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Performance measurement in the natural gas industry: a case study of Ghana's natural gas supply chain

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Abstract

Purpose: The main purpose of this research is to develop a performance measurement model for the entire supply chain that includes balanced set of performance measures.

Methodology: The conceptual model was validated empirically in case companies through semi-structured interviews and content analysis of documents.

Findings: Performance measures are important to companies in the natural gas supply chain to assess performance against set objectives in order to identify loopholes in performance. This is important in order to remain competitive. The research found that both financial and non-financial performance measures are employed by companies to measure performance. The results also indicate that six performance criteria of the conceptual model are vital to the natural gas supply chain. In addition, all identified measures under each of criteria impact on performance of the supply chain with customer service and financial criteria considered as most important.

Limitation: The empirical data collected from the natural gas supply chain in Ghana was relatively small however, additional information was obtained from company data and relevant magazines. Also, getting through to specific target participant was a challenge due to busy work schedule but, in case companies where it proved impossible, other staff who were also involved in supply chain were interviewed instead.

Practical implication: This research provides a useful source of information on performance measures for practitioners in the natural gas industry who wish to measure performance of their supply chain. It also provides areas from which further and additional research can be carried out.

Originality: This research provides performance measures for the natural gas supply chain of Ghana. Typically, performance measures have been evaluated in discrete manufacturing supply chain, petroleum industry supply chain and oil industry supply chain. This research expanded on ideas from these studies and applied them in the natural gas industry.

Keywords: performance measures, Supply chain, Natural gas, financial measurements, non-financial measurements, Ghana.

1. Introduction

As a result of the ever increasing competition and globalisation which is characterised by today's business environments, companies will not be able to compete and survive unless measures are put in place to evaluate their performance (Collin, 2003; Chan and Qi, 2003). Measuring performance according to Elgazzar (2013) is necessary to achieve strategies of efficiency, productivity and effectiveness. However, the real challenge for most companies is to how to manage trade-offs between strategies to continuously improve performance and remain competitive while delivering excellent service to customers (Solvang, 2011). Due to this challenge, most companies have put performance measures in place to continuously evaluate and monitor performance.

In recent years, measuring performance has received much attention from businesses and researchers (Gunasekaran *et al.*, 2004). It is regarded as an important activity for survival of most companies (Varma *et al.*, 2008); the reason being that it plays a vital role in objective setting, identifying success, performance evaluation and future courses of action determination (Parker, 2000). Adopting the right choice of performance measures is critical to the success and competitiveness of companies (Bhagwat and Sharma, 2007). Traditionally, companies have focused on financial performance measures for measuring performance (Ittner *et al.*, 2003). Though financial measures are still being used widely by most companies, their ability to capture other aspects of performance is limited (Elgazzar, 2013). Thus non-financial performance

measures are also considered to evaluate how well supply chain activities transform inputs into outputs for customer satisfaction and other stakeholders (Pandey, 2005).

The focus of this paper is on measuring performance in the natural gas (NG) supply chain, including the network of companies involved in upstream, midstream and downstream activities aimed at providing natural gas to consumers (Weijermars, 2010). Natural gas is expected to overtake oil as the dominant energy source as nations seek to promote the agenda of cleaner fuel sources. The demand for natural gas is increasing and it is estimated to increase globally in 2015 by 70% of its 2013 value (BERA, 2013). The NG supply chain is complex, characterised by high transportation and long supply chain; and inflexible, denoted by high infrastructure specification and less vertically integrated with high market competition. It is also faced with challenges of high operations cost, price fluctuations, human deficit and environmental issues (EY, 2013). In such a volatile environment, remaining profitable, competitive and balancing interest of various stakeholders is more of a challenge (Clyde *et al.*, 2010). These interests and concerns should be effectively and actively explored and implemented in activities of the industry (Waritimi, 2012).

Literature has highlighted the importance of performance measures in supply chains. However, most of this research has focused largely on discrete manufacturing supply chains and to a small extent on non-discrete processes of petroleum whereas research in natural gas industry supply chain remains scanty and still developing. Varma *et al.* (2008) for example evaluated performance measures in the petroleum industry of India, whereas Rashed (2013) investigated cost management and performance measurement for the petroleum upstream industry and Norouzi (2013) measured performance in the Iranian petroleum downstream supply chain. There is an opportunity, therefore, to investigate performance measures in the natural gas supply chain.

To address this gap, we develop a performance measurement system (PMS) with a comprehensive set of performance measures to measure performance of the NG supply chain with data from Ghana's supply chain. Our research objectives are review existing literature on performance measures and metrics, to provide an overview of the natural gas industry, to develop a conceptual model based with balanced performance measures for the natural gas industry supply chain, and to validate the conceptual model through interviews with experts in Ghana's natural gas supply chain. A study of Ghana is particularly timely as it has been estimated that the amount of natural gas required for power generation in the country is expected to increase annually by 7.5% from 2012-2021 and 6.3% from 2022 onwards (MOE, 2012). Presently, Ghana's main supply of natural gas is from Nigeria. However, with an estimated increase in demand and insufficient supply from Nigeria, there is a need to increase supply for existing power plants (Ghanagas, 2013). Though,

the development of natural gas in Ghana is in its nascent stage (its discovery was in 2007), when fully developed, it is expected to minimise dependence on Nigeria and meet national requirements. However, in order for the industry to remain efficient and meet its demands of customers and other stakeholders, measures must be put in place to monitor and control the performance of its supply chain and the measures of performance must reflect the perspectives of customers, suppliers and other stakeholders (Striteska and Spickova, 2012). An interpretivist epistemological stance as selected as the research philosophy of this study and three qualitative case studies as the strategy of inquiry. Primary data was obtained through semi-structured interviews from purposefully selected top managers from the natural gas supply chain as well as content analysis of documents from case companies.

The structure of the paper is as follows: a brief literature review on performance measures as well as a discussion on the context of NG of Ghana and a description of the research methodology is followed by the presentation of our results and discussion in light of the extant literature leading up to conclusions, limitations of current work and further research.

2. Review of the literature

2.1 Performance Measures

Performance has been studied in manufacturing plants, corporations, companies, supply chains, supply functions and supplier relations (Dickson, 2008). According to Lebas (1995), performance can mean anything from robustness, efficiency to return on investment. Neely (1999) suggests that measuring performance is increasingly becoming important due to increasing competition, changing demands, improvement initiatives and role of information technology. Furthermore, companies need to evaluate their performance incorporating views of suppliers, customers and other stakeholders (Moullin, 2007; Striteska and Spikova, 2012). However, the choice of performance measures adopted is considered one of the most critical challenges facing most companies (Meditinos *et al.*, 2006). According to Gomes *et al.* (2004), performance measures have evolved in two phases. This includes the traditional financial performance measures and the non-financial performance measures. Both are discussed next.

2.1.1 Financial performance measures

Traditionally, performance measures have focused on management accounting systems such as return on investment (ROI), operating income, profit margin and cash flow (Kurien and Qureshi, 2011). When using these financial performance measures, productivity is regarded as the primary indicator of performance (Ghalayini and Guba, 1996). Financial measures evaluates and monitors

company's operations in monetary terms to indicate the extent to which financial objectives set by the company has been met over a set period of time (Elgazzar, 2013). However, there have been a lot of criticisms on the role of traditional financial measures only to evaluate a company's performance (Basu, 2001). Lapide (2000) states that financial measures are based on historical data and do not focus on providing future perspectives, do not incorporate strategic, non-financial performance such as customer service and product quality and do not take into consideration operational efficiency and effectiveness. Striteska and Spikova (2012) mentioned that financial measures are less indicative of the value of shareholders. Cumba and Conrod (2001) added that in sustaining shareholder value, companies must critically consider non-financial factors such as employee satisfaction, customer loyalty and internal processes. As a consequence, Bititci *et al.* (2012) suggest that companies must choose the most suitable measures that create a balance between financial and non-financial measures.

2.1.2 Non-financial performance measures

Companies have progressed from using financial performance measures as a single source of measure to using a combination of both financial and non-financial performance measures (Dickson, 2008). Ittner *et al.* (2003) mentioned that non-financial performance measures provide a link to long-term strategies of the company, indirect quantitative indicators of a company's intangible asset and a clearer indication of the future financial performance measures. For instance, the Balanced Scorecard (BSC) by Kaplan and Norton (1992) was developed with the realisation that the use of traditional financial performance measures are usually inadequate to measure performance in today's business environment. Balanced performance measures reflect both financial and non-financial objectives and strategies of a company that impact on the overall performance (Elgazar, 2013).

In today's business environment, it is important to keep a balance when choosing the appropriate performance metrics and measures (Bititci *et al.*, 2012). Unsuitable and complex performance measures cannot reflect the actual impact of the impact of performance measures (Sarkis *et al.*, 2011). According to Tangen (2004), performance measures should have a clear link to business goals, should be clearly defined and simple to understand, and combine both non-financial and financial indicators. Barbuio (2007) identified that performance measures must be reliable, easily accessible, valid and relevant to processes. Gopal and Thakkar (2012) mentioned that performance measures must have a clear link with company's strategy, simple to understand and respond to rapid changes. Still, the challenge is to continuously evaluate and monitor performance activities

of supply chains in order to remain competitive while delivering value to its customer and other stakeholders (Elgazar, 2013).

2.2 The natural gas context

Over the last few decades, demand for natural gas (NG) has become an important component to energy companies. It differentiates itself from other fossil fuels such as coal and oil as a clean and versatile energy source (Clyde et al., 2010). It has a limited flammability range and when combusted and produces 25% and 50% less greenhouse emissions as compared to oil and coal respectively (Ecana, 2014). In 2011 it contributed about 24% of primary energy globally (Wingas, 2014). As a result of these techniques, it is estimated that the U.S. natural gas production could increase to up to 60% by 2030 (Clyde et al., 2010).

NG is considered safe when stored, transported and used (Borraz-Sanchez, 2010); therefore it is preferred as the fuel of choice in countries where policies to reduce greenhouse emissions are being implemented (USEIA, 2013). NG is used for heating, cooking, cooling, transportation, electricity generation (Ecana, 2014). In addition it is used in petrochemical industries for manufacturing ammonia, ethylene, hydrogen and sulphur (Borraz-Sanchez, 2010). Making natural gas available for its various uses goes through various stages of transformation in the supply chain before finally reaching consumers.

2.2.1 The natural gas supply chain

The global oil and gas industry is under extreme pressure to meet global demand for affordable and safe fuel (Weijermars, 2010). It is estimated that the global demand of natural gas is expected to increase from 113.0tcf in 2010 to 185.0tcf in 2040 (USEIA, 2013). The NG supply chain is seen as a physical supply involved with production, processing, storage and transportation activities (Weijermars, 2010). According to Szucs and Hassen (2012), the NG supply chain is characterised with complexity, inflexibility and vertical integration, which are discussed next.

Complexity

Complexity is augmented by customer requirement, competitive business environment, strategic alliances, mergers and acquisitions, outsourcing, new technologies and dynamic markets (Manuj and Sahin, 2011). Hussain *et al.* (2006) mentions that, the oil and gas supply chain is highly complex with linkages between various activities, capital and information flow. Delivering petroleum and natural gas to consumers requires long supply chains (Selot, 2009). Oil and gas are discussed together in energy economics but they differ in areas such as production, storage and transportation and consumption (Manuj and Sahin, 2011). This results in longer than expected

lead time of several weeks. Though NG is found in specified and limited areas, demand is global (Midthun and Tomasgard, 2010). NG transport is restricted to specialised pipelines of varying distances or LNG tanks for over long distances; unlike oil which is liquid and can be transported via road, rail and pipelines (Roje *et al.*, 2007). In addition, special mode of transportation renders NG transportation very expensive (Roje *et al.*, 2007).

Inflexibility

Inflexibility in the NG supply chain is attributed to transport and infrastructure (Neiro & Pinto, 2004). NG plant and pipeline are designed to specific capacity and pressure (Selot, 2009). This means that the plant or pipeline cannot be used for a different specification of natural gas without further modifications (RCEER, 2006). Distribution is done in a fixed pipeline capacity under an agreement on specified amount and period (Szucs and Hassen, 2012). The inflexibility of NG supply chains renders it risky for investors (Selot, 2009). This is due to the fact that if in any case the project is affected economically, almost none of the infrastructure can be put to use to at least recover the capital incurred in the project (Selot, 2009).

Vertical integration

Natural gas firms often adopt a vertically integrated structure (Szucs and Hassen, 2012). Hence, these companies are active along the entire supply chain from exploration, drilling and extracting of natural gas, transporting it around the world, processing of natural gas and distributing to consumers. This contradicts to horizontal integration by which many companies are responsible for the production processes (Moore and Media, 2014). Gainsborough (2006) mentions that vertical integration creates an advantage within the petroleum industry by having maximum control over the supply chain. It is also often coupled with a push system which translates low operational cost (Fisher, 1997). The major drawback associated with vertical integration is the loss of resilience and flexibility in the supply chain and most vertically integrated companies mitigate this challenge by outsourcing some services (Moore and Media, 2014). However, deregulation of prices in the natural gas industry has gradually introduced de-integration in some aspects of the supply chain and introduced competition (Juris, 2013).

2.2.5 Stakeholders within the natural gas supply chain

Stakeholder groups in industries have different interests and priorities and it is expected that specific stakeholder requirement are fulfilled (Wartimi, 2012; Walker *et al.*, 2008). According to Freeman (1999), stakeholders are those who can affect or be affected by the achievement of company goals. Hence, if employee's interest for example affects supply chain activities positively

or negatively, then employees must be viewed as a stakeholder (Badiru and Osisanya, 2013). In the NG industry, activities in the supply chain impact the local community one way or the other thus the local community is regarded as stakeholders (Badiru and Osisanya, 2013). Failure to do so usually results in misunderstandings in energy-related industries and communities. It is vital to identify, balance and satisfy the needs of the various stakeholders and act responsibly to all because long-term growth and success of the company depends on both external and internal stakeholders (Wartii, 2005; Inkpen and Moffet, 2011).

2.3 Performance Measurement Systems in the NG supply chain

Performance measurement system (PMS) is defined by Neely et al., (1995) as a comprehensive set of performance measures used to quantify the efficiency and effectiveness of actions. Many companies have in the past monitored their performance largely based on financial accounting principles (Lapide 2000). These measures are important but however biased towards improving financial status of a firm, and are insufficient to measure performance of other operational activities (Holmberg, 2000). Additionally, these measures lack relationships to important strategic, non-financial performance, such as customer service and loyalty, and product quality (Gunasekaran *et al.*, 2004). Because of these shortcomings, a variety of measurement approaches have been explored by different scholars (Aramyan *et al.*, 2007 and Hervani et al, 2005) including the BSC (Kaplan and Norton, 1992) and the SCOR model that can create a balance between financial and non-financial measures (Lindner, 2009), with many scholars underlining their advantages and disadvantages when considered as PMS (Gomes *et al.*, 2004). This approach has been explored earlier by Brewer and Speh (2000), Varma *et al.* (2008), and Mohapatra *et al.* (2010) to evaluate performance of the petroleum industry supply chain. Rashed (2013) also used the BSC to evaluate performance in the upstream of the NG supply chain.

However, literature has paid little attention to measuring performance within the NG supply chain. Bertocco and McCreery (2014) in their study stated that measuring performance begins with focused reporting system and balanced performance measures. They stated that performance measures must provide a balanced view of the company that portrays the health, status and performance of the business. Thereby the categories employed to evaluate performance of the oil and gas natural gas supply chain are inclusive of Health Safety and Environment (HSE), Operational, Financial, People and Customer. Rashed (2013) in his study of upstream oil and gas performance measurement stated that it is very useful for investors to assess the performance of their exploration, development, and production activities. He therefore identified performance measures under the four BSC perspectives. Research carried out by Emmanuel (2010) on maintenance performance measurement perception in the oil and gas industry identified performance measures under cost indicators, task efficiency indicators, organisational indicators, learning and improvement indicators and HSE indicators. Mohapatra *et al.* (2010) identified performance measures of the petroleum industry supply chain under the four BSC perspectives.

The dramatic change in the NG industry has resulted in a change in performance requirements of the natural gas supply chain. Prices of natural gas have become very volatile and dependent on supplier and demand relationship. End-user specification has become the major driver of quality standards and production methods in the supply chain (Aramyan *et al.*, 2007). Consequently, customers express interest in fair and reasonable price of natural gas, availability, reliability and quality of service (Hoey, 2004). Nonetheless, the supply chain is continuously vying for loyalty of customers as such internal processes of the supply chain must be aligned to deliver value to customers (Aramyan *et al.*, 2007). This process requires huge capitals and companies must ensure that they remain profitable and continuously deliver valuable products to customers. It is expected that supply chains must be able to balance the trade-off between these two strategies and this according to Elgazzar (2013) can be achieved by measuring performance of both strategies. Increasingly complexity and globalisation observed in the industry, the natural gas industry outsources some services relating to supplies of raw materials, project management and legal services to suppliers. However, managing and tracking performance of suppliers in the natural gas supply chain helps reduce cost and improve profitability, manage demand, improve cash flow and improve efficiency (Businesscasestudies, 2013). Managing relationship with suppliers, the natural gas industry can monitor availability, reliability, quality and responsiveness of the supplier.

Despite the deregulation and restructuring there is still a significant amount of regulatory issues concerning the environment. Activities relating to seismic activity, drilling operation, exploration

transportation pose issues relating to greenhouse emissions, spillage, land contamination and industrial waste which are associated with the petroleum industry (Okafor, 2011). The concern of greenhouse emission is being gradually addressed by governments encouraging the use of natural gas as a fuel source. However, other issues of environmental contamination, pollution and industrial waste disposal are being addressed by penalising supply chains that fault. This is to ensure that industries do not distort the environment, and NG industry is faced with pressure from local communities to provide safe environment. Shareholders and employees are also increasingly mounting pressure to be environmentally friendly.

2.2.3.1 Ghana's Natural gas supply chain

In June 2007, Ghana discovered oil and gas in commercial quantities in the Deepwater Tano and West cape three point blocks by Kosmos energy (FBD, 2013). These wells are collectively known as the 'Jubilee Field'. Probable natural gas reserve in the Jubilee field is estimated to be approximately 5Tcf (USEIA, 2013). In Ghana currently, the Jubilee field produces 107 MMscfd of natural gas of which about 9 MMscfd is being used daily to power plant at the FPSO, 98 MMscfd being injected back into the oil and gas field and 0.30 MMscfd flared for safety purposes (Ghanagas, 2013). Ghana Gas industry strategic objective is focused on gas monetization by adding value and providing natural gas to markets for the benefit of the people of Ghana to accelerate the nation's effort of rapid industrialization by providing cost competitive natural gas and gas based products for domestic markets including the development of petrochemical industries, fertilizer and power generation, as well as export of the products to other international markets (Ghanagas, 2013).

Ghana's main supply of natural gas is from a neighbouring country, Nigeria (Ministry of energy, 2012) through pipelines and marine vessels to storage depots. However, with an estimated increase in demand for the natural gas and its insufficient supply from Nigeria, there is a need to increase the gas supply for existing power plants (Ghanagas, 2013). Though, the development of natural gas in Ghana is in its nascent stage since its discovery in 2007; when fully developed, it is expected to minimise dependence on Nigeria and sustain power supply. However, in order for Ghana's gas industry to remain efficient and meet its customers' demands, measures must be put in place to monitor and control the performance of its supply chain, giving us the impetus for this paper.

2.4 Research gap and conceptual model

The review of literature indicates that performance measures in the industry's supply chain does not only relate to quality and cost measures but rather requires multiple-criterion evaluation processes. However quality and cost may be important factors to satisfy customer's requirements however, other important performance measures need to be considered (Tracey and Tan, 2001). Therefore NG supply chain must adopt performance measures that reflect the strategic objective of the company, activities and also satisfy needs of customers and other stakeholders (EY, 2013). Based on our literature review, we argue that NG supply chain performance would need to be based on six attributes: 'financial', 'internal business Operations', 'Customer management', 'health, safety, and the environment', 'learning and development' and 'Supplier management'. Our framework is depicted in Figure 1.

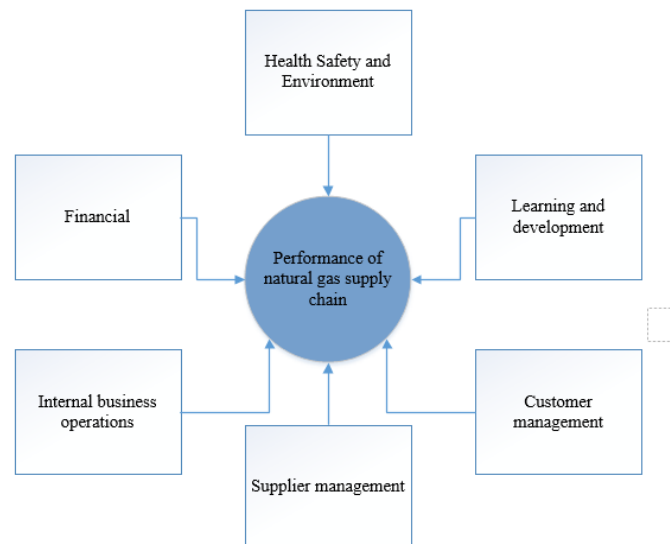


Figure 1: Conceptual framework for natural gas supply chain performance measurement.

Table 1 contains the six-main criteria with identified performance measures from literature for the NG supply chain (Bertocco and McCreery, 2014; Rashed, 2013; Thierry and Emmanuel, 2010).

Table 1: Identified Performance measures from literature

Category	Performance measures	Description
Internal Business Operations		
	Reserve replacement ratio (RRR)	Depicts the performance of replacing production

	Reserve life ratio	Relates to the number of years the company is able to produce natural gas at constant rate
	Average cost ratio	Relates to the future probability of the company
	Capacity utilization rate	Provides an oversight as to how infrastructure are utilised
	Budget cost of work	Used to combine cost, schedule and risk
	Schedule variance	Tells the difference between planned and actual schedule of work
	Pipeline throughput	The rate at which natural gas flows through the pipeline
	Percentage of plant utilisation	It relates the rate at which the plant is utilised.
Financial	Finding cost Ratio	It is used to evaluate the efficiency of companies exploration
	Operating or lifting cost per Boe (LCPB)	It states the ability of the industry to control production cost
	Success rate	Obtained by deducting dry holes from total investment
	Total shareholder return	Represents a change in value of shareholder over a specific period
	Cost variance	Relates the difference between actual and budgeted cost
HSE	Total recordable injury	Number of events that cause harm to employee or property leading to loss of work time.
	High potential incidents	Relates to an incident that have resulted in fatalities
	Environmental damage incidents	It refers to the amount of natural gas that is released to the environment
	Number of safety report	Relates to the number of hazardous concerns raised.

	HSE training completion	Number of successful training on best practises by workers.
	Incidents of non-conformance	Depicts the number of times the company is cited for violations.
Learning and growth	Employee satisfaction	Relates to the level of satisfaction of employees on job
	Training completion rates	Relates to number of training that has been successfully completed
	Cost of training	Average training cost by employees
	Human capital value added	Calculated by adding employing cost to operating cost.
	Salary competitiveness ratio	How much employees are paid in relation to other competitors
Customer Management	Quality of product	
	Flexibility to meet customers' needs	
	Percentage of customers satisfaction	
Supplier Management	Quality of product or service	This relates to the ability of suppliers to deliver specified natural gas, equipment and other services without any defect.
	Delivery performance of goods and services	This relates to the ability of suppliers to deliver required goods and services on time and at the right place
	Capability to respond to unexpected demand	Supplier has inventory and meets unexpected orders.
	Responsiveness claim	Supplier promptly responds when a problem is reported.

3. Research methodology

Epistemologically, this research obtains knowledge from details of a situation adopting a subjective ontological approach. This therefore indicates that, an interpretivist stance is more suitable for this

study. This stance is adopted because performance measurement is the natural supply chain is relatively new and interpretivist philosophy is based on the notion that a rich and deeper understanding of the phenomenon under study is achievable by exploring views of those experiencing it (Shah and Corley, 2006). This research is concerned with understanding experts' views and perceptions of performance measures. These are actors who use performance measures and possibly measure performance of supply chain their company in the natural gas industry. The aim of the research is largely exploratory in nature seeking to understand performance measures in the natural gas supply chain of Ghana. The researcher is concerned with identifying which performance measures exist in the natural gas supply chain and how and which of these measures are used by the natural gas supply chain of Ghana. These measures will be validated using questions such as what, which and why question types which are positioned firmly within interpretivist philosophy.

This study uses the qualitative case study strategy of inquiry (Silverman, 2000; Yin, 2003; Denzin and Lincoln, 2005). The aim of a good qualitative case study is to present an in-depth understanding of a case (Creswell, 2013). For this study, the views of participants regarding supply chain performance measurement of the natural gas industry in Ghana were explored so as to identify performance measures for the supply chain. A variety of data were collected, by interviews, documents, and reports (Collis and Hussey, 2006; Yin, 2003).

Purposeful sampling was used to select participants who are known to be qualified and experienced in the phenomenon of interest (Lincoln and Guba, 1985). Based on the aims of the study, the target of interviewees was supply chain managers of the various companies in the NG supply chain of Ghana.

The selection process was initiated with contact with companies in the supply chain to explain the intention of the research, why the company was chosen and the likely number of times participants will be contacted. A total of four companies were contacted. However, three out of the four companies accepted the request. These companies were selected also based on their position within the supply chain (whether they were in the upstream, midstream, or downstream).

Five semi-structured interviews with board members of each of the case companies were conducted (that is, in total 15 interviews). The flexibility of semi-structured interviews allowed for unique response to the questions and also allowing participants to fully express their viewpoints and experiences (Turner, 2010). The duration of the interviews was 45 minutes on average and

they were tape recorded. At the same time, we obtained documents by each of the companies that may be useful to our understanding of how they operate with regards to their NG supply chain.

The researchers synthesised information from documents obtained using thematic analysis (Miles and Huberman, 1994). Interviews were transcribed ad verbatim and were assigned codes, which were later revisited and augmented by the document data, building thus our analysis. At the same time, the researchers examined how and why the performance measures identified in our framework were used and perceived.

4. Findings

4.1 Upstream – Company A

Company A is an independent exploration and production company founded in 1985 in Ireland and has its headquarters based in London, UK. The company has over 85 licenses and operates in over 21 countries. Company A has a workforce of over 2,034 worldwide and it was recognised a leader in the oil and gas industry by the end of 2013.

The strategy of the company is to achieve sustainable long-term growth through balanced funding, exploration and production in core geographical areas. In pursuance of this, the group employs a cost focus generic strategy, concentrating on exploration growth in Africa with 83% of its capital expenditure being invested in the region in 2011. This approach has gained Tullow specialist knowledge and experience in Africa giving it a competitive advantage over other OGCs and a high return to its shareholders. As such, Tullow is able to compete effectively on the basis of its capabilities and resource making it one of the largest OGCs in Africa.

Importance of performance measures and performance measurement systems

Performance measures were used to assess performance against strategic objectives. Company A has a strong urge to achieve a long-term term sustainable growth through adequate resource allocation to various activities. Remaining sustainable and competitive can only be achieved when the company knows how well it is doing and this can only be done by the use of performance measures. The company designs such performance measures to reflect the company's strategy, business plans and priorities.

The company uses the BSC to assess its performance. The model is not modified and uses the originally proposed perspectives (that is, Financial, Customer, learning and growth, business or

internal process perspectives). The company pays significant attention to the financial perspective as they regard it important for the survival of the company. They also believe that customer satisfaction is paramount. At the same time, however, they would like to be cost efficient in terms of their internal business processes and to develop cost effective measures for production and development. Learning and growth is the main driver for all activities of the company.

From our interviews it was apparent that all measurement areas as suggested by our framework, including financial and non-financial measures were considered as important. Both aspects of measures are necessary to the organisation and its supply chain.

Good performance measures: the importance of keeping a balance between financial and non-financial measures

According to the company's managing director, good performance measures and metrics are supposed to reflect the strategic objective of the company. They should also provide information on cost reduction measures, product quality and customer satisfaction, as well as being visible and easy to understand. They regard the customer management as one of the most important measures, apart from the financial measures included in our conceptualisation. However, one perspective cannot be singled out as important, for example customer perspective is important to know how well the company is doing, internal business about the activities of the company and its supply chain, learning and development to develop and motivate staff to give off their best and the financial perspective to assess financial performance of the company.

4.2 Midstream – Company B

Company Background

Company B was established as a limited liability company in July, 2011. The company is responsible to build, own and operate the infrastructure required for gathering, processing, transporting and marketing natural gas in the country. Company B aims to become a fully integrated gas business firm with a strong reputation as a trusted supplier of natural gas resource and a trusted partner. Their strategy is to deliver consistent value to the people of Ghana by contributing to Ghana's industrialization drive through the building of infrastructure required for gathering, processing and delivery of natural gas resources to industry in a safe, cost effective, responsible and reliable manner. As the sole NG Aggregator, Company B is strategically positioned to meet the lean gas needs required for power generation, industrial process heating, fertilizer production and alumina

refinery in the country, as well as LPG and other liquids for domestic and commercial applications. This is done by employing the best marketing practices that aim at adding significant value to our business in an ethical and sustainable manner.

Importance of performance measures and performance measurement systems

Performance measures are considered important but at the moment Company B does not have any framework; they are considering to use BSC and SCOR as they consider the different perspectives and views of the stakeholders. However a number of performance indicators are used to measure the progress of work. Indicators such as number of near misses, number of work related illness, number of environmental incidents are used to measure performance of health EHS. The company also tracks financial performance on how much money is spent against set budget or target. The measures which drive behaviour and cost are regarded as important. Financial performance measures drive cost and non-financial measures drives behaviour of the various stakeholders. Thus all performance measures included in our framework were deemed as being very important.

Good performance measures: the importance of keeping a balance between financial and non-financial measures

The interviewees suggested that good measures are the ones that are simple and easy to understand, simple to use, and those that are in line with the company objective. Complex performance measures generally render measuring difficult and also do not usually bring out the true result of what is being measured. However, no matter if there are no performance measures used at the company, all categories within our framework deemed to be important, but there was no underlining of the importance of balance. The company seemed to have a focus in developing financial performance measures, while the non-financial ones were underplayed.

4.3.3 Downstream –Company C

Company Background

Company C was established in 1993 as a private Limited Liability Company with the Government of Ghana as the sole shareholder. The vision of the company is to be a major quality player in the Government's vision of ensuring that Ghana has a continuous, uninterrupted, reliable and safe supply, effective and efficient distribution of petroleum products at the most competitive prices for its socio-economic development. Company C has the mandate to develop a network of storage

tanks, pipelines and other bulk transportation infrastructure throughout the country and to keep Strategic Reserve Stocks for Ghana. Company C has been given an additional mandate as the Natural Gas Transmission Utility (NGTU) to develop the Natural Gas infrastructure throughout the country.

Importance of performance measures and performance measurement systems

Very often for managerial purposes, Company C measures performance using pre-specified performance measures which enable the company to emphasise on analysing and prioritising in critical areas. In all, performance measures would be described as indicators used to manage and improve processes aimed at achieving desired results. Performance measurements that are used to make very smart managerial decisions. The company uses the BSC since 2011 and has proved very successful especially in staff motivation and performance and other measures. For example, measuring health safety and environment, they measure the pollution rate of the company; in business performance, they assess the cost involved in transporting products to customers, with the aim of becoming more cost efficient by applying cost cutting measures.

Good performance measures: the importance of keeping a balance between financial and non-financial measures

According to the company interviewees, customer and cost are the key drivers for measuring performance, since every company looks to make profit obviously and every activity carried out by the company is because of its customers. A good performance measure must reflect what the company is all about. If a company for example has a strategy to be effective, measures such as quality and cycle time must be employed. But however, when choosing measures and metrics, the owner must ensure that the measures are most importantly simple and provide a clear understanding of rate of improvement. The company stakeholders suggested that all measures from our framework are important and relevant to their company, and that appropriate balance should be kept between financial and non-financial measures.

5. Discussion

5.1 Importance of performance measures and performance measurement systems

Findings obtained indicate that performance measures are considered important by respondents. Respondents share the very important view that measures are used to assess the performance of

companies and their supply chain against the objective of the company. Information obtained from these measures is particularly important to all management and operational levels (Wei, 2014). Management aims to know how well and efficient the supply chains are performing. In process industries such as the natural gas industry, performance measures provide information on monitoring, control, feedback and evaluation (Varma et al., 2008). Gunasekaran *et al.* (2001) mention that performance measures are needed to assess and inspect how viable the strategies of a company are in line with improvement and achieving goals. The findings from the empirical study correspond with theoretical study. However, other vital importance of these performance measures suggested by Ghalayini and Noble (1996) is that they are used to evaluate, control and improve activities in organisations and supply chain. Though the empirical findings did not identify these other importance of performance measures, it is vital to acknowledge these other importance.

Based on empirical findings, two of the companies have implemented the BSC model as the performance measurement system and one considers using the BSC model as a measurement system when the company is ready. All of the respondents argued that the reason to adopt the BSC model is based on the fact that it considers the interest and concerns of all stakeholders of the supply chain. From empirical data, respondents use performance measures and consider it important. Supply chain performance measurement systems have been studied since the concept of SCM was founded (Wei, 2014). Many researchers have mentioned that measuring performance of supply chains is a complicated task and requires varying systems. Gunasekaran *et al.* (2004) mentioned that the fundamental challenge to measure performance is the lack of a balanced approach and inability to measure the whole supply chain. Due to these challenges Lindner (2009) suggests that the BSC and SCOR systems should be used to measure supply chains because they are balanced and measures the whole supply chain. However, BSC is regarded popular by most companies because it creates a balance between financial and non-financial measures and also considers the interests of stakeholders involved (Kaplan and Norton, 1992).

5.2 Good performance measures: the importance of keeping a balance between financial and non-financial measures

Our findings show that the case companies employ financial and non-financial performance measures to assess the performance of the company's supply chain. Most research on performance measurement has elaborated on the use of both financial and non-financial measures to assess the

performance of supply chains. Ghalayini and Noble (1996) mentioned that balancing the two measures provides an overall view of performance of supply chains and guard against sub-optimization. The use of financial measures has a huge drawback in highly competitive markets (Arif-Uz-Zaman, 2012), and therefore implementing non-financial measures into evaluating performance eliminates the drawbacks of financial measures.

The key feature of a good performance measure was that performance measures and metric must be designed to reflect the strategic objective of the company. Other characteristics were given as that it must be easy to understand, visible, clear and transparent. If the measure or metrics does not reflect the strategic objective of the company and too complex, the impact of the performance measures is lost in translation (Sarkis *et al.*, 2011). Furthermore, the companies have argued that keeping a balance between financial and non-financial measures is of paramount importance. Turnock and Thomson (1994) defined attributes of performance measures as valid, reliable and responsive, directly relate to corporate objectives, credible to support stakeholders interest, understandable and readily available.

Finally, with regards to our proposed framework and the identification of the six main criteria for performance measurement (learning and growth, financial, customers, HSE, suppliers and internal business process), all respondents (even those of Company B that do not have a PMS yet) agreed on the importance of the criteria and its corresponding performance measures as complete for measuring the performance of the NG supply chain. This reason can be explained using stakeholder theory. Our framework included measures that comprehensively covered areas of interest to stakeholders such as employees, shareholders, suppliers and society that should be considered when developing or setting company targets (Wartimi, 2012), as well as externalities that may affect stakeholders such as customers, suppliers, community, shareholders and employees (Sarkis *et al.*, 2011). Therefore, our research confirms the view that the long-term growth and success of companies is largely dependent on the support of stakeholders and that their needs and wants should be effectively managed (Freeman and McVea, 2005).

Our contribution, therefore lies in: (i) exploring and arguing for a PMS (conceptualised through a framework) that entails particular measures for measuring the performance of the NG supply chain, and (ii) suggesting that, as in the case of other types of supply chain, that is important to attend to both financial and non-financial measures. The use of BSC or SCOR is not necessary, but what is needed is an approach that considers the different needs and wants of the diverse stakeholders involved.

6. Conclusion, Limitations and Future Scope of Research

The research sought to develop a performance measurement system for the NG supply chain. The Ghana natural gas supply chain was chosen as the case to be studied. Supply chain performance measurements have been studied a great deal during the past decades. However the amount of studies that have been conducted relating to performance measurement in the natural gas supply chain is minimal. In this study, a conceptual framework was developed based on concepts from the review of validated measurements in the NG supply chain, and was validated through three cases in the context of Ghana.

The result of this thesis verify the importance of performance measurement for economic growth and productivity in the natural gas industry. Management can increase productivity and profitability which gives them a competitive edge by employing a comprehensive set of performance measures to measure performance of their supply chain. Practitioners could also use our suggested framework as a discussion when evaluating their supply chain performance, or as an evaluation tool that enables them to understand and measure areas of focus while paying attention to both financial and non-financial measures and stakeholders.

A number of limitations were encountered during the course of this research. The first limitation deals with the amount of data obtained. The research focused on NG industry in Ghana which is relatively in its nascent stage. The amount of data obtained through interviews was relatively small. However, this limitation was overcome by obtaining additional data from content analysis of documents from the case companies. Another limitation also was the difficulty in getting through to participants due to busy work schedule. It was challenging at times to identify and discuss performance with participants due to restrictive company policies. However, adequate information was obtained in order to understand participants' views and also to achieve the research aim.

Notwithstanding the aforementioned limitations, there is scope for further research. Firstly, we argue for studies that will further confirm our framework in a larger population, even through the use of questionnaires and quantitative methods in order to test whether our criteria hold true. Secondly, our framework has been based on the NG industry and verified through case studies in Ghana. It would be fruitful to examine its application in other countries, and especially developed, to further test its application.

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