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Performance measurement framework for the oil and gas supply chain

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Purpose: There is evidence in the literature suggesting the usage of performance measurement framework has a positive impact on organizational performance. This is in line with resource based view (RBV) theory, which argues attaining competitive advantage through internal resources and capabilities. In this regard, Performance Measurement Framework (PMF) can be viewed as a 'resource' that can be explored in enabling organisational performance. This paper is aimed at developing performance measurement framework for the oil and gas supply chain as a resource and strategic capability.
Methodology: Drawing on RBV theory, a questionnaire survey was designed based on prior literature review and exploratory interview with five supply chain experts. Following this, the questionnaires were distributed to 550 companies in the UK and 120 companies in Malaysia, which resulted in 15% overall response rate.
Findings: This study presents the prevalence of Performance Measures (PM) for the oil and gas industry based on the level of importance. It also reveals the impact of the usage of Performance Measurement Framework (PMF) on overall organisational performance. In addition, it identifies the challenges in managing supply chain performance and factors to be considered in choosing performance measures.
Originality: This study identifies the challenges in managing supply chain performance and establishes distinctive factors to consider when choosing performance measures in the oil and gas supply chain.
Keywords – **Performance measurement framework, performance measures, supply chain, oil and gas**

1. Introduction

PMF is defined as a set of PMs used in assessing the performance of a given task within an organisation (Neely, 2005). It is an essential resource in improving organisational performance (Parker, 2000; Gunasekaran, Patel and McGaughey, 2004; Bai and Sarkis, 2012). The increase in reliance on supply chain management has raised the need to improve supply chain (SC) efficiency and effectiveness. One way of doing this is by having a proper PMF to assess SC performance. Despite extensive previous research into performance measurement, most of which are focused on manufacturing and services industry (Garengo, Biazzo and Bititci, 2005; Martínez Sánchez and Pérez Pérez, 2005; Sambasivan, Mohamed and Nandan, 2009), the oil and gas sector remains under researched. Some of the existing study on supply chain performance for this industry are concerned with sustainability measures (Yusuf *et al.*, 2013; Yusuf, Gunasekaran, *et al.*, 2014). Varma, Wadhwa and Deshmukh (2008) explored the prevalence of performance measures in the oil and gas supply chain. However, it was limited to the downstream petroleum refining sector of the industry. More importantly, it did not investigate the choice of performance measures and its impact on organisational performance – the two primary issues of interest in this study. In addition, the need for this study also comes from the fact that performance measurement framework is influenced by the type of industry in which organisations operate (Otto and Kotzab, 2003; Gunasekaran and Kobu, 2007; Kumar and Markeset, 2007; Hsu *et al.*, 2009; Kumar and Nambirajan, 2013). Furthermore, the nature of the oil and gas industry requires high technical competencies, multiple experts and diverse companies to deliver a project from upstream through to the downstream. This necessitates the oil and gas companies to improve their supply chain performance in pursuit of better competitive edge. This research attempts therefore to study the PMF for the oil and gas supply chain and its implications on organisational performance. The research employed a mixed method approach involving industrial interview followed by a survey by questionnaire. The expert opinions sought during the interview phase was validated with a large number of respondents at the questionnaire stage. The research is explained by Resource based view (RBV) theory in which it is argued that PMF is a 'resource' tool in managing performance. The research objectives can be delineated as follows:

(1) To identify the prevalence of performance measures in the oil and gas industry.
(2) To analyse the effects of the choice of performance measures on organizational performance.
(3) To investigate factors that determine the choice of performance measures in the oil and gas industry.
(4) To examine the challenges faced by oil and gas companies in managing supply chain performance.

This paper is structured as follows; Section 2 is a review of the literature on performance measurement framework, performance measures and RBV theory. The methodology is presented in Section 3 followed by data analysis in Section 4. The results are discussed in Section 5. Finally, the conclusion is shown in Section 6.

2. Literature review

2.1 Performance measurement framework

In comparison to other industries, the oil and gas industry has several distinguishing characteristics. These include; i) long supply chain links, ii) higher technical requirement, iii) involvement of diverse expertise, iv) high transportations and machinery costs (Varma, Wadhwa and Deshmukh, 2008; Chima, 2011; Rui *et al.*, 2017). As a result, the oil and gas operations normally involved multiple companies to deliver a project. These involvements can be in the form of joint venture, subcontracting some of their scope of works, or combination of both (Ernst & Young, 2014; Organisation of Petroleum Exporting Countries, 2015). Our exploratory interviews with supply chain experts suggested that up to 60% of oil and gas business execution are outsourced. The reliance on other parties throughout oil and gas projects require a proper supply chain management (SCM). In fact, SCM has been recognised as a determinant factor of overall organisational performance (Tan, Kannan and Handfield, 1998; Gunasekaran, Patel and McGaughey, 2004; Youn *et al.*, 2014). Therefore, many organisations place greater emphasise on managing supply chain performance.

The reliance on supply chain activities not only driven by internal factors but also many external factors. Gunasekaran *et al.* (2004) suggest those external factors are; an increase in business globalisation, the growth of international trade, ease of access to information, and environmental awareness. Parker (2000) suggests that all organisations are assessing their performance whether informally or systematically. PMF is recognized as an essential resource in improving organisational performance (Parker, 2000; Gunasekaran, Patel and McGaughey, 2004; Bai and Sarkis, 2012). In line with this, many researches have been conducted to develop PMF for measuring organisational performance. Early research on PMF concentrated on manufacturing and services industry (Garengo, Biazzo and Bititci, 2005; Martínez Sánchez and Pérez Pérez, 2005; Sambasivan, Mohamed and Nandan, 2009). There are several considerations in designing PMF. These include; i) PMF should be designed based on organisational strategies (Parker, 2000; Gunasekaran, Patel and McGaughey, 2004; Neely, Gregory and Platts, 2005), ii) to ensure inclusiveness of financial and non – financial PMs (Gunasekaran, Patel and McGaughey, 2004), iii) the PMs need to be easily understood (Neely, Gregory and Platts, 2005; Gunasekaran and Kobu, 2007), and iv) information derived from PMF must enable decision making (Bai and Sarkis, 2012).

2.2 Performance measures in supply chain environment

This section discusses some performance measures that are widely cited in the literature. These include delivery speed, delivery reliability, quality, flexibility, financial measure, and innovations. Moreover, it also discusses safety measures and other sustainable measures that have received much attention from researcher and practitioner nowadays, which are social responsibility and environmental measures.

2.2.1 Delivery speed

Delivery speed is a metric used to assess the ability of an organisation to deliver services or goods within the agreed time (Ketchen and T. M. Hult, 2007). Delivery speed is regarded as one of the organisations' competitive priorities (Chen and Paulraj, 2004; Yusuf et al., 2014). For activities that involve various business functions, delay in one area might affect the consequent events. This eventually will affect customer satisfaction and increase the inventory cost. There are various factors that influence this performance including vehicle speed, driver reliability, frequency of delivery, and depots' location (Gunasekaran et al., 2004). Despite that, delivery speed measures might be different and very much influenced by the type of industry. For instance, the concept of Just in Time (JIT) where the emphasis is on reducing inventories by delivering goods by the supplier at the time it is needed is more common in manufacturing industry than any other sectors (Kannan and Tan, 2005). Thus, how to measure delivery speed is determined by the supply chain strategy of each organisation.

2.2.2 Delivery reliability

Delivery reliability is a criterion regarding the performance of a company/supplier in delivering the ordered goods/ services to the right place, at the agreed time, in the required quantity and quality (Huang and Keskar, 2007). The delivery reliability measures are the combination of delivery performance, fill rate, and perfect order (Cagnazzo, Taticchi and Brun, 2010; Talapatra and Uddin, 2019). This measure was ranked as the second important competitive priority after quality in the oil

and gas industry (Yusuf et al., 2014). Moreover, Ho (2007) claimed that this measure is critical in assessing the performance of supply chain members. Another author, Kim (2009) claimed that delivery reliability can be achieved by supply chain integration.

2.2.3 Quality

Quality is defined as the ability of an organisation to deliver services or goods to meet the minimum standard required by the customers. The management of suppliers' quality has a direct association with high level of overall quality, reduced variation in quality performance, and minimisation of costs (Cagnazzo, Taticchi and Brun, 2010; Talapatra *et al.*, 2020). Kannan and Tan (2005) who investigated the link between JIT, TQM, and SCM with business performance found that quality indicates a positive correlation with all business performance measures except return on asset (ROA). In a similar note, due to an increase in reliance on outsourcing activities, there is a growing area of research around quality management and supply chain management focusing on suppliers' quality (Soltani *et al.*, 2011; Talapatra, Uddin and Rahman, 2018). The authors claimed that focusing on suppliers' quality is very important as it can affect the overall cost of products/ services. Moreover, poor quality performances could impact their revenues and diminish customer and stakeholders' trust (Li et al., 2011; Soltani et al., 2011). For instance, due to improper supply chain quality assurance, a world renowned automobile manufacturer had to recall millions of its vehicle due to issues with the brake and floor mat (Li et al., 2011). Another example of poor quality control is the event of adulterated milk in China (Chen et al., 2014). The finding shows that this incident was caused by improper quality control at the supply chain network. Some studies suggest information technology can improve quality standards through data accuracy, timely communication, and integration of information (Li et al., 2011). However, the reliance on automated systems or guidelines should not undermine employees' own observations and decisions. In their case study, Vanichchinchai and Igel (2011) imply some problems arise when employees practice stringent quality compliance without a proper understanding of SCM urgencies. Thus, when quality problems arise, they have no standardised guidelines to follow in order to resolve the problem. This will eventually result in longer lead times and higher costs. Therefore, Vanichchinchai and Igel (2011) concluded that training on quality awareness is very important. The examples of quality measures include product quality, services quality, quality of delivered goods, and quality of documentation.

2.2.4 Flexibility

Flexibility in SCM is very important to respond to uncertain demand in today's business environment. A flexible supply chain can be regarded as having the capacity to meet the changing demands of customers (Gunasekaran et al., 2004; Ketchen and Hult, 2007). This includes flexibility in the supply chain process and with the end products or services delivered to customers. A flexible supply chain is important, particularly to meet special requirements by providing a variety of service or goods. It is also critical in supporting new products introduction (Chan, 2003). From a manufacturing perspective, flexibility is defined as; "the capability of a manufacturing system or facility to effectively address uncertainty from a wide variety of sources, yet continue to produce efficiently different products or product volumes of acceptable quality, cost, and timeframe"(Boyle and Scherrer-Rathje, 2009). Whilst for services industry, it refers to supply chain flexibility in responding to the changing needs of the customer, the focus of measuring flexibility is on the supply chain process as well as the services they provided (Ketchen and G. T. M. Hult, 2007). The importance of flexibility has been widely discussed in the supply chain literature. Amongst the earliest research that recognised flexibility as one of the important elements in supply chain performance was undertaken by Beamon (1999).

2.2.5 Forecast accuracy

Forecast accuracy is the ability to accurately estimate some unknown future events (Fleischmann and Meyr, 2003). This measure is important in reducing inventory levels and eventually increase organisations' cost savings (Ramanathan, 2014). Oil and gas associations such as OPEC and IEA emphasis forecasting accuracy to ensure that their productions are able to meet markets' demand. Moreover, they also forecast the capacity of natural resources in the country of operation to estimate the energy futures in the long run. Fleischmann and Meyr (2003) argued that accurate forecasts allow organisations to tailor their productions based on the forecast instead of orders which speed up the process. Moreover, they contend that some goods have seasonal demand patterns. Hence, the inventory level, products quantities, working times, cost and potential revenues need to be planned in advance using the forecast information. For instance, in the implementation of make-to-order strategy, contingency stocks need to be introduced to deal with unavoidable forecast error.

2.2.6 *Financial*

Financial measures focus on the monetary goals of an organisation. Examples of financial measures include cost savings, return on investment, and return on asset. These measures were recognised as the most important element in measuring performance long before non-financial measures such as operation measures were introduced (Kaplan and Norton, 1992). Varma et al. (2008) argued that focusing on financial measures alone is only suitable for simple SCM applications and only measure past events. Nevertheless, these measures are required for measuring organisations financial situations and especially important to provide information for stakeholders and potential investors. Gunasekaran and Kobu (2007) contend that financial measures are still the most widely used criteria in measuring organisations' performance. This shows that they have a major role in supply chain performance, especially with regards to the decision-making process.

2.2.7 *Innovation*

Innovation is the ability of an organisation to innovate its strategies, services or products, or operations to attain a competitive advantage over their competitor (Chima and Hills, 2007). Increase in customers' expectation is one of the key drivers of services and products innovation (Bhagwat and Sharma, 2007). The earliest literature on innovation concentrated on the advancement in technological information. This focus then expanded to creating value-added innovation (Lin et al., 2010). Despite its importance in improving supply chain management, Gunasekaran and Kobu (2007) found only 27% of organisations consider this measure in assessing supply chain performance. Two possible reasons for this are this measure is neglected by the researcher or this measure is still lacking in practice by the industry (Gunasekaran and Kobu, 2007). Bhagwat and Sharma (2007) proposed a few examples of innovation measures, which include supplier assistance in solving technical problems, supplier ability to respond to quality problem, supplier cost saving initiatives, and level of customer perceived value of products.

2.2.8 *Safety measures*

Safety measure is the most important criterion for a high risk industry (UNEP, 1997; Zhao et al., 2017). This measure is required to ensure the workplace/ operations are safe for the people, equipment, and environment (Zhao et al., 2017). Some examples of safety measures include safety compliance, accident rate, injury rate (Dahl and Olsen, 2013; Talapatra *et al.*, 2019), number of safety and development programmes (Mearns and Flin, 1995). One of the important safety measures, safety compliance, refers to "core safety tasks that have to be carried out by individuals to maintain safety at work" (Kvalheim and Dahl, 2016). Poor safety compliance is recognised as the main cause of accidents in the workplace (Ruifeng and Subramaniam, 2011; Dahl and Olsen, 2013). In the oil and gas industry, safety precautions are highly regulated and all of the work operations are guided through safety rules and procedures (Kvalheim and Dahl, 2016). Therefore, safety training and developments are very important in enhancing safety performance and overall organisational success.

2.2.9 *Environmental measures*

The drivers for environmental awareness include scarcity of resources, legislation changes pertaining to environmental issues, and natural disasters (Perera, Perera and Wijesinghe, 2013; Fu *et al.*, 2020). The concerns on environmental issues started in the 1990s in the manufacturing industry (Boon-itt and Wong, 2011). Similarly, the integration of development and environment within the oil and gas industry was the central theme in the United Nation's Conference on Environment and Development (UNICED) in the year 1992 (Oil industry International Exploration and Production Forum, 1997). This indicates that environmental concerns have also started in the oil and gas industry about the same time as in the manufacturing field. Moreover, the United Nation Environment Programme (UNEP) was established in 1975 with the aim of collaborating between government and industry on environmental management. Its goals are to encourage the incorporation of environmental criteria in industrial development plans, to facilitate the implementation of procedures and principles for the protection of the environment (Oil industry International Exploration and Production Forum, 1997). UNEP and E&P joint forum has developed environmental protection measures for each potential source of environmental impact on upstream oil and gas operations (Oil industry International Exploration and Production Forum, 1997). Youn et al. (2013) argued that poor supply chain partner management is the main cause of most environmental incidents. Failure in critical environment areas have a huge impact not only on the environment, but also on the organisations' finance and company's' brand. In some cases, it might lead to fatality as in the case of Bhopal disaster (Youn et al., 2013). Environmental measures need to be designed to facilitate desired outcomes. These measures must be easily understood by non-scientists, support environmental and social objectives of organisations, and provide information needed by the

stakeholders (Perera et al., 2013).The environmental measures include the recycling rates, reduction of waste, preparing environmentally friendly work place or operations (Youn et al., 2013).

2.2.10 Social responsibility measures

Social responsibility measures the ability of an organisation to invest in voluntary activities to improve social conditions (Zhang *et al.*, 2013; Cheng, Lee and Chen, 2014; Hasan and Habib, 2017). These social activities involve employees, customers, suppliers, and local communities at large (Chenhall and Langfield-Smith, 2007). The examples of social activities include to develop local suppliers, investment in charitable projects to help less fortunate people, and provide scholarships for outstanding students and other environmental aspects as discussed earlier. Apart from organisations' internal motives regarding social responsibility, it has gained greater attention in recent years due to the pressure from local government, non-governmental organisations, and the public. Government's policies to promote sustainable supply chain is conducted through incentive and punitive mechanisms (Zhao et al., 2017). The incentive approach includes subsidy, tax preferences, and price regulations. On the other hand, the punitive approaches include economic sanctions and legal supervision. The external pressure for social responsibility aspects drive organisations to be concerned with the incorporation of social responsibility values in their business operations. Some organisations have included social responsibility measures in their performance framework. These include Novo Nordisk and Shell (Chenhall and Langfield-Smith, 2007). Large oil and gas organisations such as Exxon Mobil and British Petroleum incorporate sustainability development factors which cover social, environmental, and safety concerns in their business operations (Chenhall and Langfield-Smith, 2007; Shell Royal Dutch, 2009; BP p.l.c, 2016; Exxon Mobil Corporation, 2016). In line with growing needs of social responsibility measures, Gopal and Thakkar (2012) recommend further research to incorporate environmental and social responsibility measures as discussed in in their review of supply chain performance measures.

There is much literature discussed the performance measures in various industries. However, there is a need to understand the nature of the industry and business strategy to devise a PMF for a specific organisation. For instance, in the automobile industry, inventory turnover might be a key performance measures for the industry to minimise inventory cost and delays in productions (Gunasekaran and Kobu, 2007). In contrast, flexibility in terms of product variety could be the key measure for the fashion industry. These examples indicate the need for further research on performance measures for industry specifics (Gunasekaran et al., 2004; Shepherd and Günter, 2006; Gunasekaran and Kobu, 2007; Taticchi et al., 2013). These lead to two research questions: RQ1 What are the prevalence of performance measures in the oil and gas industry? RQ2: What is the impact of performance measures on organisational performance?

2.3 Resource based view theory

Resources are defined as tangible and intangible assets of a firm that can be used to gain competitive advantage. These include but not limited to brand names, in-house technological knowledge, skilled personnel, machinery, efficient and complex systems (Wernerfelt, 1984; Rivard et al., 2006). RBV focuses more on the internal resources management throughout the firm and not the one acquired externally by outsourcing mechanism (Coates and Mcdermott, 2002). RBV is known as a paradigm that helps many organisations to gain competitive advantage through four characteristics of resources; valuable, rare, non-transferable, and difficult to imitate (Peteraf, 1993; Hart, 1995). It improvises the competitive advantage idea by emphasising that competitive advantage can only be sustained if the capabilities in creating the advantage are supported by four characteristics of resources mentioned earlier (Sirmon et al., 2011; Barney, 2012). Szymaniec-mlicka (2014) stated that resources management is increasingly important in the unpredictable market situation. In this kind of market, maximising the potential of intangible resources, such as management strategy, and performance management is particularly important. The external factors of the oil and gas industry such as world oil and gas prices, exposure to high uncertainties, and high operations cost are very least control by the organization. Furthermore, the final products of this industry such as refined oil and gas have very minimal differentiation for a company to achieve competitive advantage through it (Chima and Hills, 2007). For that reason, it is important for the industry to instead focusing on managing resources and capabilities, which can be achieved by managing organisational performance. Therefore, this research aims to explain RBV theory through the usage of performance measurement framework as a 'resource' in managing resources and capabilities of an organisation.

3. Research methodology

After extensive review on supply chain performance measurement, we outlined relevant performance measures to the industry. The performance measures comprise of four main elements namely, financial, operational, safety compliance, environmental and corporate social responsibility. These performance measures were then validated through interviews with five supply chain experts in the oil and gas industry. This is to have better understanding on its application in the oil and gas industry. This information was used as the basis to propose the expanded set of performance measures. In this

process, the initial set of performance measures was amended to incorporate additional measures based on the interviews findings. The outcomes of this interview process are structured in the form of questionnaires to test it with larger group of respondents. Prior to distribution of the questionnaire, the survey instrument was validated by academicians and industrial practitioners. The questionnaire was mailed to CEO of oil and gas companies in the UK, which enclosed with paid envelope and cover letter. Whereas, the CEO of oil and gas companies in Malaysia was approached using email containing the link to the online survey and a copy of survey form. The questionnaire was aimed to identify the prevalence of listed performance measures to the oil and gas industry. The participants were asked to rate the level of importance of performance measures based on five Likert-scale ranging from very low to very high. The flow chart of the research process is presents in Figure 1.

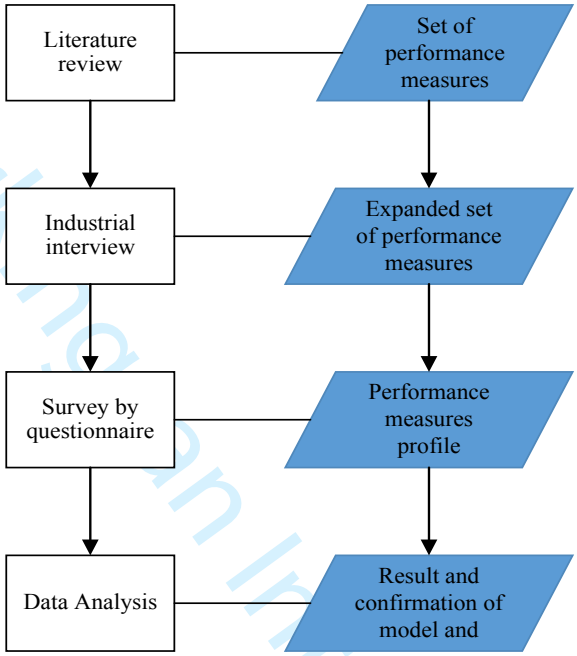

Figure 1: Research methodology

3.1 Respondents profile of exploratory interviews

Table 1 provided respondents information that involved in the exploratory interviews. There are five supply chain experts participated in the interviews, which have experiences ranging from 15 to 30 years. The table summarises the year of experiences, role of the participants in their current company, the country, and educational background. It also reveals the role of company the participants are currently involved and the role of their previous company.

Table 1: Respondents profile of exploratory interviews

Participant	Year of experience	Role in company	Country	Educational background	Previous companies	Current company
A	20	President	UK	Engineering	Services advisory – oil and gas operator	Services advisory
B	25	Project procurement manager	USA	Business administration	Oil and gas operator and contractor	Services advisory
C	15	Senior supply chain manager	Indonesia	Engineering	Oil and gas operator and contractor	Oil and gas operator
D	30	Head of supply chain	Malaysia	Quantity surveying	Oil and gas operator and contractor	Oil and gas contractor
E	15	Leader, supply chain	Malaysia	Engineering	Oil and gas operator and contractor	Oil and gas contractor

3.2 Data collection

A total of five hundred fifty (550) questionnaires were mailed out to the CEO of the oil and gas companies in the UK. These companies were randomly selected from Pegasus energy (www.pegasusenergy.co.uk) and Subsea oil and gas energy (www.subsea.org.uk) databases for UK samples. Out of 550 companies, 62 companies returned the completed questionnaires. On the other hand, 120 companies from Malaysia were randomly selected from oil and gas association databases including Malaysia oil and gas service council (www.mogsc.org, my), Malaysia gas association (http://www.malaysiangas.com/portal/), and Malaysia oil and gas engineering council (mogec.org.my). 39 companies completed the questionnaire for Malaysia sample. Total response rates from both countries is 15%, despite the low response, we consider adequate to represent the industry considering around 70% of respondents consists of managerial level and above. Previous studies have recorded response rates as low as 10% (Coughlan and Coghlan, 2002)

3.3 Sample profile

Table 2 demonstrates the demographic profile of the respondents consists of the size of organisations based on number of employees, respondents' designation, major business sectors and proportion of the UK and Malaysia responses. The table indicates that the data is taken from diverse sectors of the oil and gas industry. In addition, the size of organisation shows that the sample of this study derived from small medium enterprises (SMEs) to large organisations. Nevertheless, the majority of the respondents were from SMEs, which demonstrated a similar proportion as the previous research survey conducted by (Yusuf, Musa, *et al.*, 2014).

TABLE 2: Demographic profile of respondents

Total number of respondents	**Frequency**	**Percentage**
Size by number of employees		
Less than 50	50	50.%
51 -200	19	19%
201 – 500	12	12%
501 – 1500	9	9.0%
1501 – 3000	3	3.0%
Above 3000	5	5.0%
Total	98	98%
Designation of respondents		
MD/ CEO/ CFO/ Director	29	30.5%
Manager: Supply chain & contracts	16	16.8%
General Manager/ Country Manager	11	11.6%
Manager: Technical / Operations	12	12.7%
Executive: Procurement/ Contracts specialist	10	10.5%
Engineer: Project/ Process/ Cost	5	5.3%
Executive (others)	2	2.1%
Major business sectors		
Exploration and production	21	14.3%
Marine and subsea services	25	17%
Energy consultancies including geographical consultancies	12	8.2%
Transportation, storage, logistics, catering and allied services	17	11.6%
Well and drilling services	13	8.8%
Engineering services, facilities management, structure designs and fabricators	39	26.5%
Refining, refined oil distribution and marketing	13	8.8%
Other services:		
Decommissioning	3	2%
Repair and Maintenance	2	1.4%
Trading and supply	3	2%
Country		
UK	62	61.3%
Malaysia	39	39%

4. Preliminary analysis of data

4.1 Tests for normality

Normality assessment is conducted to determine whether the data set is well-represented by normal distribution population or Gaussian distribution (Ghasemi and Zahediasl, 2012). This assessment is a pre-requisite for parametric analysis such as t-test, regression, analysis of variance (ANOVA) (Tabachnick and Fidell, 2007; Pallant, 2016). There are two categories of normality assessment which are; i) graphical method and ii) statistics method. The graphical method includes histogram, stem-and-leaf plot, box plot, normal distribution plot, and detrended normal plot. There are also two statistical methods, namely, Kolmogorov–Smirnov (K-S) and Shapiro-Wilk tests. The methods used for normality assessment in this study were histogram, normal quantile-quantile plot (q-q plot), Detrended q-q plot. Figure 2 depicts the histogram of the data set

for the two constructs; i) the choice of performance measures, and ii) organisation performance. It can be observed that the histogram for both constructs was normally distributed.

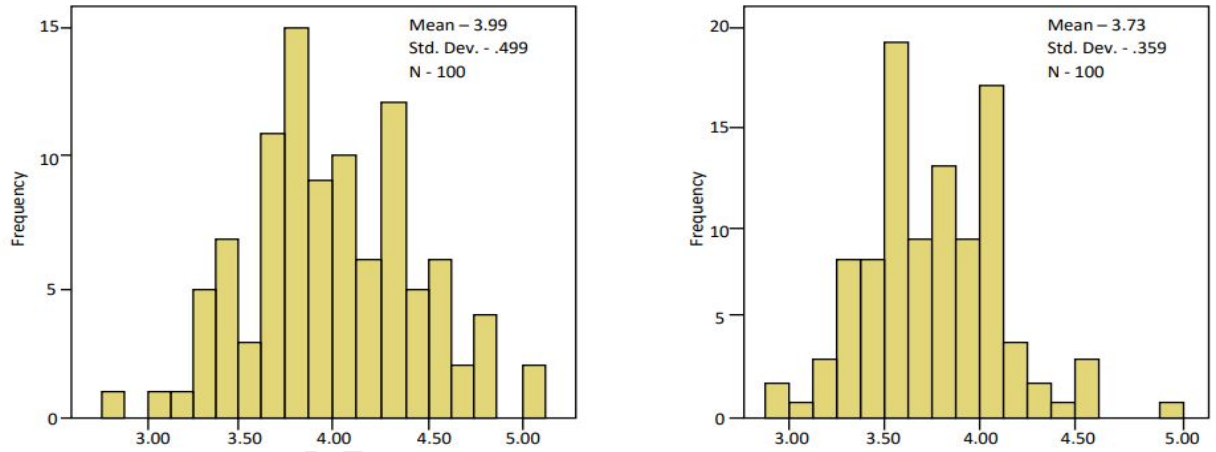

Figure 2: Histogram plot of the choice of performance measures and overall organisational performance

In addition, the normality of data may also be examined from the normal quantile – quantile plot (q-q plot) as in Figure 3. The figure shows that the data set for the choice of performance measures and organisational performance are normally distributed with minimal deviation from the straight line (Ghasemi and Zahediasl, 2012).

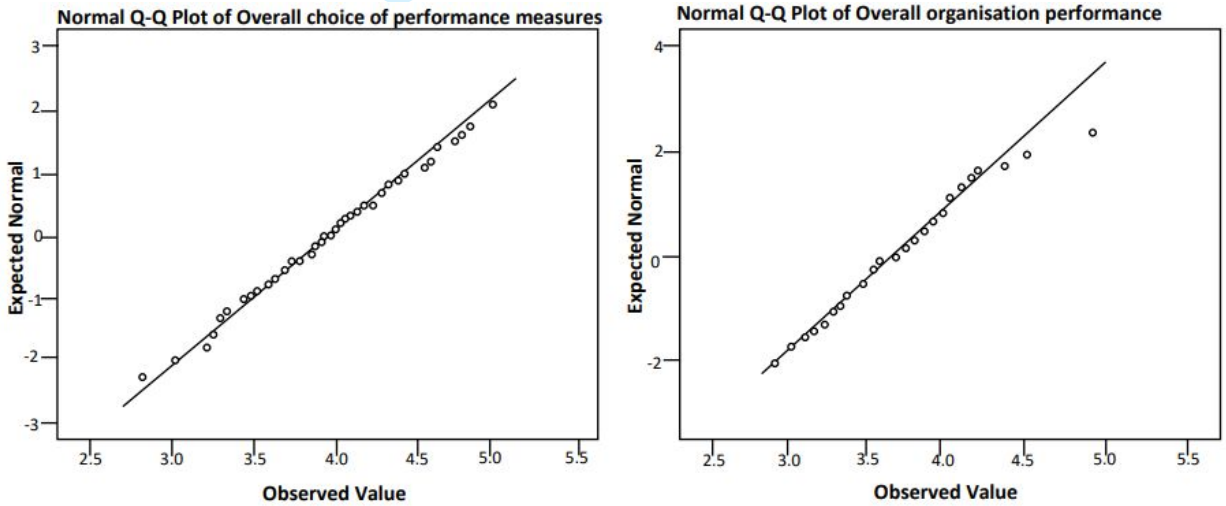

Figure 3: Normal Q-Q plot of the choice of performance measures and overall organisational performance.

Another visual method, box plot was also utilised in this research. The box plot is a standard five number summary consisting of minimum and maximum ranges value, the upper and lower quartiles, and the median (Potter, 2006). The box plot in Figure 4 for the choice of performance measures and organisational performances reports that the data set is normally distributed.

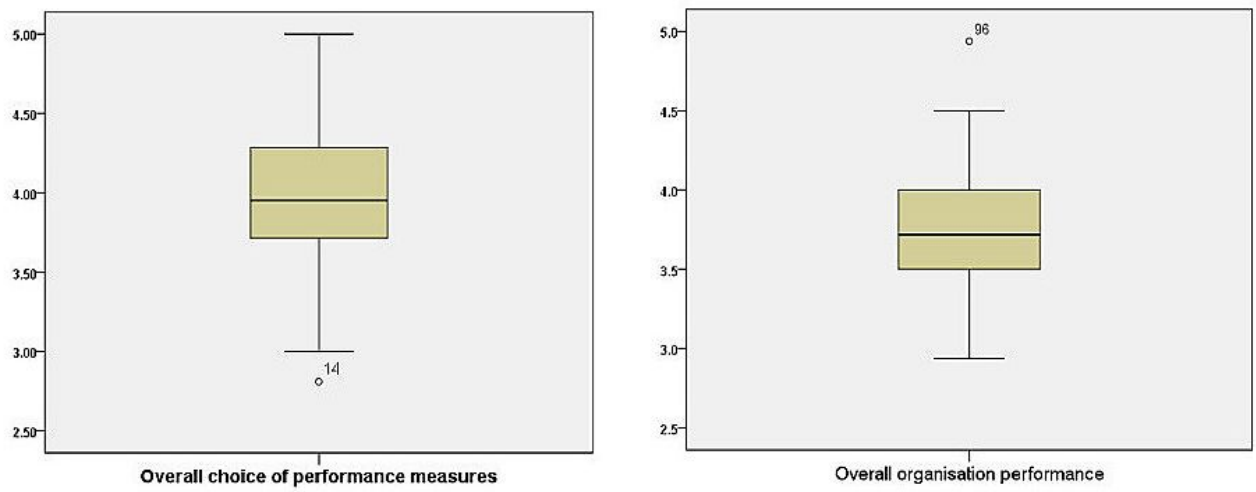

Figure 4: The box plot for the choice of performance measures and overall organizational performance

It can be seen that there is only one observed value outside the lower quartile for the choice of performance measure and only one observed value outside the upper quartile for the overall organisational performance.

4.2 Reliability and validity assessment

A reliability analysis using Cronbach alpha test was conducted to determine the internal consistency of the survey instrument. This involves overall questionnaire, performance measures and organisational performances. The Cronbach alpha value for the entire questionnaire account 0.909, whereas performance measure is at 0.893, organisational performance account of 0.76. These reliability test values show a strong internal consistency of the research instrument (Sekaran and Bougie, 2013). In addition, T-test analysis was conducted to identify a potential non-response bias. This test was performed by comparing the first 50% of respondents and the last 50% of respondents, which are considered as non-responses. This is based on the company's characteristics, such as: size of companies based on the number of employees, turnover, and overall organisational performance. The outcomes of this test show that the null hypothesis that there is no significant difference of the mean value between the first wave and the second, where the significance values is more than 0.05. This indicates that there is no significant non-response bias of the sample population (Palant, 2009; Sekaran and Bougie, 2013).

5. Results and analysis

5.1: Performance measures of the oil and gas industry

The exploratory interviews have sought the relevance and applications of the commonly used performance measures in the industry, which presented in Table 4. From eight PMs listed in Table 4, only flexibility and innovation are perceived by some participants as less common performance measures in the industry. Nevertheless, it does not mean being innovative and flexible is not important to the industry. In fact, the high exposure of risks, the involvement of multiple expertise and high transportation cost might require more innovation and flexibility in managing oil and gas business. Even though it is not clearly defined in their performance frameworks, most participants acknowledged these two measures are very subjective, and are used in crafting solutions for their companies.

Table 3: Performance measures and the application in the industry

Performance measures	Characteristics	Application in the oil and gas industry
Quality measures	-Very important - Requires involvement of multiple departments to assess services quality	-Actual performance to the specifications -Quality compliance certification -Number of reworks -Number of rejects
Flexibility	-Very subjective and less common in this industry	-Flexibility in supply chain strategies based on the current market
Innovation	-Very subjective and less common in this industry -Need to plan prior to project execution -Focus on operating systems -Relevant to the strategic level	-By getting more oil out, or getting oil faster or moving it faster -Packaging or contracting strategy or terms and condition -Developing environmental friendly working conditions -Supplier initiative in facilitating organisation on financial and non- financial aspects
Cost/price	-Straight forward -Easy to quantified	- Return on investment -Use world oil price per barrel as a benchmark -Compare against the lowest offer from the market

	-Can be easily compared with financial target	
Delivery reliability	-Very important -Straight forward and can be quantified easily	-Use to assess supplier performance
Delivery speed	-Relevant and straightforward to measure	-Use no– delay of the main work-barge vessel as an indicator for delivery speed
Safety measures	-First priority in the oil and gas industry	-Use safety monitoring record to manage this measure -Number of safety compliance records -Safety to the people, equipment, and environment -Safety training -Safety requirements that are stated in the contract will be cascaded down to all the vendors
Environmental and corporate social responsibility	-Important to the oil and gas industry -Part of local content requirements -Can improve corporate image of company	-Not buying goods or services from companies that use child labours -Providing job opportunities for local communities through on the job training -Engaging local suppliers -Feed the poor and less fortunate -Financial support for orphanage shelter -Environmental campaigns

On top of the performance measures in Table 4, the participants have suggested additional PMs and some revised PMs, which resulted to 21 PMs. Table 4 presents the final PMs based on the level of importance, which resulted from questionnaire survey. Safety compliance was recognised as the most important PM. This followed by i) product/ services quality, ii) product/ services reliability, and iii) cost savings. On the other hand, the least important PMs perceived by the industry were; i) investment in charitable programmes, ii) number of innovation ideas generated, iii) supplier compliance on social responsibility, and iv) innovation in operations. Even though safety compliance was not widely discussed in supply chain research, it is recognised as the most important measure in the oil and gas industry due to their high exposure of risks. Safety compliance is also important in enhancing customers' perspective in this industry. This indicator is also driven by various external factors particularly, the local content requirement by the government, the stakeholders' expectation, and social responsibility pressure, which normally driven by the non-government organisation. In essence, safety compliance is a measure that is motivated by both internal and external factors.

TABLE 4: Level of importance of performance measures

Rank	Performance measures	Mean	Mode	Frequency	Standard deviation
1	Safety compliance	4.59	5	63	0.57
2	Product/ services quality	4.48	5	55	0.674
3	Product/ services reliability	4.39	4	48	0.6
4	Cost saving	4.33	5	45	0.711
5	Flexibility in meeting customers' needs	4.29	4	45	0.729
6	Safety training	4.29	5	46	0.795
7	Timeliness	4.21	4	59	0.656
8	Return on investment	4.18	4	53	0.687
9	Process compliance	4.14	4	49	0.752
10	Ethical business	4.12	4	45	0.795
11	Supplier reliability	4.09	4	57	0.754
12	Accuracy of schedule	4.08	4	57	0.734
13	Supplier flexibility	3.92	4	50	0.8
14	Environmental pollutant control	3.88	4	43	1.017
15	Forecast accuracy	3.85	4	57	0.77
16	Reduction of waste	3.68	4	48	0.963
17	Technology innovations	3.62	4	37	0.94
18	Innovation in operations	3.59	4	40	0.865
19	Supplier compliance on social responsibilities policy	3.58	4	42	0.966
20	Number of innovation ideas generated	3.45	4	39	0.89
21	Investment in charitable programmes	3.08	3	48	0.795

It can be observed that cost savings were the fourth-ranked PM, which conflicts with previous research on performance management in the oil and gas industry. The research by Yusuf, Musa, et al., (2014) found that oil and gas organisations perceived competing through cost as their least consideration. The nature of huge profit in this industry considers this factor as least important in determining organisational performance. Thus, the focus on cost measure in this study may be driven by the current drop in the oil price. The current oil environment left oil and gas industry no choice but to enhance their cost savings efforts. The need to focus on cost minimisation was also mentioned by the supply chain experts during the exploratory interviews.

One of the least important performance measure is 'Investment in charitable events'. The distribution of respondents' organisation based on the number of employees could explain this finding where the majority of them were small and medium companies. Therefore, they might have limited financial budget for the charity investments. In addition, the current oil price may also affect financial allocation for charitable events. The table also suggests that most of the innovation measures were ranked among the least important performance measures. Unlike other industry such as automotive, electronic, and fashion industry (Sukwadi et al., 2013), the final products/ services of the oil and gas industry has very minimal differentiation (Chima and Hills, 2007). Therefore, innovation might be perceived by the oil and gas industry as less important in determining organisational performance.

5.3: The impact of the usage of performance measures on organisational performance

In order to understand the impact of the usage of performance measures on organisational performance, a Pearson r correlation is conducted between performance measures and overall organisational performance.

TABLE 5: Correlation between performance measures and organisational performance

Performance measures	Organisational performance
PM1 Cost savings	NSC
PM2 Return on investment	.248*
PM3 Accuracy of schedule	.359**
PM4 Timeliness	.313**
PM5 Product/ services reliability	.450**
PM6 Supplier reliability	.257**
PM7 Flexibility in meeting customers' needs	.417**
PM8 Supplier flexibility	.382**
PM9 Products/ services quality	.389**
PM10 Forecast accuracy	.347**
PM11 Process compliance	.527**
PM12 Innovation ideas generated	.377**
PM13 Innovation in operations	.561**
PM14 Technology innovations	.529**
PM15 Environmental pollutant control	.320**
PM16 Reduction of waste	.387**
PM17 Safety compliance	.371**
PM18 Safety training	.440**
PM19 Supplier compliance on social responsibilities policy	.367**
PM20 Ethical business	.211**
PM21 Investment in charitable programmes	.394**

*Correlation is significant at .05 levels (2-tailed). **Correlation is significant at .01 levels (2-tailed).

Out of twenty-one performance measures, PM13: innovation in operation demonstrates the highest correlation value (0.561) with overall organisational performance. This followed by PM14: technology innovation (0.529). This implies that the organisation that focusing on innovation measures provide greater impact on the overall organisation performance. The importance of innovation measures in a PMF has been widely discussed in previous research (Bhagwat and Sharma, 2007; Yeh, Cheng and Chi, 2007; Varma, Wadhwa and Deshmukh, 2008; Thakkar, Kanda and Deshmukh, 2009; Halman and Voordijk, 2012). Terziovski (2010) demonstrated a positive impact of innovation strategy on the performance of SME manufacturer in Taiwan. A study by Yang (2012) in Chinese manufacturing firms exerts positive relationship between innovation capabilities and supply chain performance. Nevertheless, the innovation measures were rated amongst the least important in the oil and gas industry. This shows that innovations are still lacking in this industry. Also, it indicates innovations have a strong potential to be utilised in attaining competitive advantage. The third highest correlation is at PM11: process compliance (0.527). A possible explanation for this is an organisation that emphasises process compliance is presumed as having a well-structured governance. Therefore, most of the aspects of performance in these organisations received comprehensive attention by the manager and lead to a better performance. To support this, Bauer *et al.* (2008) on corporate governance in Japan demonstrates that well-governed organisations outperform loose-govered counterpart by 15%. In addition, research by Andreou, Louca and Panayides (2014), which focused on the maritime industry demonstrates

a positive association between corporate governance and organisational performance. Following the process compliance measures, PM5: products/ services reliability shows a correlation value of 0.455. This measure was ranked third based on the level of importance. This suggests that this PM is not only crucial for this industry, but also could determine overall organisational performance.

5.3 Regression analysis between clustered performance measures and organisational performances

To investigate the link between clustered performance measures and organisational performance, a multiple regression analysis was undertaken. Prior to that, a factor analysis is conducted to group performance measures according to its relevance. Based on the factor analysis, the performance measures are classified into four main components as in Table 6. The four components represent financial measures, operational measures, safety and environmental measures, and corporate social responsibility measures.

TABLE 6: Clustered performance measures based on factor analysis

C1 Financial measures	**C2 Operational measures**	**C3 Safety and environment**	**C4 Social resp. measures**
PM1: Cost saving	PM3: Accuracy of schedule	PM15: Environmental pollutant control	PM 19: Supplier compliance on social resp. policy
PM2: Return on investment	PM4: Timeliness	PM16: Reduction of waste	PM20: Ethical business
PM10: Forecast accuracy	PM5: Product/ services reliability	PM 17: Safety compliance	PM 21: Investment in charitable programmes
	PM 6: Supplier reliability	PM 18: Safety training	
	PM7: Flexibility in meeting customers' needs		
	PM8: Supplier flexibility		
	PM9: Products/ services quality		
	PM 11: Process compliance		
	PM 12: Number of innovation ideas generated		
	PM 13: Innovation in operations		
	PM 14: Technology innovations		

Table 7 presents the outcome of regression analysis. The analysis is between clustered performance measures as independent variables and organisational performance as dependent variables. It can be observed from Table 7 that the regression value, R is 0.693, while R^2 is 0.48. The R^2 value indicates the predicting power of a set of performance measures (PMF) on organisational performance. In order words, the PMF has 48% predicting power in explaining organisational performance. Also, the significance value marked as Sig. in the table indicates the clustered performance measures that have unique contribution to the organisational performance. It can be observed that only Operational measures has significant value less than 0.05. Based on the Beta value, operational measures has 0.58 predicting power in explaining the model when other independent variables are held constant. This also means operational measures are the most influential variable in predicting overall organisational performance.

TABLE 7: Model 1 of the regression analysis

Model	Independent variables	(Beta)	Sig.	R	R^2
1	(Constant)		0.000	.693	.48
	Financial	-0.117	0.195		
	Operational	0.580	0.000		
	Safety	0.132	0.180		
	Social resp.	0.160	0.093		

In order to further explore the usage of PMF in determining organisational performance, the performance measures are re-grouped into five clusters. These are Financial, Operational, Innovation, Safety, and Social Responsibilities. These performance measures are re-grouped based on two considerations: factor analysis and the balance score card model by Kaplan and Norton (1992). The outcome of factor analysis shows that innovation measures are compounded closely together. Thus, we separated it from operational cluster. The balance scorecard model has four dimensions, which are financial, internal business, customer, and innovation and learning. In this regard, innovation is not in the same group with

internal business, which comprises of operational measures. Based on these two considerations, three innovations measures, which are innovation in operations, technology innovations and number of innovation ideas generated are grouped together. Table 8 presents the summary of regression model consisting of five clustered performance measures. It can be observed that the R and R^2 values for this model has increased from the model 1. The R^2 value is 0.494, which explain the predicting power of this model.

TABLE 8: Model 2 of regression analysis

Model	Independent variables	(Beta)	Sig.	R	R^2
2	(Constant)		0.000	.703	.494
	Innovation	0.354	.000		
	Safety	0.171	.060		
	Financial	-0.090	.319		
	Social resp.	0.120	.229		
	Operational	0.343	.000		

The significant value for the Beta shows there are two clustered PM that have unique contribution to the model. These are Innovation and Operational with Beta value of 0.354 and 0.343 respectively. These Beta value indicates that both clustered measures have 35% and 34% of unique contribution to the model when other clustered measures are held constant. The outcomes of both regression model positively support the usage of PMF in determining organisational performance. Accordingly, it supports the usage of PMF in determining organisational performance in line with RBV theory.

Based on the outcome of the second model, the following PMF in Table 9 is proposed.

TABLE 9: Performance measurement frameworks

Dimensions	Performance measures	Mean	SD
Operational	Products/ services quality	4.48	0.674
	Product/ services reliability	4.39	0.6
	Flexibility in meeting customers' needs	4.29	0.729
	Timeliness	4.21	0.656
	Process compliance	4.14	0.752
	Supplier reliability	4.09	0.754
	Accuracy of schedule	4.08	0.734
	Supplier flexibility	3.92	0.8
Safety	Safety compliance	4.59	0.57
	Safety training	4.29	0.795
Innovation	Technology innovations	3.62	0.94
	Innovation in operations	3.59	0.865
	Number of innovation ideas generated	3.45	0.89
Environmental and corporate social responsibility	Ethical business	4.12	0.795
	Environmental pollutant control	3.88	1.017
	Reduction of waste	3.68	0.963
	Supplier compliance on social responsibilities policy	3.58	0.966
	Investment in charitable programmes	3.08	0.976
Financial	Cost saving	4.33	0.711
	Return on investment	4.18	0.687
	Forecast accuracy	3.85	0.77

There are five dimensions of PMF proposed for the oil and gas industry. These are operation, safety, innovation, environmental and corporate social responsibility, and financial. The performance measures of each dimension are arranged according to the level of importance based on the mean value. The framework is not rigid, but can be used as a guidance in measuring supply chain performance for the oil and gas supply chain. From this framework, individual company can do some adjustment to suit their business activities. In addition, the findings of this study suggest that PMF is an important resource in attaining competitive advantages in line with RBV theory. Nevertheless, in order to deploy performance measurement framework as a basis for competitive advantage, it is essential for it to be designed in a way that are valuable, rare, inimitable and non-transferable.

From the valuable aspect, PMF should be designed in a balanced approach considering financial and non-financial factors. This is important to be able to give the information in assisting organisations' decision making process. The rareness aspect of PMF is the organisations culture than willing to implement the usage of PMF in their day to day operations. This is based on the exploratory interview where the interviewer highlighted the issue of lack in cooperation in implementing PMF. The CEO involvement will be able to cultivate the culture to utilise PMF as a tool in improving performance (Zin et al., 2013). The non- transferable perspectives of PMF is pertaining socially complex resources involving multiple departments. These collaboration is crucial to provide input in ensuring the measures used are relevance to the current market. The inimitable aspect considers the use of systematic data recording systems in managing PMF. A proper system will ensure that there is no information delay during project execution. Thus, any problem arises can be resolved in time. Table 10 summarises the PMF characteristics from RBV perspectives.

Table 10: PMF from RBV perspectives

Valuable	**Rareness**	**Non – transferable**	**Inimitable**
The design of performance measurement framework that consider balanced approach and able to give the true meaning of company performance.	A socially complex resource involving a culture that wanting to use PMF as a tool in improving performance	A socially complex resources involving multiple departments in providing inputs in updating the measures where necessary	The complex skills set in managing performance measurement framework including the use of systematic data recording system create competitive advantage which difficult to imitate.

5.4 Challenges in managing supply chain performance

This study also explores the challenges faced by the industry in managing supply chain performance. These challenges were derived from the exploratory interviews with five supply chain experts of the oil and gas industry. The listed challenges are lack of data consistency, lack of inter-departmental cooperation, compliance with local content requirement, instability of global oil prices, the need for fast completion at minimal costs, and the need to manage urgency at minimal cost. Table 11 summarises the challenges with the mean, standard deviation (SD), mode, and frequency (Freq) based on the quantitative survey. It can be observed that 'The need for fast completion at minimal cost' and 'The need to manage urgency at minimal cost' recorded the highest mean of 3.95 and 3.96, respectively. Both attributes are concerned with the time aspect, which would always affect the cost. These two challenges are influenced by the higher cost involved in the industry. In this industry, the high cost is not only caused by transportation activities to deliver goods and services offshore, but is also added from the operation activities that involve multiple expertise. One of the ways to deal with these challenges is by having supply chain partners that are flexible on delivery term and agile in response to urgency (Sambasivan, Mohamed and Nandan, 2009). Nevertheless, the issue here is not only to deliver the services or goods, but instead to also deliver it at minimal cost. Thus, there is the need to have flexible contract with supply chain partners with agreed upon prices on urgent requirement. Although, suppliers would definitely increase the price for a shorter lead-time. But, advanced agreement may limit their bargaining power to put unnecessary cost in such event.

Table 11: Challenges in managing supply chain performance

Challenges in managing supply chain performance	Mean	SD	Mode	Freq
Lack of data consistency	3.14	0.829	3	44
Lack of inter-departmental cooperation	2.9	0.937	3	44

Compliance with local content requirement	3.01	1.01	3	41
Instability of world oil prices	3.75	1.12	4	32
The need for fast completion at minimal cost	3.95	0.88	4	53
The need to manage urgency at minimal cost	3.96	0.8	4	52

The next challenge is instability of global oil prices with a mean value of 3.75. This challenge has been cited in many researches in the oil and gas industry (Villar and Joutz, 2006; Al-Othman et al., 2008; Varma et al., 2008; Lima, Relvas and Barbosa-Póvoa, 2016). Not only that, this issue has also been discussed by the oil and gas institutions (Ernst and Young, 2016). In fact, Varma et. al. (2008) considered raw oil prices as one of the strategic objectives in devising performance measurement model. The extracts from exploratory interview highlighted the need to consider oil prices in strategising organisations' supply chain. In this regard, organization will focus more on minimising cost in low oil prices environment, while focusing on fast project completion during high oil prices environment.

"In the 100$per barrel prices of oil, if we are in a supply chain and all we want to measure is cost, the business might be saying that the most important factor now is the speed of completion. Because if we can get stuff on-board faster, the higher profitability from more quickly obtaining oil & gas sales is greater than focusing on reducing project costs."

"When the price of oil dropped, say what we have today 50$ per barrel range, you see the shifting of more emphasis on the cost side."

The views shared by all of the experts during the exploratory interviews. This concept of focusing either on minimizing cost or speeding up the project completion is also shared with other industries. For instance, Lee (2004, p. 102) stated that "When business was booming, executives concentrated on maximising speed, and when the economy head south, firms desperately tried to minimise supply costs". In other words, for the oil and gas industry, global oil prices is one of the important factor in managing supply chain strategy.The least challenge perceived by participants is the lack of interdepartmental cooperation. This might suggest that inter-department cooperation is not an issue in most oil and gas organisations.

5.5 Determinant factors in choosing performance measures

Table 12 tabulates the details of determinant factors in choosing performance measures. At a glance, it can be clearly seen that the highest frequency (65) chosen by the organisations was profitability potential with mode of four. However, 'Desire for safety' was rated with the highest mean (4.4) in this construct. This is followed closely by company reputations with a mean value of 4.38. The desire for safety implies the importance of considering safety factor in managing supply chain activities. The oil and gas industry is exposed to high risks, thus, safety considerations are critical in determining organisational performances. This is in line with the safety compliances measure, which was rated by surveyed organisations as the most important performance measure in Table 4.

Table 12: Determinant factors in choosing performance measures

Determinant factors	Mean	Mode	Freq	SD
Company objectives	4.18	4	57	0.702
Requirement of local content	3.37	4	44	0.914
Role of company in supply chain	3.45	4	45	0.936
Profitability potential	4.07	4	65	0.655
Desire for safety	4.4	5	53	0.791
Company reputation	4.38	4	50	0.663
Risk mitigations	4.05	4	53	0.744
World oil prices per barrel	3.7	4	39	1.132

Company's reputation is very important to the oil and gas companies. This is due to the fact that their operations required license to operate from the local government. In fact, reputational damage caused by environmental or ethical issues might result in high penalty by the local government. Moreover, pressures from the public such as environmental associations may lead the oil companies to discontinue their operation. The decision of Shell to quit their operation in the Arctic is one of those examples. This decision was made after they had spent around USD 7billion from the early stage of the project (Macalister, 2015). The rest of the variables have mean values of greater than 4, except for global oil prices per barrel, role of company in the supply chain, and requirement of local content. The mean value for these three factors are 3.7, 3.45, and 3.37 respectively. The least score of determinant factor, requirement of local content raised further questions on which countries that rated this factor as the least scores. Based on the interview conducted in this research, it was suggested that the pressure on local content requirements is more on the companies that operated in developing countries than those in the developed countries. Apart from environmental protections and socially responsible practices, the local content in developing countries requires oil and gas companies to engage local suppliers. The following interview extracts explained this trend:

"The local content required us to deal with the local supplier where most of them are the middle person and do not have sufficient knowledge on product or services they provided." [Participant C]
"In my opinion, the following also applies when companies are working in a developed country such as the USA. Companies do not want to have environmental issues, do not want to have oil spills, and do not want to have safety incidents. So I think that has the big impact on companies. I think those factors are more important than cost and schedule. I mean, companies should be socially responsible, should protect the environment, and should operate safely"[Participant B]

In the extracts, Participant B is the supply chain expert from a developed country (USA) while Participant C is from developing country (Indonesia).
Table 13 indicates that 44% of UK organisations rated this determinant factor as high and very high. Meanwhile, 59% of Malaysian organisations rated this factor in similar range as the UK organisations. This finding is in accordance with the exploratory interview in the earlier phase of this research.

Table 13: Local content requirement according to country

Local content requirement	UK		Malaysia	
Very low	2	3.27%	2	5.1%
Low	7	11.5%	5	12.8%
Neutral	25	41%	9	23%
High	25	41%	19	48.7%
Very high	2	3.22%	4	10.3%
Total	61		39	

The understanding of the most important determinant factors rated by oil and gas companies provides some insight to academicians for further research in this field. On the other hand, practitioners may consider these factors as a guideline in devising their PMF.

6. Conclusion

In researching PMF for the oil and gas industry, this study provides important and useful insights into the prevalence of performance measures (PM) in the oil and gas supply chain. A key observation resulting from the outcomes of this study is that safety compliance is the most widely used PMs in this industry followed by product/ services quality, product/ services quality, product/ services reliability, and cost savings. On the other hand, investment in charitable organisations turned out to be the least important performance measure.

Theoretical implications

From a theoretical perspective, the results show that the usage of PMF enhances organisational performance in line with Resource Based View theory. This is significant given that PMF is an intangible resource. The inputs into organisations are either tangible or intangible resources. The outcomes of this study demonstrate that RBV is as relevant to intangible resources as it is to tangible resources.

Practical implications

The results show that performance measurement framework has a significant positive impact on the overall organisational performance. In other words, PMF is a tool for managing and enhancing organisational performance. Innovation measures posted the greatest impacts on organisational performance. Those organisations that focus on innovation measures enhance their innovation performances, and subsequently, the overall organisational performance.

Whilst innovation measures are the most influential measures in determining organisational success and gaining competitive advantage, the measure is not widely used in the oil and gas industry. This is because of the non-discrete nature of the oil and gas products. In order to leverage on innovation in this industry, therefore, the focus should be on services innovation. There is greater opportunities for services innovation than tangible products innovation.

Also, the results provide guidance to the practitioner on the potential of specific measures in enhancing organisational performance. Overall, the results will support and enable managers in devising suitable supply chain performance measurement strategies.

6.1 Research limitations and future directions

This study has the following limitations. Firstly, it recorded low response rates of 11% in the UK and 33% in Malaysia which resulted in 15% aggregate response rate. These response rates are however considered adequate given that the unit of analysis is the organization and not individuals. Also, the study is limited to two countries, UK and Malaysia, and future studies should attempt to expand and cover additional countries to enhance regional generalisability of results. In addition, there are implications for further research. For instance, further research can be done to explore indepth the two key most influential measures in the industry - innovation and process compliance. Since innovation measure, though seen as very influential, was rated as amongst the least prevalent measure, there is a need to investigate specific innovation efforts within the industry and the drivers and barriers of such innovation practices.

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REFERENCES

Al-Othman, W.B.E. *et al.* (2008) 'Supply chain optimization of petroleum organization under uncertainty in market demands and prices', *European Journal of Operational Research*, 189, pp. 822–840. doi:10.1016/j.ejor.2006.06.081.

Andreou, P.C., Louca, C. and Panayides, P.M. (2014) 'Corporate governance, financial management decisions and firm performance: Evidence from the maritime industry', *Transportation Research Part E: Logistics and Transportation Review*, 63(2014), pp. 59–78. doi:10.1016/j.tre.2014.01.005.

Bai, C. and Sarkis, J. (2012) 'Supply-chain performance-measurement system management using neighbourhood rough sets', *International Journal of Production Research*, 50(9), pp. 2484–2500. doi:10.1080/00207543.2011.581010.

Barney, J.B. (2012) 'Purchasing, Supply Chain Management and Sustained Competitive Advantage: The Relevance of Resource-based Theory', *Journal of Supply Chain Management*, 48(2), pp. 3–6. doi:10.1111/j.1745-493X.2012.03265.x.

Bauer, R. *et al.* (2008) 'The impact of corporate governance on corporate performance: Evidence from Japan', *Pacific-Basin Finance Journal*, 16, pp. 236–251. doi:10.1016/j.pacfin.2007.05.001.

Beamon, B.M. (1999) 'Measuring supply chain performance', *International Journal of Operations & Production Management*, pp. 275–292. doi:10.1108/01443579910249714.

Bhagwat, R. and Sharma, M.K. (2007) 'Performance measurement of supply chain management: A balanced scorecard approach', *Computers & Industrial Engineering*, 53(1), pp. 43–62. doi:10.1016/j.cie.2007.04.001.

Boyle, T.A. and Scherrer-Rathje, M. (2009) 'An empirical examination of the best practices to ensure manufacturing flexibility: Lean alignment', *Journal of Manufacturing Technology Management*, 20(3), pp. 348–366. doi:10.1108/17410380910936792.

BP p.l.c (2016) *BP Global*. Available at: http://www.bp.com/en/global/corporate/about-bp.html (Accessed: 19 December 2016).

Cagnazzo, L., Taticchi, P. and Brun, A. (2010) 'The role of performance measurement systems to support quality improvement initiatives at supply chain level', *International Journal of Productivity and Performance Management*, 59(2), pp. 163–185. doi:10.1108/17410401011014249.

Chan, F.T.S. (2003) 'Performance Measurement in a Supply Chain', *The International Journal of Advanced Manufacturing Technology*, 21(7), pp. 534–548. doi:10.1007/s001700300063.

Chen, C., Zhang, J. and Delaurentis, T. (2014) 'Quality control in food supply chain management: An analytical model and case study of the adulterated milk incident in China', *International Journal of Production Economics*, 152, pp. 188–199. doi:10.1016/j.ijpe.2013.12.016.

Chen, I.J. and Paulraj, A. (2004) 'Towards a theory of supply chain management: the constructs and measurements', *Journal of Operations Management*, 22, pp. 119–150. doi:10.1016/j.jom.2003.12.007.

Cheng, J., Lee, C. and Chen, H. (2014) 'Assessing Inter-Organizational Performance in Supply Chain : Corporate Social Responsibility as a Mediator', *Asia Pacific Management Review*, 19(1), pp. 61–79. doi:10.6126/APMR.2014.19.1.04.

Chenhall, R.H. and Langfield-Smith, K. (2007) 'Multiple Perspectives of Performance Measures', *European Management Journal*, 25(4), pp. 266–282. doi:10.1016/j.emj.2007.06.001.

Chima, C.M. (2011) 'Supply-chain management issues in the oil and gas industry', *Journal of Business & Economics Research*, 5(6).

Chima, C.M. and Hills, D. (2007) 'Supply-chain management issues in the oil and gas industry', *Journal of Business & Economic Research*, 5(6), pp. 27–36.

Coates, T.T. and Mcdermott, C.M. (2002) 'An exploratory analysis of new competencies : a resource based view perspective', *Journal of Operations Management*, 20, pp. 435–450.

Coughlan, P. and Coghlan, D. (2002) 'Action research for operations management', *International Journal of Operations and Production Management*, 22(2), pp. 220–240. doi:10.1108/01443570210417515.

Dahl, Ø. and Olsen, E. (2013) 'Safety compliance on offshore platforms: A multi-sample survey on the role of perceived leadership involvement and work climate', *Safety Science*, 54, pp. 17–26. doi:10.1016/j.ssci.2012.11.003.

Ernst & Young (2014) *UK upstream oil and gas supply chain - Economic contribution*. London.

Ernst and Young (2016) *Review of the UK oilfield services industry*, *Review of the UK oilfield services industry*. Available at: http://www.ey.com/UK/en/Industries/Oil---Gas/EY-review-of-the-UK-oilfield-services-industry.

Exxon Mobil Corporation (2016) *ExxonMobil*. Available at: http://corporate.exxonmobil.com/ (Accessed: 19 December 2016).

Fleischmann, B. and Meyr, H. (2003) 'Supply Chain Management: Design, Coordination and Operation', *Handbooks in Operations Research and Management Science*, 11, pp. 455–523. doi:10.1016/S0927-0507(03)11009-2.

Fu, L. *et al.* (2020) 'Environmental awareness and pro-environmental behavior within China's road freight transportation industry: Moderating role of perceived policy effectiveness', *Journal of Cleaner Production*, 252, p. 119796. doi:10.1016/j.jclepro.2019.119796.

Garengo, P., Biazzo, S. and Bititci, U.S. (2005) 'Performance measurement systems in SMEs: a review for a research agenda', *International journal of management reviews*, 7(1), pp. 25–47.

Ghasemi, A. and Zahediasl, S. (2012) 'Normality tests for statistical analysis: A guide for non-statisticians', *International Journal of Endocrinology and Metabolism*, 10(2), pp. 486–489. doi:10.5812/ijem.3505.

Gopal, P.R.C. and Thakkar, J. (2012) 'A review on supply chain performance measures and metrics: 2000-2011', *International Journal of Productivity and Performance Management*, 61(5), pp. 518–547. doi:10.1108/17410401211232957.

Gunasekaran, A. and Kobu, B. (2007) 'Performance measures and metrics in logistics and supply chain management: a review of recent literature (1995–2004) for research and applications', *International Journal of Production Research*, 45(12), pp. 2819–2840. doi:10.1080/00207540600806513.

Gunasekaran, A., Patel, C. and McGaughey, R.E. (2004) 'A framework for supply chain performance measurement', in *International Journal of Production Economics*, pp. 333–347. doi:10.1016/j.ijpe.2003.08.003.

Halman, J.I.M. and Voordijk, J.T. (2012) 'Balanced framework for measuring performance of supply chains in house building', *Journal of Construction Engineering and Management*, 138(12), pp. 1444–1450. doi:10.1061/(ASCE)CO.1943-7862.

Hart, S.L. (1995) 'A Natural-Resource-Based View of the Firm', *The Academy of Management Review*, 20(4), pp. 986–1014.

Hasan, M.M. and Habib, A. (2017) 'Corporate life cycle, organizational financial resources and corporate social responsibility', *Journal of Contemporary Accounting and Economics*, 13(1), pp. 20–36. doi:10.1016/j.jcae.2017.01.002.

Ho, C.-J. (2007) 'Measuring system performance of an ERP-based supply chain', *International Journal of Production Research*, 45(6), pp. 1255–1277. doi:10.1080/00207540600635235.

Hsu, C.-C. *et al.* (2009) 'Supply chain management practices as a mediator of the relationship between operations capability and firm performance', *International Journal of Production Research*, 47(3), pp. 835–855. doi:10.1080/00207540701452142.

Huang, S.H. and Keskar, H. (2007) 'Comprehensive and configurable metrics for supplier selection', *International Journal of Production Economics*, 105(2), pp. 510–523. doi:10.1016/j.ijpe.2006.04.020.

Kannan, V.R. and Tan, K.C. (2005) 'Just in time, total quality management, and supply chain management: understanding their linkages and impact on business performance', *Omega*, 33(2), pp. 153–162. doi:10.1016/j.omega.2004.03.012.

Kaplan, R.S. and Norton, D.P. (1992) 'The Balanced Scorecard – Measures that Drive Performance The Balanced Scorecard — Measures', *Harvard Business Review*, pp. 71–79.

Ketchen, D.J. and Hult, G.T.M. (2007) 'Toward greater integration of insights from organization theory and supply chain management', *Journal of Operations Management*, 25(2), pp. 455–458. doi:10.1016/j.jom.2006.05.001.

Ketchen, D.J. and Hult, T.M. (2007) 'Bridging organization theory and supply chain management: The case of best value supply chains', *Journal of Operations Management*, 25, pp. 573–580. doi:10.1016/j.jom.2006.05.010.

Kim, S.W. (2009) 'An investigation on the direct and indirect effect of supply chain integration on firm performance', *International journalof Production Economics*, 119(2), pp. 328–346. doi:10.1016/j.ijpe.2009.03.007.

Kumar, C.G. and Nambirajan, T. (2013) 'An Integrated Model for Supply Chain Management Components , Supply Chain Performance and Organizational Performance : Purification and Validation of', *Contemporary Management Research*, 8(2), pp. 37–56.

Kumar, R. and Markeset, T. (2007) 'Development of performance-based service strategies for the oil and gas industry: a case study', *Journal of Business & Industrial Marketing*, 22, pp. 272–280. doi:10.1108/08858620710754531.

Kvalheim, S. a. and Dahl, O. (2016) 'Safety compliance and safety climate: A repeated cross-sectional study in the oil and gas industry', *Journal of Safety Research*, 59, pp. 33–41. doi:10.1016/j.jsr.2016.10.006.

Li, L., Su, Q. and Chen, X. (2011) 'Ensuring supply chain quality performance through applying the SCOR model', *International Journal of Production Research*, 49(1), pp. 33–57. doi:10.1080/00207543.2010.508934.

Lima, C., Relvas, S. and Barbosa-Póvoa, A.P.F.D. (2016) 'Downstream oil supply chain management: A critical review and future directions', *Computers & Chemical Engineering*, 92, pp. 78–92. doi:10.1016/j.compchemeng.2016.05.002.

Lin, Y., Wang, Y. and Yu, C. (2010) 'Investigating the drivers of the innovation in channel integration and supply chain performance: A strategy orientated perspective', *International Journal of Production Economics*, 127(2), pp. 320–332. doi:10.1016/j.ijpe.2009.08.009.

Macalister, T. (2015) *Shell abandons Alaska Arctic drilling*, *The Guardian*. Available at: https://www.theguardian.com/business/2015/sep/28/shell-ceases-alaska-arctic-drilling-exploratory-well-oil-gas-disappoints (Accessed: 27 February 2017).

Martínez Sánchez, A. and Pérez Pérez, M. (2005) *Supply chain flexibility and firm performance*, *International Journal of Operations & Production Management*. doi:10.1108/01443570510605090.

Mearns, K. and Flin, R. (1995) 'Risk perception and attitudes to safety by personnel in the offshore oil and gas industry: a review', *Journal of Loss Prevention in the Process Industries*, 8(5), pp. 299–305. doi:10.1016/0950-4230(95)00032-V.

Neely, A. (2005) 'The evolution of performance measurement research', *International Journal of Operations & Production Management*, 25(12), pp. 1264–1277. doi:10.1108/01443570510633648.

Neely, A., Gregory, M. and Platts, K. (2005) 'Performance measurement system design: A literature review and research agenda', *International Journal of Operations & Production Management*, 25(12), pp. 1228–1263. doi:10.1108/01443570510633639.

Oil industry International Exploration and Production Forum (1997) *Environmental management in oil and gas exploration and production - An overview of issues and management approaches*, *Industry And Environment*. Oxford: Unep Technical Publication & E&P Forum. doi:10.65/Jss2003.09.085.

Organisation of Petroleum Exporting Countries (2015) *OPEC-IEA cooperation and the international oil market outlook*. Available at: http://www.opec.org/opec_web/en/886.htm (Accessed: 10 April 2015).

Otto, A. and Kotzab, H. (2003) 'Does supply chain management really pay? Six perspectives to measure the performance of managing a supply chain', *European Journal of Operational Research*, 144(2), pp. 306–320. doi:10.1016/S0377-2217(02)00396-X.

Pallant, J. (2016) *SPSS survival manual: a step by step guide to data analysis using SPSS*. 6th ed., *Step by step guide to data analysis using the SPSS program*. 6th ed. Maidenhead: Open University Press.

Parker, C. (2000) 'Performance Measurement', *Work Study*, 49(2), pp. 63–66.

Perera, P.S.T., Perera, H.S.C. and Wijesinghe, T.M. (2013) 'Environmental Performance Evaluation in Supply Chain', *Vision: The Journal of Business Perspective*, 17(1), pp. 53–61. doi:10.1177/0972262912469566.

Peteraf, M.A. (1993) 'The connerstones of competitive advantage: A resource-based view', *Strategic Management Journal*, 14(3), pp. 179–191.

Potter, K. (2006) 'Methods for Presenting Statistical Information: The Box Plot', *Visualization of Large and Unstructured Data Sets*, 4, pp. 97–106.

Ramanathan, U. (2014) 'Performance of supply chain collaboration – A simulation study', *Expert Systems with Applications*, 41(1), pp. 210–220. doi:10.1016/j.eswa.2013.07.022.

Rivard, S., Raymond, L. and Verreault, D. (2006) 'Resource-based view and competitive strategy: An integrated model of the contribution of information technology to firm performance', *The Journal of Strategic Information Systems*, 15(1), pp. 29–50. doi:10.1016/j.jsis.2005.06.003.

Rui, Z. *et al.* (2017) 'Development of Industry Performance Metrics for Offshore Oil and Gas Project', *Journal of Natural Gas Science and Engineering*, In Press, pp. 44–53. doi:10.1016/j.jngse.2017.01.022.

Ruifeng, C. and Subramaniam, V. (2011) 'Performance evaluation for tandem multi-factory supply chains: an approximate solution', *International Journal of Production Research*, 49(11), pp. 3285–3305. doi:10.1080/00207541003792243.

Sambasivan, M., Mohamed, Z.A. and Nandan, T. (2009) 'Performance measures and metrics for e-supply chains', *Journal of Enterprise Information Management*, 22(3), pp. 346–360. doi:10.1108/17410390910949751.

Sekaran, U. and Bougie, R. (2013) 'Research methods for business', in *Research methods for business*. 6th ed. Sussex: John Wiley and Son Limited, p. 436.

Shell Royal Dutch (2009) *Company Monitor*. London.

Shepherd, C. and Günter, H. (2006) 'Measuring supply chain performance: current research and future directions', *The International Journal of Productivity and Performance Management*, 55(3/4), pp. 242–258.

Sirmon, D.G. *et al.* (2011) 'Resource Orchestration to Create Competitive Advantage', *Journal of Management*, 37(5), pp. 1390–1412. doi:10.1177/0149206310385695.

Soltani, E. *et al.* (2011) 'Quality performance in a global supply chain: finding out the weak link', *International Journal of Production Research*, 49(1), pp. 269–293. doi:10.1080/00207543.2010.508955.

Szymaniec-mlicka, K. (2014) 'Resource-based view in strategic management of public organizations – a review of the literature', *Management*, 18(2), pp. 19–31.

Tabachnick, B.G. and Fidell, L.S. (2007) *Using multivariate statistics*. 5th ed., *Using multivariate statistics*. 5th ed. Harlow: Pearson Education Limited. doi:10.1037/022267.

Talapatra, S. *et al.* (2019) 'Main benefits of integrated management systems through literature review', *International Journal for Quality Research*, 13(4), pp. 1037–1054. doi:10.24874/IJQR13.04-19.

Talapatra, S. *et al.* (2020) 'An empirical study to investigate the effects of critical factors on TQM implementation in the garment industry in Bangladesh', *International Journal of Quality and Reliability Management*, 37(9–10), pp. 1209–1232. doi:10.1108/IJQRM-06-2018-0145.

Talapatra, S. and Uddin, M.K. (2019) 'Prioritizing the barriers of TQM implementation from the perspective of garment sector in developing countries', *Benchmarking*, 26(7), pp. 2205–2224. doi:10.1108/BIJ-01-2019-0023.

Talapatra, S., Uddin, M.K. and Rahman, M.H. (2018) 'Development of an Implementation Framework for Integrated Management System Based on the Philosophy of Total Quality Management', *American Journal of Industrial and Business Management*, 08(06), pp. 1507–1516. doi:10.4236/ajibm.2018.86101.

Tan, K.C., Kannan, V.R. and Handfield, R.B. (1998) 'Supply chain management: supplier performance and firm performance', *International Journal of Purchasing and Materials Management*, (summer), pp. 2–9.

Taticchi, P., Tonelli, F. and Pasqualino, R. (2013) 'Performance measurement of sustainable supply chains: A literature review and a research agenda', *International Journal of Productivity and Performance Management*, 62(8), pp. 782–804. doi:10.1108/IJPPM-03-2013-0037.

Terziovski, M. (2010) 'Research notes and commentaries- Innovation practice and its performance implications in small and medium enterprise (SMEs) in the manufacturing sector: A resource-based view', *Strategic Management Journal*, 31, pp. 892–902. doi:10.1002/smj.

Thakkar, J., Kanda, A. and Deshmukh, S.G. (2009) 'Supply chain management for SMEs: a research introduction', *Management Research News*, 32, pp. 970–993. doi:10.1108/01409170910994178.

UNEP (1997) *Environmental management in oil and gas exploration and production*, *Industry and Environment*. London. doi:10.65/Jss2003.09.085.

Vanichchinchai, A. and Igel, B. (2011) 'The impact of total quality management on supply chain management and firm's supply performance', *International Journal of Production Research*, 49(11), pp. 3405–3424. doi:10.1080/00207543.2010.492805.

Varma, S., Wadhwa, S. and Deshmukh, S.G. (2008) 'Evaluating petroleum supply chain performance: Application of analytical hierarchy process to balanced scorecard', *Asia Pacific Journal of Marketing and Logistics*, 20(3), pp. 343–356. doi:10.1108/13555850810890093.

Villar, J. a and Joutz, F.L. (2006) 'The relationship between crude oil and natural gas prices', *Energy Information Administration*, (October 2006), pp. 1–43.

Wernerfelt, B. (1984) 'A Resource-based View of the Firm', *Strategic Management Journal*, 5(2), pp. 171–180.

Yang, J. (2012) 'A structural model of supply chain performance in an emerging economy', *International Journal of Production Research*, 50(14), pp. 3895–3903. doi:10.1080/00207543.2011.603373.

Yeh, D.-Y., Cheng, C.-H. and Chi, M.-L. (2007) 'A modified two-tuple FLC model for evaluating the performance of SCM: By the Six Sigma DMAIC process', *Applied Soft Computing*, 7(3), pp. 1027–1034. doi:10.1016/j.asoc.2006.06.008.

Yew, C., Boon-itt, S. and Wong, C.W.Y. (2011) 'The contingency effects of environmental uncertainty on the relationship between supply chain integration and operational performance', *Journal of Operations Management*, 29(6), pp. 604–615. doi:10.1016/j.jom.2011.01.003.

Youn, S. *et al.* (2013) 'Strategic supply chain partnership, environmental supply chain management practices, and performance outcomes: an empirical study of Korean firms', *Journal of Cleaner Production*, 56, pp. 121–130. doi:10.1016/j.jclepro.2011.09.026.

Youn, S.H. *et al.* (2014) 'Supply chain information capabilities and performance outcomes: An empirical study of Korean steel suppliers', *International Journal of Information Management*, 34(3), pp. 369–380. doi:10.1016/j.ijinfomgt.2014.01.008.

Yusuf, Y.Y. *et al.* (2013) 'The UK oil and gas supply chains: An empirical analysis of adoption of sustainable measures and performance outcomes', *International Journal of Production Economics*, 146(2), pp. 501–514. doi:10.1016/j.ijpe.2012.09.021.

Yusuf, Y.Y., Gunasekaran, A., *et al.* (2014) 'A relational study of supply chain agility, competitiveness and business performance in the oil and gas industry', *International Journal of Production Economics*, 147, pp. 531–543. doi:10.1016/j.ijpe.2012.10.009.

Yusuf, Y.Y., Musa, A., *et al.* (2014) 'A study of the diffusion of agility and cluster competitiveness in the oil and gas supply chains', *International Journal of Production Economics*, 147, pp. 498–513. doi:10.1016/j.ijpe.2013.04.010.

Zhang, M. *et al.* (2013) 'Do Suppliers Applaud Corporate Social Performance?', *Journal of Business Ethics*, 121(4), pp. 543–557. doi:10.1007/s10551-013-1735-x.

Zhao, R. *et al.* (2017) 'An optimization model for green supply chain management by using a big data analytic approach', *Journal of Cleaner Production*, 142, pp. 1085–1097. doi:10.1016/j.jclepro.2016.03.006.