.8 | 764.3 | **776.5** | 1.9% | 23.0% |

## Natural gas consumption

## Consumption*

| Billion cubic metres | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | **2013** | Change 2013 over 2012 | 2013 share of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| US | 630.8 | 634.4 | 623.4 | 614.4 | 654.2 | 659.1 | 648.7 | 682.1 | 693.1 | 723.0 | **737.2** | 2.4% | 22.2% |
| Canada | 97.7 | 95.1 | 97.8 | 96.9 | 96.2 | 96.1 | 94.9 | 95.0 | 100.9 | 100.3 | **103.5** | 3.5% | 3.1% |
| Mexico | 51.4 | 54.3 | 61.0 | 66.6 | 63.5 | 66.3 | 72.5 | 72.5 | 76.6 | 79.6 | **82.7** | 4.2% | 2.5% |
| Total North America | 779.9 | 783.8 | 782.2 | 778.0 | 813.9 | 821.5 | 816.1 | 849.6 | 870.6 | 902.9 | **923.5** | 2.7% | 27.8% |
| Argentina | 34.6 | 37.9 | 40.4 | 41.8 | 43.9 | 44.4 | 43.2 | 43.3 | 45.7 | 47.3 | **48.0** | 1.7% | 1.4% |
| Brazil | 15.8 | 18.8 | 19.6 | 20.6 | 21.2 | 24.9 | 20.1 | 26.8 | 26.7 | 31.7 | **37.6** | 19.2% | 1.1% |
| Chile | 8.0 | 8.7 | 8.4 | 7.8 | 4.6 | 2.7 | 3.1 | 5.3 | 5.4 | 5.4 | **4.3** | -19.4% | 0.1% |
| Colombia | 6.0 | 6.3 | 6.7 | 7.0 | 7.4 | 7.6 | 8.7 | 9.1 | 8.8 | 9.8 | **10.7** | 9.1% | 0.3% |
| Ecuador | 0.3 | 0.3 | 0.3 | 0.4 | 0.5 | 0.4 | 0.5 | 0.6 | 0.5 | 0.7 | **0.6** | -8.7% | * |
| Peru | 0.5 | 0.9 | 1.5 | 1.8 | 2.7 | 3.4 | 3.5 | 5.4 | 6.1 | 6.8 | **6.6** | -2.7% | 0.2% |
| Trinidad & Tobago | 13.4 | 14.8 | 16.3 | 21.2 | 21.9 | 21.3 | 22.2 | 23.2 | 23.1 | 22.2 | **22.4** | 1.1% | 0.7% |
| Venezuela | 25.2 | 28.4 | 27.4 | 31.5 | 36.2 | 34.3 | 32.3 | 29.0 | 29.7 | 31.4 | **30.5** | -2.5% | 0.9% |
| Other S. & Cent. America | 3.1 | 3.0 | 3.3 | 3.9 | 4.5 | 4.7 | 5.0 | 5.4 | 5.8 | 7.1 | **7.8** | 11.4% | 0.2% |
| Total S. & Cent. America | 106.8 | 119.0 | 123.9 | 136.0 | 142.8 | 143.7 | 138.6 | 148.0 | 151.9 | 162.3 | **168.6** | 4.2% | 5.0% |
| Austria | 9.4 | 9.5 | 10.0 | 9.4 | 8.9 | 9.5 | 9.3 | 10.1 | 9.5 | 9.0 | **8.5** | -5.9% | 0.3% |
| Azerbaijan | 7.7 | 8.3 | 8.6 | 9.1 | 8.0 | 9.2 | 7.8 | 7.4 | 8.1 | 8.5 | **8.6** | 1.5% | 0.3% |
| Belarus | 15.8 | 17.9 | 18.4 | 19.0 | 18.8 | 19.2 | 16.1 | 19.7 | 18.3 | 18.3 | **18.3** | 0.3% | 0.5% |
| Belgium | 16.0 | 16.2 | 16.4 | 16.7 | 16.6 | 16.5 | 16.8 | 18.8 | 16.6 | 16.9 | **16.8** | -0.4% | 0.5% |
| Bulgaria | 2.8 | 2.8 | 3.1 | 3.2 | 3.2 | 3.2 | 2.3 | 2.6 | 2.9 | 2.7 | **2.6** | -3.1% | 0.1% |
| Czech Republic | 8.7 | 9.1 | 9.5 | 9.3 | 8.7 | 8.7 | 8.2 | 9.3 | 8.4 | 8.2 | **8.4** | 3.2% | 0.3% |
| Denmark | 5.2 | 5.2 | 5.0 | 5.1 | 4.6 | 4.6 | 4.4 | 5.0 | 4.2 | 3.9 | **3.7** | -4.1% | 0.1% |
| Finland | 4.5 | 4.3 | 4.0 | 4.2 | 3.9 | 4.0 | 3.6 | 3.9 | 3.5 | 3.1 | **2.8** | -6.7% | 0.1% |
| France | 43.2 | 45.1 | 44.8 | 43.7 | 42.4 | 43.8 | 41.8 | 46.9 | 40.5 | 42.2 | **42.8** | 1.7% | 1.3% |
| Germany | 85.5 | 85.9 | 86.2 | 87.2 | 82.9 | 81.2 | 78.0 | 83.3 | 74.5 | 78.4 | **83.6** | 7.0% | 2.5% |
| Greece | 2.4 | 2.7 | 2.7 | 3.1 | 3.7 | 3.9 | 3.3 | 3.6 | 4.4 | 4.1 | **3.6** | -11.5% | 0.1% |
| Hungary | 13.2 | 13.1 | 12.2 | 10.8 | 13.1 | 14.0 | 12.7 | 12.6 | 10.3 | 10.2 | **8.6** | -16.2% | 0.3% |
| Republic of Ireland | 4.1 | 4.1 | 3.9 | 4.4 | 4.8 | 5.0 | 4.7 | 5.2 | 4.6 | 4.5 | **4.5** | -0.1% | 0.1% |
| Italy | 71.2 | 73.9 | 79.1 | 77.4 | 77.8 | 77.8 | 71.5 | 76.2 | 71.4 | 68.7 | **64.2** | -6.2% | 1.9% |
| Kazakhstan | 8.8 | 6.7 | 8.5 | 9.0 | 9.3 | 8.9 | 8.6 | 9.0 | 9.6 | 10.4 | **11.4** | 9.6% | 0.3% |
| Lithuania | 3.1 | 3.1 | 3.3 | 3.2 | 3.6 | 3.2 | 2.7 | 3.1 | 3.4 | 3.3 | **2.7** | -18.3% | 0.1% |
| Netherlands | 40.0 | 40.9 | 39.3 | 38.1 | 37.0 | 38.6 | 38.9 | 43.6 | 38.1 | 36.4 | **37.1** | 2.0% | 1.1% |
| Norway | 4.3 | 4.6 | 4.5 | 4.4 | 4.3 | 4.3 | 4.1 | 4.1 | 4.3 | 4.4 | **4.4** | 1.4% | 0.1% |
| Poland | 12.5 | 13.2 | 13.6 | 13.7 | 13.8 | 14.9 | 14.4 | 15.5 | 15.7 | 16.6 | **16.7** | 1.1% | 0.5% |
| Portugal | 3.0 | 3.7 | 4.2 | 4.1 | 4.3 | 4.7 | 4.7 | 5.1 | 5.2 | 4.5 | **4.1** | -9.6% | 0.1% |
| Romania | 18.3 | 17.5 | 17.6 | 18.1 | 16.1 | 15.9 | 13.3 | 13.6 | 13.9 | 13.5 | **12.5** | -7.5% | 0.4% |
| Russian Federation | 379.5 | 389.3 | 394.1 | 415.0 | 422.0 | 416.0 | 389.7 | 414.2 | 424.6 | 416.3 | **413.5** | -0.4% | 12.3% |
| Slovakia | 6.3 | 6.1 | 6.6 | 6.0 | 5.7 | 5.7 | 4.9 | 5.6 | 5.2 | 4.9 | **5.4** | 11.5% | 0.2% |
| Spain | 23.6 | 27.4 | 32.4 | 33.7 | 35.1 | 38.6 | 34.6 | 34.6 | 32.2 | 31.3 | **29.0** | -7.2% | 0.9% |
| Sweden | 0.8 | 0.8 | 0.8 | 0.9 | 1.0 | 0.9 | 1.1 | 1.6 | 1.3 | 1.1 | **1.1** | -1.8% | * |
| Switzerland | 2.9 | 3.0 | 3.1 | 3.0 | 2.9 | 3.1 | 3.0 | 3.3 | 3.0 | 3.3 | **3.6** | 12.4% | 0.1% |
| Turkey | 20.9 | 22.1 | 26.9 | 30.5 | 36.1 | 37.5 | 35.7 | 39.0 | 44.7 | 45.3 | **45.6** | 1.1% | 1.4% |
| Turkmenistan | 14.2 | 15.0 | 16.1 | 18.4 | 21.3 | 20.5 | 19.9 | 22.6 | 23.4 | 26.4 | **22.3** | -15.5% | 0.7% |
| Ukraine | 69.0 | 68.5 | 69.0 | 67.0 | 63.2 | 60.0 | 46.8 | 52.2 | 53.7 | 49.5 | **45.0** | -8.9% | 1.3% |
| United Kingdom | 95.3 | 97.4 | 94.9 | 90.0 | 91.0 | 93.4 | 87.0 | 94.2 | 78.1 | 73.7 | **73.1** | -0.6% | 2.2% |
| Uzbekistan | 45.8 | 43.4 | 42.7 | 41.9 | 45.9 | 48.7 | 43.5 | 45.5 | 49.1 | 46.9 | **45.2** | -3.3% | 1.3% |
| Other Europe & Eurasia | 15.3 | 16.9 | 17.1 | 17.8 | 18.2 | 17.6 | 14.7 | 16.0 | 16.6 | 16.1 | **14.9** | -6.9% | 0.4% |
| Total Europe & Eurasia | 1053.6 | 1077.6 | 1098.2 | 1117.4 | 1128.0 | 1133.5 | 1048.2 | 1127.4 | 1099.3 | 1082.6 | **1064.7** | -1.4% | 31.7% |
| Iran | 85.0 | 98.7 | 102.8 | 112.0 | 125.5 | 134.8 | 143.2 | 152.9 | 162.4 | 161.5 | **162.2** | 0.7% | 4.8% |
| Israel | † | 1.2 | 1.7 | 2.3 | 2.8 | 4.1 | 4.5 | 5.3 | 5.0 | 2.6 | **6.9** | 168.7% | 0.2% |
| Kuwait | 11.0 | 11.9 | 12.2 | 12.5 | 12.1 | 12.8 | 12.4 | 14.5 | 17.0 | 18.2 | **17.8** | -1.9% | 0.5% |
| Qatar | 12.2 | 15.0 | 18.7 | 19.6 | 19.3 | 19.3 | 20.0 | 20.4 | 23.1 | 23.5 | **25.9** | 10.3% | 0.8% |
| Saudi Arabia | 60.1 | 65.7 | 71.2 | 73.5 | 74.4 | 80.4 | 78.5 | 87.7 | 92.3 | 99.3 | **103.0** | 4.0% | 3.1% |
| United Arab Emirates | 37.9 | 40.2 | 42.1 | 43.4 | 49.2 | 59.5 | 59.1 | 60.8 | 62.5 | 65.6 | **68.3** | 4.5% | 2.0% |
| Other Middle East | 25.0 | 26.5 | 28.4 | 31.5 | 32.4 | 36.5 | 38.9 | 44.2 | 40.6 | 42.3 | **44.3** | 5.1% | 1.3% |
| Total Middle East | 231.1 | 259.3 | 277.0 | 294.8 | 315.7 | 347.4 | 356.5 | 385.8 | 402.8 | 412.9 | **428.3** | 4.0% | 12.8% |
| Algeria | 21.4 | 22.0 | 23.2 | 23.7 | 24.3 | 25.4 | 27.2 | 26.3 | 27.8 | 31.0 | **32.3** | 4.3% | 1.0% |
| Egypt | 29.7 | 31.7 | 31.6 | 36.5 | 38.4 | 40.8 | 42.5 | 45.1 | 49.6 | 52.6 | **51.4** | -2.0% | 1.5% |
| South Africa | 1.0 | 2.1 | 3.1 | 3.5 | 3.5 | 3.7 | 3.4 | 3.9 | 3.9 | 4.0 | **3.9** | -1.0% | 0.1% |
| Other Africa | 22.7 | 25.4 | 27.7 | 25.6 | 30.1 | 31.4 | 26.9 | 32.5 | 33.4 | 35.4 | **35.7** | 1.3% | 1.1% |
| Total Africa | 74.8 | 81.2 | 85.6 | 89.3 | 96.2 | 101.3 | 100.1 | 107.9 | 114.8 | 123.0 | **123.3** | 0.6% | 3.7% |
| Australia | 22.4 | 22.8 | 22.2 | 24.4 | 26.6 | 25.5 | 25.2 | 25.4 | 25.2 | 18.6 | **17.9** | -3.5% | 0.5% |
| Bangladesh | 12.3 | 12.8 | 13.8 | 15.1 | 15.9 | 17.0 | 18.5 | 19.9 | 20.1 | 21.1 | **21.9** | 4.2% | 0.7% |
| China | 33.9 | 39.7 | 46.8 | 56.1 | 70.5 | 81.3 | 89.5 | 106.9 | 130.5 | 146.3 | **161.6** | 10.8% | 4.8% |
| China Hong Kong SAR | 1.8 | 2.7 | 2.7 | 2.9 | 2.7 | 3.2 | 3.1 | 3.8 | 3.1 | 2.8 | **2.6** | -5.5% | 0.1% |
| India | 29.5 | 31.9 | 35.7 | 37.3 | 40.1 | 41.3 | 51.9 | 63.0 | 61.4 | 58.8 | **51.4** | -12.2% | 1.5% |
| Indonesia | 35.0 | 32.2 | 33.2 | 33.2 | 31.3 | 33.3 | 37.4 | 40.3 | 37.3 | 35.8 | **38.4** | 7.6% | 1.1% |
| Japan | 79.8 | 77.0 | 78.6 | 83.7 | 90.2 | 93.7 | 87.4 | 94.5 | 105.5 | 116.9 | **116.9** | 0.2% | 3.5% |
| Malaysia | 27.3 | 24.7 | 31.4 | 33.7 | 33.4 | 33.8 | 33.0 | 35.1 | 31.8 | 34.7 | **34.0** | -1.8% | 1.0% |
| New Zealand | 4.3 | 3.9 | 3.6 | 3.7 | 4.0 | 3.8 | 4.0 | 4.3 | 3.9 | 4.2 | **4.4** | 5.6% | 0.1% |
| Pakistan | 30.4 | 34.5 | 35.5 | 36.1 | 36.8 | 37.5 | 38.4 | 39.6 | 39.2 | 41.2 | **38.6** | -6.2% | 1.1% |
| Philippines | 2.5 | 2.4 | 3.2 | 3.0 | 3.6 | 3.7 | 3.8 | 3.5 | 3.9 | 3.7 | **3.4** | -8.2% | 0.1% |
| Singapore | 4.0 | 5.0 | 6.8 | 7.1 | 8.6 | 8.2 | 8.1 | 8.4 | 8.8 | 9.4 | **10.5** | 12.3% | 0.3% |
| South Korea | 24.2 | 28.4 | 30.4 | 32.0 | 34.7 | 35.7 | 33.9 | 43.0 | 46.3 | 50.2 | **52.5** | 4.9% | 1.6% |
| Taiwan | 7.7 | 9.3 | 9.4 | 10.1 | 10.7 | 11.6 | 11.4 | 14.1 | 15.5 | 16.3 | **16.3** | 0.6% | 0.5% |
| Thailand | 28.6 | 29.9 | 32.5 | 33.3 | 35.4 | 37.4 | 39.2 | 45.1 | 46.6 | 51.2 | **52.2** | 2.2% | 1.6% |
| Vietnam | 2.4 | 4.2 | 6.4 | 7.0 | 7.1 | 7.5 | 8.0 | 9.4 | 8.5 | 9.4 | **9.8** | 4.5% | 0.3% |
| Other Asia Pacific | 4.2 | 4.5 | 5.2 | 5.5 | 6.0 | 5.7 | 5.2 | 5.8 | 6.2 | 6.6 | **6.7** | 1.7% | 0.2% |
| Total Asia Pacific | 350.3 | 365.7 | 397.3 | 424.2 | 457.6 | 480.3 | 497.9 | 562.2 | 593.5 | 627.1 | **639.2** | 2.2% | 19.0% |
| **Total World** | **2596.6** | **2686.7** | **2764.3** | **2839.6** | **2954.4** | **3027.7** | **2957.4** | **3180.8** | **3233.0** | **3310.8** | **3347.6** | **1.4%** | **100.0%** |
| of which: OECD | 1394.8 | 1417.1 | 1430.0 | 1430.9 | 1478.5 | 1501.2 | 1459.9 | 1551.8 | 1539.9 | 1573.9 | **1596.5** | 1.8% | 47.8% |
| Non-OECD | 1201.8 | 1269.6 | 1334.3 | 1408.7 | 1475.8 | 1526.5 | 1497.5 | 1629.0 | 1693.0 | 1736.8 | **1751.1** | 1.1% | 52.2% |
| European Union | 476.7 | 489.7 | 497.1 | 490.1 | 486.3 | 496.3 | 465.4 | 502.2 | 451.0 | 444.1 | **438.1** | -1.1% | 13.1% |
| Former Soviet Union | 551.7 | 560.8 | 569.8 | 592.3 | 601.7 | 595.0 | 542.6 | 581.5 | 598.9 | 588.4 | **575.5** | -1.9% | 17.1% |

## Appendix B

**Association between SCI and performance factors**

| **Articles** | **Scale size (no of respondents)** | **Types of informants/ Analysis method** | **SCI dimensions** | **Measures of performance** | **Study results** |
|---|---|---|---|---|---|
| Frohlich and Westbrook (2001) | 322 | Directors and managers / Scheffe analysis ANOVA | SI, CI | Marketplace, productivity, non-productivity | A significant and direct relationship between supplier integration and performance and also between customer integration and performance were found |
| Rosenzweig et al. (2003) | 867 | Vice presidents and directors / Regression analysis | SCI | Customer satisfaction, sales, delivery process flexibility, growth, reliability, cost leadership, quality, ROA, revenues from new products | A significant and direct relationship were found between the following:<br><br>SCI and product quality, SCI and delivery reliability, SCI and process flexibility, SCI and cost leadership, SCI and revenues from new products, SCI and ROA<br><br>A non-significant relationships were also found between SCI and customer satisfaction, and SCI with sales growth |
| Vickery et al. (2003) | 57 | CEOs and directors / SEM | SCI | Financial performance, customer service | A significant and direct relationship was found between SCI and customer service. However a non-significant relationship was found between SCI and financial performance |
| Droge et al. (2004) | 57 | CEOs/ Regression analysis | II, EI | Financial performance, market share, product cycle time, Product development time, responsiveness | A significant and direct relationship were found between the following:<br><br>• External integration, product development, time, product cycle time, and responsiveness<br>• Internal integration, product development time, product cycle time, and responsiveness<br>• External integration and market share<br>• Internal integration and financial performance<br>• Interaction of internal interaction and external integration and market share<br>• Interaction of internal interaction and external integration and financial performance |
| Gimenez and Ventura (2005) | 64 | Supply chain managers / SEM | II, EI | Performance | A significant and direct relationship were found between the following:<br><br>• Internal integration in the logistics/production interface and external integration<br>• Internal integration in the logistics/production interface and internal integration in the logistics/marketing interface<br>• Internal integration in the logistics/marketing interface and external integration<br>• External integration and performance<br><br>However non-significant relationships were also presented: |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | • Internal integration in the logistics/production interface and performance<br>• Internal integration in the logistics/marketing interface and performance |
| Koufteros et al. (2005) | 244 | Managers, directors, CEOs / SEM | II, CI, supplier product integration, and supplier process integration | Quality, innovation, profitability | A significant and direct relationship were found between the following:<br>• Internal integration and customer integration<br>• Internal integration and supplier product integration<br>• Internal integration and supplier process integration<br>• Customer integration and product innovation<br>• Supplier product integration and product innovation<br>However non-significant relationships were also presented:<br>• Customer integration and quality<br>• Supplier product integration and quality<br>• Supplier process integration and product innovation<br>• Supplier process integration and quality |
| Saeed et al. (2005) | 38 | Vice presidents / Regression analysis | II, EI | Sourcing leverage, process efficiency | A significant and direct relationship was found between external integration and process efficiency. However non-significant relationship was also found between external integration and sourcing leverage |
| Cousins and Menguc (2006) | 142 | Managers / SEM | SCI and supply chain socialization | Communication and operational performance | A significant and direct relationship was found between supply chain integration and supplier's communication performance. However non-significant relationship was also found between supply chain integration and supplier's operational performance |
| Das et al.(2006) | 322 | Executives, managers, directors / Regression analysis | SI practices – internal and external integration practices | Operational performance | A significant and direct relationship was found between supplier integration practices and operational performance |
| Kim (2006) | 623 | Managers, directors, CEOs / SEM | II, SI, CI | Customer satisfaction, financial and market performance | A significant and direct relationship was found between supply chain integration and firm performance |
| Vereecke and Muylle(2006) | 374 | Managers / ANOCA and Correlation analysis | Structural collaboration with supplier and structural collaboration with customer | Performance improvement | A significant and direct relationship were found between the following:<br>• Structural collaboration with suppliers and performance improvement<br>• Structural collaboration with customers and performance improvement |
| Devaraj et al. (2007) | 120 | Directors, vice presidents / SEM | SI, CI | Operational performance | A significant and direct relationship was found between supplier integration and operational performance. However non-significant relationship was also found between customer integration and operational performance . |

| | | | | | |
|---|---|---|---|---|---|
| Koufteros et al. (2007a) | 157 | Purchasing professionals / SEM | Black-box integration and gray-box integration | Product innovation | A significant and direct relationship was found between gray-box supplier integration and product innovation. However non-significant relationship was found between black-box supplier integration and product innovation |
| Sanders (2007) | 245 | CEOs, directors and presidents / SEM | Inter-organizational collaboration and intra-organizational collaboration | Organizational performance | A significant and direct relationship were found between the following:<br>• Intra-organizational collaboration and organizational performance<br>• Inter-organizational collaboration and intra-organizational collaboration |
| Swink et al. (2007) | 224 | Plant managers / SEM | Strategic CI , strategic SI, corporate strategy integration, and product-process technology integration | Business performance, competitive capability | A significant and direct relationship were found between the following:<br>• Product-process technology integration and competitive capabilities<br>• Corporate strategy integration and competitive capabilities<br>• Competitive capabilities and business performance<br>However non-significant relationships were also presented:<br>• Strategic customer integration and competitive capabilities<br>• Strategic supplier integration and competitive capabilities |
| Chen et al. (2007) | 125 | Directors and presidents / SEM | Marketing/logistics collaboration and firm-wide cross-functional integration | Profit margin, sales, competitive position, customer satisfaction, ROQ | A significant and direct relationship was found between firm-wide cross-functional integration and Performance. However non-significant relationship was found between marketing/logistics collaboration and performance |
| Sanders (2008) | 241 | Directors, presidents, CEOs, / SEM | Operational coordination and strategic coordination | Strategic and Operational performance | A significant and direct relationship were found between the following:<br>• Operational coordination and operational performance<br>• Strategic coordination and strategic performance<br>• Strategic coordination and operational performance<br>However non-significant relationship was found between operational coordination and strategic performance |
| Handfield et al. (2009) | 151 | Managers / SEM | SI and cross-enterprise integration | Buyer financial performance, sourcing enterprise performance | A significant and direct relationship were found between the following:<br>• Cross-enterprise integration and supplier integration<br>• Cross-enterprise integration and sourcing enterprise performance<br>• Supplier integration and sourcing enterprise performance |

| | | | | | |
|---|---|---|---|---|---|
| Kim (2009) | 623 | Managers / SEM | SCI | Firm performance | A significant and direct relationship was found between supply chain integration and firm performance |
| Villena et al. (2009) | 133 | Managers, directors / Regression analysis | Supply chain integration – information exchange and resource allocation | Operational performance | A significant and direct relationship was found between supply chain integration and operational performance |
| Flynn et al. (2010) | 617 | Manager, president, CEO / Regression analysis | II, CI, SI | Business and operational performance | A significant and direct relationship were found between the following:<br>• Internal integration and operational performance<br>• Internal integration and business performance<br>• Customer integration and operational performance<br>However non-significant relationships were also presented:<br>• Supplier integration and operational performance<br>• Customer integration and business performance<br>• Supplier integration and business performance |
| Koufteros et al. (2010) | 191 | Professional individuals / SEM | II, CI, supplier product and process integration | Glitches, on-time execution, market success | A significant and direct relationship were found between the following:<br>• Internal integration and customer integration<br>• Internal integration and supplier product integration<br>• Internal integration and supplier process integration<br>• Customer integration and market success Supplier product integration and supplier process integration<br>• Supplier product integration and glitch<br>• Supplier process integration and on-time execution<br>However non-significant relationships were also presented:<br>• Customer integration and glitch<br>• Customer integration and on-time execution |
| Lau et al.(2010) | 251 | Directors, presidents, CEO, manager / SEM | Supply chain integration – information sharing, product co-development, and organizational coordination | Product modularity, product performance | A significant and direct relationship were found between the following:<br>• Organizational coordination within SCI and product modularity<br>• Information sharing within SCI and product modularity<br>• Product co-development within SCI and product modularity<br>• Product co-development within SCI and product performance<br>However non-significant relationships were also presented: |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | • Information sharing within SCI and product performance<br>• Organizational coordination within SCI and product performance |
| Cao et al. (2010) | 211 | Directors, presidents, CEO, manager / SEM | Supply chain collaboration | Firm performance | A significant and direct relationship was found between supply chain collaboration and firm performance |
| Allred et al. (2011) | 980 | Directors, presidents, CEO, manager / SEM | Internal collaboration, and external collaboration | Customer satisfaction, productivity, business performance | A significant and direct relationship were found between the following:<br>• External collaboration and productivity<br>• Internal collaboration and productivity<br>• External collaboration and customer satisfaction<br>• Internal collaboration and customer satisfaction |
| Cao and Zhang (2011) | 211 | Directors, presidents, CEO, manager / SEM | Supply chain collaboration – information sharing, goal congruence decision, synchronization, incentive alignment, resource sharing, collaborative communication, and joint knowledge creation | Firm performance, collaborative advantage | A significant and direct relationship were found between the following:<br>• Supply chain collaboration and collaborative advantage<br>• Supply chain collaboration and firm performance |
| Danese and Romano (2011) | 200 | Engineers and managers / Regression analysis | CI, SI | Efficiency | A non-significant relationship was reported between customer integration and efficiency performance |
| Wong et al. (2011) | 151 | Supply chain manager, directors, presidents, CEO, manager / structural path analyses | II, CI, SI | Cost, flexibility, delivery, quality | Environmental uncertainty significantly moderates the relationship between:<br>• Internal integration and cost and quality performance,<br>• Supplier integration and delivery and flexibility performance, and<br>• Customer integration and flexibility performance. |
| Zhao et al. (2011) | 617 | CEO, directors, managers, supply chain professionals / SEM | II, CI, SI | Customer and supplier commitment | A significant and direct relationship was found between:<br>• Relationship commitment to customers influences customer integration,<br>• Relationship commitment to suppliers influences supplier integration;<br>• Internal integration influences both customer and supplier integration |

| | | | | | |
|---|---|---|---|---|---|
| He and Lai(2012) | 229 | Managers / SEM | operational integration strategic integration | Firm performance, customer action-based service, product-based service | A significant and direct relationship were found between the following:<br>• Operational integration and product-based service<br>• Operational integration and customer action-based service<br>• Operational integration and firm performance<br>• Strategic integration and product-based service<br>• Strategic integration and customer action-based service<br>• Strategic integration and firm performance |
| Prajogo and Olhager (2012) | 232 | Managers / SEM | Logistics integration, information technology, and information sharing | Operational performance | A significant and direct relationship were found between the following:<br>• Logistics integration and performance<br>• Information technology and logistics integration<br>• Information sharing and logistics integration |
| Prajogo et al. (2012) | 232 | Managers / SEM | Logistic integration, supplier assessment, and strategic long-term relationship with supplier | Cost, flexibility, delivery, cost | A significant and direct relationship were found between the following:<br>• Logistics integration and delivery performance<br>• Logistics integration and flexibility performance<br>• Logistics integration and cost performance<br>• Supplier assessment and quality performance<br>• Strategic long-term relationship with supplier and delivery performance<br>• Strategic long-term relationship with supplier and flexibility performance<br>• Strategic long-term relationship with supplier and cost performance<br>However non-significant relationships were also presented:<br>• Supplier assessment and delivery performance<br>• Supplier assessment and cost performance<br>• Strategic long-term relationship with supplier and quality performance |
| Olhager and Prajogo (2012) | 216 | Managers / Regression analysis | Internal lean practices, logistics integration, and supplier rationalisation | Business performance | A significant and direct relationship were found between the following:<br>• Internal lean practices and business performance<br>• External logistics integration and business performance<br>However a non-significant relationship was reported between supplier rationalization and business performance |
| Droge et al. (2012) | 57 | Directors, CEO, presidents / Regression and correlation analysis | SI, CI | Delivery and support performance | A significant and direct relationship were found between the following:<br>• Supplier integration and delivery performance<br>• Customer integration and support performance |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | • Customer integration and delivery performance<br><br>However a non-significant relationship was reported between supplier integration and support performance |
| Huo (2012) | 617 | Directors, CEO, presidents, managers / SEM | II, CI, SI | Financial performance, supplier and customer-oriented performance | A significant and direct relationship were found between the following:<br><br>• Internal integration and Customer-oriented performance<br>• Internal integration and Supplier-oriented performance<br>• Internal integration and Financial performance<br>• Customer integration and Customer-oriented performance<br>• Supplier integration and Supplier-oriented performance<br><br>However non-significant relationships were also presented:<br><br>• Customer integration and Supplier-oriented performance<br>• Customer integration and Financial performance<br>• Supplier integration and Customer-oriented performance<br>• Supplier integration and Financial performance |
| Liu et al. (2012) | 266 | Plant managers / SEM | Functional integration | Operational performance | A significant and direct relationship was found between functional integration and Operational performance |
| Danese and Romano (2012) | 200 | Managers / Hierarchical regression analysis | Downstream integration | Efficiency performance | A non-significant relationship was reported between downstream integration and Efficiency performance |
| Moyano-Fuentes et al. (2012) | 84 | CEOs / Hierarchical regression analysis | Cooperation with suppliers and cooperation with customers | Lean production adoption | A significant and direct relationship was found between cooperation with customers and lean production adoption. However a non-significant relationship was reported between cooperation with suppliers and Lean production adoption |
| Schoenherr and Swink, (2012) | 403 | Annual Global Survey of Supply Chain Progress (2007, 2008) / Hierarchical regression analysis | II, EI | Delivery, flexibility, quality, cost | A significant and direct relationship was reported that internal integration strengthened the positive impacts of external integration on both delivery and flexibility performance. However, no significant relationship was found for the same association for either quality or cost performance. |
| Danese et al. (2013) | 266 | HRM, CEOs, plant manager, (multiple) / Regression analysis and ANOVA | II, EI | Responsive performance | A significant and direct relationship was found between external integration practices and responsive performance. Also it was found that internal integration also had a positive impact on responsive performance. |

| | | | | | |
|---|---|---|---|---|---|
| Danese (2013) | 186 | Engineers, managers / Regression analysis | SI, fast supply network structure | Buyer performance( Schedule attainment, efficiency, flexibility | A significant and direct relationship was found between supplier integration practices and buyer's performance (Efficiency, Schedule attainment, Flexibility). |
| Liu et al. (2013) | 246 | President, CEO operations expert / Hierarchical regression analysis | SCI<br><br>Information sharing, Operational coordination | Business and operational performance | A significant and direct relationship was found between operational coordination and operational performance and business performance. However information sharing was found to only affect operational performance and a non-significant relationship was reported between information sharing and business performance. |
| Zhao et al. (2013) | 317 | Managers, supervisors, laborers / SEM | II, CI, SI | Schedule attainment, customer satisfaction, competitive performance | A significant and direct relationship was found between supplier integration and schedule attainment. A significant and direct relationship was found between customer integration and schedule attainment. A significant and direct relationship was found between Internal integration and schedule attainment. A significant and direct relationship was found between customer integration and competitive performance. A significant and direct relationship was found between internal integration and competitive performance. A significant and direct relationship was found between customer integration and customer satisfaction (Only high significant associations were reported here). |
| He et al. (2014) | 320 | General manager, CEO, director / SEM | SI, CI | New product performance | A significant and direct relationship was found on supplier integration and new product performance, customer integration and new product performance. Also it was found that supplier integration had a positive impact on customer integration through the mediating role of manufacturing flexibility. |
| Huang et al. (2014) | 164 | Financial, sales marketing managers / Hierarchical regression analysis | SCI | Supplier performance | A significant and direct relationship was found between SCI and suppliers' performance. The positive SCI-performance relationship can be moderately weakened by demand uncertainty; however, this positive SCI-performance relationship will be strengthened by technological uncertainty. |

(II= Internal integration, SI= Supplier integration, CI= Customer integration, EI = External integration)

## Appendix C

Adopted from (Shepherd and Günter, 2006)

| SCOR stages in SC | Measures | Cost, Time, Quality and Flexibility | Qualitative or Quantitative | Source |
|---|---|---|---|---|
| Plan | Sales | Cost | Quantitative | Beamon (1999) |
| | Profit | Cost | Quantitative | Beamon (1999) |
| | Return on investment (ratio of net profits to total assets) | Cost | Quantitative | Beamon (1999) |
| | Rate of return on investment | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Net profit vs productivity ratio | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Information carrying cost | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Variations against budget | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Total supply chain management costs | Cost | Quantitative | SCOR level 1 metrics |
| | Cost of goods sold | Cost | Quantitative | SCOR level 1 metrics |
| | Asset turns | Cost | Quantitative | SCOR level 1 metrics |
| | Value added productivity | Cost | Quantitative | SCOR level 1 metrics |
| | Overhead cost | Cost | Quantitative | Chan (2003) |
| | Intangible cost | Cost | Quantitative | Chan (2003) |
| | Incentive cost and subsides | Cost | Quantitative | Chan (2003) |
| | Sensitivity to long-term costs | Cost | Quantitative | Chan (2003) |
| | Percentage sales of new product compared with whole sales for a period | Cost | Quantitative | Chan (2003) |
| | Expansion capability | Cost | Quantitative | Chan (2003) |
| | Capital tie-up costs | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Total supply chain response time | Time | Quantitative | Schonsleben (2003) |
| | Total supply chain cycle time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Order lead time | Time | Quantitative | Gunasekaran et al. (2001)<br>VDI guidelines (association of engineers) |
| | Order fulfilment lead time | Time | Quantitative | SCOR level 1 metrics |
| | Customer response time | Time | Quantitative | Beamon (1999) |
| | Product development cycle time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Total cash flow time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Cash-to-cash cycle time | Time | Quantitative | SCOR level 1 metrics |

| | | | | |
|---|---|---|---|---|
| | Horizon of business relationship | Time | Qualitative | Hieber (2002) |
| | Percentage decrease in time to produce a product | Time | Quantitative | Chan (2003) |
| | Fill rate (target fill rate achievement & average item fill rate) | Quality | Quantitative | Beamon (1999)<br>Chan (2003)<br>Chan and Qi (2003)<br>Schonsleben (2003) |
| | Order entry methods | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Accuracy of forecasting techniques | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Autonomy of planning | Quality | Qualitative | Hieber (2002) |
| | Perceived effectiveness of departmental relations | Quality | Qualitative | (Ellinger, 2000) |
| | Order flexibility | Quality | Quantitative | Chan and Qi (2003) |
| | Perfect order fulfillment | Quality | Quantitative | Gunasekaran et al. (2001)<br>Chan and Qi (2003) |
| | Mix flexibility | Flexibility | Quantitative | Beamon (1999)<br>Chan (2003) |
| | New product flexibility | Flexibility | Quantitative | Beamon (1999) |
| | Number of new products launched | Flexibility | Quantitative | Chan (2003) |
| | Use of new technology | Flexibility | Quantitative | Chan (2003) |
| Source | Supplier cost-saving initiatives | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Percentage of late or wrong supplier delivery | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Supplier lead time against industry norm | Time | Quantitative | Gunasekaran et al. (2001) |
| | Supplier's booking-in procedures | Time | Quantitative | Gunasekaran et al. (2001) |
| | Purchase order cycle time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Efficiency of purchase order cycle time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Buyer-supplier partnership level | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Level of supplier's defect-free deliveries | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Supplier rejection rate | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Mutual trust | Quality | Qualitative | Hieber (2002) |
| | Satisfaction with knowledge transfer | Quality | Qualitative | (Sperka, 1997) |
| | Satisfaction with supplier relationship | Quality | Qualitative | (Artz and Norman, 1998) |
| | Supplier assistance in solving technical problems | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Extent of mutual planning cooperation leading to improved quality | Quality | Qualitative | (Graham et al., 1994) |

| | | | | |
|---|---|---|---|---|
| | Extent of mutual assistance leading in problem-solving efforts | Quality | Qualitative | (Maloni and Benton, 1997) |
| | Distribution of decision competences between supplier and customer | Quality | Qualitative | (Windischer and Grote, 2003) |
| | Quality and frequency of exchange of logistics information between supplier and customer | Quality | Qualitative | Windischer and Grote (2003) |
| | Quality of perspective taking in supply networks | Quality | Qualitative | (Parker and Axtell, 2001) |
| | Information accuracy | Quality | Qualitative | (Van der Vorst and Beulens, 2002) |
| | Information timeliness | Quality | Qualitative | Van der Vorst and Beulens (2002) |
| | Information availability | Quality | Qualitative | Van der Vorst and Beulens (2002) |
| | Supplier ability to respond to quality problems | Flexibility | Qualitative | Gunasekaran et al. (2001) |
| Make | Total cost of resources | Cost | Quantitative | Beamon (1999) |
| | Manufacturing cost | Cost | Quantitative | Beamon (1999)<br>Chan (2003) |
| | Inventory investment | Cost | Quantitative | Beamon (1999) |
| | Inventory obsolescence | Cost | Quantitative | Beamon (1999) |
| | Work in process | Cost | Quantitative | Beamon (1999) |
| | Cost per operation hour | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Capacity utilization as incoming stock level, work-in-progress, scrap level, finished goods in transit | Cost | Quantitative | Gunasekaran et al. (2001)<br>Schonsleben (2003) |
| | Inventory cost | Cost | Quantitative | Chan (2003) |
| | Inventory turnover ratio | Cost | Quantitative | Schonsleben (2003) |
| | Inventory flow rate | Cost | Quantitative | Chan and Qi (2003) |
| | Inventory days of supply | Cost | Quantitative | SCOR level 1 metrics |
| | Economic order quantity | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Effectiveness of master production schedule | Cost | Quantitative | Gunasekaran et al. (2001) |
| | Number of items produced | Cost | Quantitative | Beamon (1999) |
| | Warehouse costs | Cost | Quantitative | Chan and Qi (2003)<br>Chan (2003) |
| | Stock capacity | Cost | Quantitative | Chan and Qi (2003) |
| | Inventory utilization | Cost | Quantitative | Chan and Qi (2003) |
| | Stockout probability | Cost | Quantitative | Beamon (1999)<br>Chan (2003) |

| | | | | |
|---|---|---|---|---|
| | Number of backorders | Cost | Quantitative | Beamon (1999) |
| | Number of stockouts | Cost | Quantitative | Beamon (1999) |
| | Average backorder level | Cost | Quantitative | Beamon (1999) |
| | Percentage of excess/lack of resource within a period | Cost | Quantitative | Chan (2003) |
| | Storage costs per unit of volume | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Disposal costs | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Planned process cycle time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Manufacturing lead time | Time | Quantitative | Beamon (1999) |
| | Time required to produce a particular item or set of items | Time | Quantitative | Beamon (1999) |
| | Time required to produce new product mix | Time | Quantitative | Chan (2003) |
| | Inventory accuracy | Quality | Quantitative | Chan and Qi (2003) |
| | Inventory range | Flexibility | Quantitative | VDI guidelines (association of engineers) |
| | Percentage of wrong products manufactured | Quality | Quantitative | Chan (2003) |
| | Production flexibility | Flexibility | Quantitative | SCOR level 1 metrics |
| | Capacity flexibility | Flexibility | Quantitative | Schonsleben (2003) |
| | Volume flexibility | Flexibility | Quantitative | Beamon (1999)<br>Chan (2003) |
| | Number of tasks worker can perform | Flexibility | Quantitative | Chan (2003) |
| Deliver | Total logistics costs | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Distribution costs | Cost | Quantitative | Beamon (1999)<br>Chan (2003) |
| | Delivery costs | Cost | Quantitative | Chan and Qi (2003) |
| | Transport costs | Cost | Quantitative | Chan and Qi (2003) |
| | Transport costs per unit of volume | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Personnel costs per unit of volume moved | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Transport productivity | Cost | Quantitative | Chan and Qi (2003) |
| | Shipping errors | Cost | Quantitative | Beamon (1999) |
| | Delivery efficiency | Cost | Quantitative | VDI guidelines (association of engineers) |
| | Percentage accuracy of delivery | Cost | Quantitative | Chan (2003) |

| | | | | |
|---|---|---|---|---|
| | Delivery lead time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Frequency of delivery | Time | Quantitative | Gunasekaran et al. (2001) |
| | Product lateness | Time | Quantitative | Beamon (1999) |
| | Average lateness of orders | Time | Quantitative | Beamon (1999) |
| | Average earliness of orders | Time | Quantitative | Beamon (1999) |
| | Percent of on-time deliveries | Time | Quantitative | Beamon (1999)<br>Chan (2003) |
| | Delivery performance | Quality | Quantitative | Gunasekaran et al. (2001)<br>SCOR level 1 metrics |
| | Delivery reliability | Quality | Quantitative | Chan and Qi (2003)<br>Gunasekaran et al. (2001)<br>Schonsleben (2003)<br>SCOR level 1 metrics |
| | Number of on-time deliveries | Quality | Quantitative | Beamon (1999) |
| | Effectiveness of distribution planning schedule | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Effectiveness of delivery invoice methods | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Driver reliability for performance | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Quality of delivered goods | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Achievement of defect-free deliveries | Quality | Quantitative | Gunasekaran et al. (2001) |
| | Quality of delivery documentation | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Delivery flexibility | Flexibility | Quantitative | Beamon (1999)<br>Chan and Qi (2003) |
| | Responsiveness to urgent deliveries | Flexibility | Quantitative | Gunasekaran et al. (2001)<br>Chan and Qi (2003) |
| | Transport flexibility | Flexibility | Quantitative | Chan and Qi (2003) |
| | Warranty/returns processing costs | Cost | Quantitative | SCOR level 1 metrics |
| | Customer query time | Time | Quantitative | Gunasekaran et al. (2001) |
| | Customer satisfaction (or dissatisfaction) | Quality | Qualitative | Beamon (1999)<br>Chan (2003) |
| | Level of customer perceived value of product | Quality | Qualitative | Gunasekaran et al. (2001) |
| | Customer complaints | Quality | Quantitative | Beamon (1999) |
| | Rate of complaint | Quality | Quantitative | Schonsleben (2003) |
| | Product quality | Quality | Qualitative | Beamon (1999)<br>Chan and Qi (2003) |
| | Flexibility of service systems to meet particular customer needs | Flexibility | Qualitative | Gunasekaran et al. (2001) |

**Appendix D**
**Cover letter**

The University Of Sheffield.

E-Futures

# Examining The Impact Of Supply Chain Integration On Organization Structure And Operational Performance in Oil and Gas Supply Chains: A Contingency Approach

**Dear Sir/Madam**

The management school at the University of Sheffield in collaboration with the E-Futures doctoral training centre are conducting a research on the relationship between Organisational Structure and Supply Chain Integration and their effects on Operational Performance in the Oil and Gas industry.

This research will be beneficial to firms wanting to improve their Supply Chain Integration and Operational Performance. A summary report of the findings will be sent to all those participating in the research.

The questionnaire will take no longer than 25 minutes to complete and as a token of appreciation, the respondents will be entered in to a draw to win a gift voucher of £ 50 so please do not forget to include your email address. All your responses will be treated in the strictest confidence and we will not disclose your personal details to anyone. The Sheffield University Management School's research ethics committee has already approved this project.

Thank you for your time and support, yours sincerely

**Seyed M Ebrahimi**
Doctoral researcher
Email: Dtp10se@sheffield.ac.uk,
Phone: +447763804078
**Research supervisor contact details:** Professor S.C. Lenny Koh (email: s.c.l.koh@shef.ac.uk), Dr Niraj Kumar (email: n.kumar@sheffield.ac.uk), Dr Andrea Genovese (email: a.genovese@sheffield.ac.uk)

The University Of Sheffield.

**Section A) Company Background**
Please answer each question by either writing in the space provided or selecting the most suitable option.

## A1. Please select the oil and gas sector your company operates in:

- ☐ Upstream Sector (Exploration and Appraisal, Development, Production, Drilling, Pipelines, Services)
- ☐ Downstream activities (Processing (Oil/Gas), Transportation, Storage, Marketing, Refineries (Oil/Gas), Petrochemical plants, Dispatching & Distribution, LNG)

## A2. Please select the type of your Company:

- ○ Public Company (i.e. National State/Government Company)
- ○ Private Company (i.e. International Oil Company, oil fields developers/ EPC contractor) or Public/Private partnership

## A3. Please select whether your company is:

- ○ A. Services provider (e.g. Technical Support and Services (TSA)/Production Support and Assistant (PSAC)/ Logistic Company/ Management Contracting (MC)/ Management Consultancy (MC))
- ○ B. Manufacturer (e.g. vendors/designer/producer of oil and gas equipments and materials) and/or Manufacturer-Service provider

## A4. Please indicate your company's 'operational size':

- ○ High Input/output (e.g. Supplier >500 | Customer >100 | Sales per annum >10billion$ | Operational expenditure >5billion$)
- ○ Low Input/out put (e.g. Supplier < 500 | Customer <100 | Sales per annum <10billion$ | Operational expenditure < 5billion$)

## A.5 Which of the following regions of the world does your company operate in:

- [ ] Africa
- [ ] Asia Pacific
- [ ] Europe and Eurasia
- [ ] Middle East
- [ ] North America
- [ ] South and Central America

## A6. What is your job-title in this Company (eg. CEO, General Manager, Director, Manager in Supply chain/Operations/ Strategy etc.)?

>>

## Section B) Your Company's Operational performance
**In this section, please focus on your company's Operational performance . Please select your response to each statement by comparing it to the industry benchmark and tick the most appropriate option.**

### B1. To what degree would you rate the following statements regarding your process quality.

| | Extremely poor 1 | Poor 2 | Below average 3 | Average 4 | Above average 5 | Good 6 | Excellent 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Rate the level of your company's ability in utilising information/data from quality programs (such as quality assurance and quality control) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Rate the level of your company's supplier surveys, which indicate the level of qualities set or met by your suppliers | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Rate the level of your company's quality systems, which measure and monitor the standard of internal quality | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Rate the level of your company's ability in uncovering discrepancies | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

### B2. To what degree would you rate the following statements regarding your process lead-time.

| | Extremely poor 1 | Poor 2 | Below average 3 | Average 4 | Above average 5 | Good 6 | Excellent 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Rate the level of your company's order process for supplier selection (i.e. performing approved vendor list check or evaluating supplier quality records) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Rate the level of your company's system/methods for sending orders to supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Rate the level of your supplier's delivery ability/speed. | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Rate the level of your company's adherence to deadlines set by clients | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

### B3. To what degree would you rate the following statements regarding process flexibility.

| | Extremely poor 1 | Poor 2 | Below average 3 | Average 4 | Above average 5 | Good 6 | Excellent 7 | N/A |
|---|---|---|---|---|---|---|---|---|

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1. Rate the level of your company's capability to discover alternative suppliers for each of its components and raw materials | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2. Rate the level of your company's ability to have access to widespread and alternative equipment in different regions | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 3. Rate the level of your company's ability to introduce new/alternative incentive criteria for supply of equipment | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 4. Rate the level of your company's responsiveness to changes occurring in industry business practices (e.g. green supply chain, fracturing) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

## B4. To what degree would you rate the following statements regarding process cost (capital cost CAPEX, operating cost OPEX)

| | Extremely poor 1 | Poor 2 | Below average 3 | Average 4 | Above average 5 | Good 6 | Excellent 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Rate the level of your company's design cost (e.g. 3D Modeling and Visualization, Geoscience and Mining Graphics) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2. Rate the level of your company's equipment costs (e.g. related to pipes, valves and fittings, electric cables, cladding, instrumentation) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 3. Rate the level of your company's fabrication costs | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 4. Rate the level of your company's installations costs (e.g. onshore and offshore platforms) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 5. Rate the level of your company's commissioning costs | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 6. Rate the level of your company's insurance spare costs | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 7. Rate the level of your company's project reinvestment cost | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 8. Rate the level of your company's man-hour costs for each function | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 9. Rate the level of your company's spare parts costs for each refinery unit (service and maintenance) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 10. Rate the level of your company's energy consumption costs (e.g. fuels, energy lubricants, chemicals, office supplies, technical equipment) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 11. Rate the level of your company's logistics support costs, (e.g. procurement, scheduling, stocking, and distribution of spares, repair parts, facilities, support equipment) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

**Section C) Your Company's Supply Chain**
**In this section, please focus on your company's Supply Chain Integration (Internal, customer and supplier). Please select your response to each statement by comparing it to the industry benchmark and tick the most appropriate option.**

**C1. Please indicate the extent of integration or information sharing between your company and your major customer in the following areas (1 = not at all; 7 = extensive).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Linkage with our major customer through information networks | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Computerization for our major customer's ordering | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Sharing of market information from our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Communication with our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. The establishment of quick ordering systems with our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 6. Follow-up with our major customer for feedback | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 7. The frequency of period contacts with our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 8. Our major customer shares Point of Sales (POS) information with us | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 9. Our major customer shares demand forecast with us | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 10. We share our available inventory with our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 11. We share our production plan with our major customer | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

**C2. Please indicate the extent of integration or information sharing between your company and your major supplier in the following areas (1 = not at all; 7 = extensive).**

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Information exchange with our major supplier through information networks | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. The establishment of quick ordering systems with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Strategic partnership with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Stable procurement through network with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. The participation level of our major supplier in the process of procurement and production | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 6. The participation level of our major supplier in the design stage | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 7. Our major supplier shares their production schedule with us | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 8. Our major supplier shares their production capacity with us | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 9. Our major supplier shares available inventory with us | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 10. We share our production plans with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 11. We share our demand forecasts with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 12. We share our inventory levels with our major supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 13. We help our major supplier to improve its process to better meet our needs | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## C3. Please indicate the degree of integration in the following areas (1 = not at all; 7 = extensive).

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Data integration among internal functions | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Enterprise application integration among internal functions | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Integrative inventory management | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Real-time searching of the level of inventory | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 5. Real-time searching of logistics-related operating data | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 6. The utilisation of periodic interdepartmental meetings among internal functions | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 7. The use of cross functional teams in process improvement | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 8. The use of cross functional teams in new product development | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 9. Real-time integration and connection among all internal functions from raw material management through production, shipping, and sales | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

>>

**Section D) Your Company's Organisational Structure**
**In this section, please focus on your company's Organisational Structure. Please select your response to each statement by selecting the most appropriate option.**

## D1. To what degree would you agree or disagree with the following statement in relation to centralization

| | Strongly disagree 1 | Disagree 2 | Somewhat Disagree 3 | Neutral 4 | Somewhat agree 5 | Agree 6 | Strongly agree 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. The power to make considerable operational decisions is concentrated in the organisation (e.g. targeting alternative suppliers for operational activates, purchasing procedures for alternative equipment) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Even small operational matters have to be referred to someone higher up the hierarchy for a final decision (e.g. Supervisor's decision determine how is work done) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Your firm senses that staff would need a great level of control over their responsibilities (e.g. Employees do not have much autonomy) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. Your company encourages lower level (middle managers) participation in operational decision-making process where problems occur | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## D2. To what degree would you agree or disagree with the following statement in relation to formalization

| | Strongly disagree 1 | Disagree 2 | Somewhat Disagree 3 | Neutral 4 | Somewhat agree 5 | Agree 6 | Strongly agree 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. Your firm has formal strategic planning process, which results in a written mission, long-range goals and strategies for implementation | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 2. Your company has strategic plans (coded & put in writing) to respond to customer/supplier | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 3. Your firm relies on strict supervision (rules and procedures) in controlling day-to-day operation (e.g. have low tolerance for rule violation) | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| 4. If a written rule does not cover some situation, staff make up informal rules for carrying out their tasks | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |

## D3. To what degree would you agree or disagree with the following statement in relation to hierarchical relationship

| | Strongly disagree 1 | Disagree 2 | Somewhat Disagree 3 | Neutral 4 | Somewhat agree 5 | Agree 6 | Strongly agree 7 | N/A |
|---|---|---|---|---|---|---|---|---|
| 1. A large hierarchical distance exists between operational managers and senior executives (e.g. CEOs) | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 2. We have a tall organizational structure | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 3. There are many levels in our organizational chart | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |
| 4. Our organisation structure is relatively flat | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ |

**If you would like to receive a summary of this study, and also like to take part in the draw for a chance to win a gift voucher worth £50. Please don't forget to include your email address here, Email:**

**Thank you**
**Seyed Mohammad Ebrahimi**

>>

# Appendix E

PhD Research Survey

**Seyed M Ebrahimi** <dtp10se@sheffield.ac.uk> 04/12/2013

to azren_mnoor

Dear

I was given your respective email address by my father Dr. Seyed N. Ebrahimi (International legal negotiator in Oil and Gas) an affiliate of yours. I am emailing to inform you that the management school at the University of Sheffield in collaboration with the E-Futures doctoral training centre in the UK are conducting a research on ***the relationship between Organisational Structure and Supply Chain Integration and their effects on Operational Performance in the Oil and Gas industry***.

This research will be beneficial to firms wanting to improve their Supply Chain Integration and Operational Performance. A summary report of the findings will be sent to all those participating in the research.

The questionnaire will take no longer than 25 minutes to complete and as a token of appreciation, the respondents will be entered in to a draw to win a gift voucher of £ 50 so please do not forget to include your email address. All your responses will be treated in the strictest confidence and we will not disclose your personal details to anyone. The Sheffield University Management School's research ethics committee has already approved this project. You can either fill the questionnaire online at:

https://sheffieldmanagement.eu.qualtrics.com/SE/?SID=SV_6SiMqTz46GDADoF

Alternatively you may download the attached questionnaire and cover letter.

Thank you for your time and support, yours sincerely

Seyed M Ebrahimi

Doctoral researcher

Email: Dtp10se@sheffield.ac.uk,
Room B3, Management School Doctoral Centre, Sheffield, UK
Phone: +447763804078

**Research supervisor contact details:** Professor S.C. Lenny Koh (email: s.c.l.koh@shef.ac.uk), Dr Niraj Kumar (email: n.kumar@sheffield.ac.uk), Dr Andrea Genovese (email: a.genovese@sheffield.ac.uk)

## Appendix F Invariance test

| CFL | | | Estimate | | Default | | | Estimate |
|---|---|---|---|---|---|---|---|---|
| Qlty1 | <--- | OP | 0.894 | -0.015 | Qlty1 | <--- | OP | 0.879 |
| Qlty2 | <--- | OP | 0.858 | 0.002 | Qlty2 | <--- | OP | 0.86 |
| Qlty3 | <--- | OP | 0.909 | -0.024 | Qlty3 | <--- | OP | 0.885 |
| Qlty4 | <--- | OP | 0.867 | -0.02 | Qlty4 | <--- | OP | 0.847 |
| Flex1 | <--- | OP | 0.873 | -0.019 | Flex1 | <--- | OP | 0.854 |
| Flex2 | <--- | OP | 0.833 | -0.003 | Flex2 | <--- | OP | 0.83 |
| Flex3 | <--- | OP | 0.875 | -0.023 | Flex3 | <--- | OP | 0.852 |
| Flex4 | <--- | OP | 0.899 | -0.015 | Flex4 | <--- | OP | 0.884 |
| Ltime1 | <--- | OP | 0.871 | -0.016 | Ltime1 | <--- | OP | 0.855 |
| Ltime2 | <--- | OP | 0.882 | 0.006 | Ltime2 | <--- | OP | 0.888 |
| Ltime3 | <--- | OP | 0.824 | 0.009 | Ltime3 | <--- | OP | 0.833 |
| Ltime4 | <--- | OP | 0.841 | 0.011 | Ltime4 | <--- | OP | 0.852 |
| Ccost1 | <--- | OP | 0.879 | 0.01 | Ccost1 | <--- | OP | 0.889 |
| Ccost2 | <--- | OP | 0.861 | 0.022 | Ccost2 | <--- | OP | 0.883 |
| Ccost3 | <--- | OP | 0.88 | 0.017 | Ccost3 | <--- | OP | 0.897 |
| Ccost4 | <--- | OP | 0.863 | 0.014 | Ccost4 | <--- | OP | 0.877 |
| Ccost5 | <--- | OP | 0.877 | 0.014 | Ccost5 | <--- | OP | 0.891 |
| Ccost6 | <--- | OP | 0.868 | 0.016 | Ccost6 | <--- | OP | 0.884 |
| Ccost7 | <--- | OP | 0.875 | 0.011 | Ccost7 | <--- | OP | 0.886 |
| Ocost1 | <--- | OP | 0.884 | 0.017 | Ocost1 | <--- | OP | 0.901 |
| Ocost2 | <--- | OP | 0.88 | 0.014 | Ocost2 | <--- | OP | 0.894 |
| Ocost3 | <--- | OP | 0.871 | 0.019 | Ocost3 | <--- | OP | 0.89 |
| Ocost4 | <--- | OP | 0.877 | 0.011 | Ocost4 | <--- | OP | 0.888 |
| Sintg1 | <--- | SI | 0.914 | -0.001 | Sintg1 | <--- | SI | 0.913 |
| Sintg2 | <--- | SI | 0.908 | 0.007 | Sintg2 | <--- | SI | 0.915 |
| Sintg3 | <--- | SI | 0.903 | 0.002 | Sintg3 | <--- | SI | 0.905 |
| Sintg4 | <--- | SI | 0.917 | 0.011 | Sintg4 | <--- | SI | 0.928 |
| Sintg5 | <--- | SI | 0.919 | 0.003 | Sintg5 | <--- | SI | 0.922 |
| Sintg6 | <--- | SI | 0.912 | 0.007 | Sintg6 | <--- | SI | 0.919 |
| Sintg7 | <--- | SI | 0.931 | 0.004 | Sintg7 | <--- | SI | 0.935 |
| Sintg8 | <--- | SI | 0.943 | 0.009 | Sintg8 | <--- | SI | 0.952 |
| Sintg9 | <--- | SI | 0.933 | 0.003 | Sintg9 | <--- | SI | 0.936 |
| Sintg10 | <--- | SI | 0.904 | 0.01 | Sintg10 | <--- | SI | 0.914 |
| Sintg11 | <--- | SI | 0.911 | 0.008 | Sintg11 | <--- | SI | 0.919 |
| Sintg12 | <--- | SI | 0.909 | 0.009 | Sintg12 | <--- | SI | 0.918 |
| Sintg13 | <--- | SI | 0.901 | 0.007 | Sintg13 | <--- | SI | 0.908 |
| Cintg1 | <--- | CI | 0.905 | -0.004 | Cintg1 | <--- | CI | 0.901 |
| Cintg2 | <--- | CI | 0.894 | 0.003 | Cintg2 | <--- | CI | 0.897 |
| Cintg3 | <--- | CI | 0.912 | 0.001 | Cintg3 | <--- | CI | 0.913 |
| Cintg4 | <--- | CI | 0.903 | 0.001 | Cintg4 | <--- | CI | 0.904 |
| Cintg5 | <--- | CI | 0.928 | 0 | Cintg5 | <--- | CI | 0.928 |
| Cintg6 | <--- | CI | 0.933 | 0.001 | Cintg6 | <--- | CI | 0.934 |
| Cintg7 | <--- | CI | 0.922 | 0.004 | Cintg7 | <--- | CI | 0.926 |
| Cintg8 | <--- | CI | 0.89 | -0.001 | Cintg8 | <--- | CI | 0.889 |
| Cintg9 | <--- | CI | 0.899 | 0.002 | Cintg9 | <--- | CI | 0.901 |
| Cintg10 | <--- | CI | 0.91 | 0.002 | Cintg10 | <--- | CI | 0.912 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Cintg11 | <--- | CI | 0.919 | 0.001 | Cintg11 | <--- | CI | 0.92 |
| Iintg1 | <--- | II | 0.911 | 0.002 | Iintg1 | <--- | II | 0.913 |
| Iintg2 | <--- | II | 0.922 | -0.001 | Iintg2 | <--- | II | 0.921 |
| Iintg3 | <--- | II | 0.906 | 0 | Iintg3 | <--- | II | 0.906 |
| Iintg4 | <--- | II | 0.911 | 0.001 | Iintg4 | <--- | II | 0.912 |
| Iintg5 | <--- | II | 0.923 | 0 | Iintg5 | <--- | II | 0.923 |
| Iintg6 | <--- | II | 0.918 | 0 | Iintg6 | <--- | II | 0.918 |
| Iintg7 | <--- | II | 0.926 | 0 | Iintg7 | <--- | II | 0.926 |
| Iintg8 | <--- | II | 0.915 | 0 | Iintg8 | <--- | II | 0.915 |
| Iintg9 | <--- | II | 0.941 | -0.001 | Iintg9 | <--- | II | 0.94 |
| HierStr1 | <--- | HR | 0.898 | 0.004 | HierStr1 | <--- | HR | 0.902 |
| HierStr2 | <--- | HR | 0.924 | 0.007 | HierStr2 | <--- | HR | 0.931 |
| HierStr3 | <--- | HR | 0.885 | 0.008 | HierStr3 | <--- | HR | 0.893 |
| HierStr4 | <--- | HR | -0.849 | 0.004 | HierStr4 | <--- | HR | -0.845 |
| Form1 | <--- | Form | 0.935 | 0.001 | Form1 | <--- | Form | 0.936 |
| Form2 | <--- | Form | 0.93 | 0 | Form2 | <--- | Form | 0.93 |
| Form3 | <--- | Form | 0.865 | -0.001 | Form3 | <--- | Form | 0.864 |
| Form4 | <--- | Form | -0.882 | 0.004 | Form4 | <--- | Form | -0.878 |
| Cent1 | <--- | Cent | 0.92 | 0.003 | Cent1 | <--- | Cent | 0.923 |
| Cent2 | <--- | Cent | 0.876 | 0.01 | Cent2 | <--- | Cent | 0.886 |
| Cent3 | <--- | Cent | 0.885 | 0.005 | Cent3 | <--- | Cent | 0.89 |
| Cent4 | <--- | Cent | -0.821 | -0.001 | Cent4 | <--- | Cent | -0.822 |