# The impact of low-sulphur fuel requirements in shipping on seaport competitiveness : a study on LNG bunkering in Dubai, UAE and Sohar, Oman

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# The Impact of Low-Sulphur Fuel Requirements in Shipping on the Seaport competitiveness; A study on LNG bunkering in Dubai,UAE and Sohar,Oman

## Abstract

Bunkering is strategic importance in port and shipping businesses. The overview of the development progress of LNG bunkering projects in the region ports of Persian Gulf and Arabian Sea ports shows, although the main investors and operators for LNG bunkering facilities are private industrial players, but the port authorities have crucial role in facilitating and promoting the use of LNG as a marine fuel.

This article formulates a framework and a method for assessing the competitiveness between two ports as bunkering hubs in Persian Gulf and Arabian Sea. In order to asses competitiveness of the ports, a combination of two strategic modelling tools, RBV and Michel Porters Diamond, conducted with the hypothesis of study.

The study found, Dubai was rated a better performer in the assessment. Besides Sohar's naturally better strategic location, which planned to attract large cargo volume in future, the fundamental reason for Dubai excellent performance is its attractive market structure due to remarkable economics of scale and more sustainability, which results in attractive pricing and affectivity and efficiency, Hence, Dubai has a better performance and stronger port activity with highly likely increasing demand in LNG bunkering in near future while the

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strategic location of Sohar upgrade its position as the port gate for the GCC ports also has an important role as gate of demand for LNG bunkering.

**Keywords:** LNG bunkering, seaport competitiveness, seaport cluster, RBV, Porter's Diamond competitiveness

## I. Introduction

To date, many studies have assessed the competitiveness and attractiveness of ports but, few studies have been devoted to the topic of bunkering. (Alizadeh et al. 2004)

Reviewing literature extensively and interview with dominant shippers and bunker supplier in Persian Gulf and Oman Sea showed that efficiency, reputation, infrastructure, port charges, shipping frequency, responsiveness, and location are regarded as the most important criteria for port selection. Meantime some studies conducted interviews with liners revealing that they attached great value to often neglected factors, such as feeder connectivity, environmental issues, and the port's total portfolio, cost competitiveness and supply chain (Magala & Sammons 2008). By the meantime, providing LNG bunkering as a new port activities have a considerable environmental impact not only at the local level but also on an entire region. (Dooms et al. 2015). On the other hand, deviations from main trunk routes, frequency of large container ships calling and diversity of ship's routes are used to evaluate seaport competitiveness from a foreland point of view. Then, level of service for fresh water, (Yeo at al. 2008). Bunkering facilities include storage facilities, bunker barges, pumps, and bunkering anchorages. Bunkering facilities not only affect suppliers' reliability and punctuality, but they also affect the bunkering costs, as the number of barges and operating standards will also influence the bunker delivery costs (Cockett 1997) while bunker costs represent almost 50% of voyage costs (Stopford 2009). Moreover, size of company and bunkering facilities not only affect suppliers' reliability and punctuality, but they also influence the total fuel bunkering cost.

Meanwhile, form the technical interviews found that adequacy and efficacy of bunkering facilities, pumping rate of bunkers, and availability of safe and availability of anchorages, and less deviation from the shipping route are most important factors for shipping companies to select a port in comparison to other neighbourhood.

By the meantime, ports are affected by new competitive forces as a result of forces of global competitiveness which is more sensible between ports in the one region. (Notteboom & Rodrigue 2005). Thus the port managers and strategic decision makers try to improve the port position in terms of services and facility providing constantly. Increasing the port total portfolio can increase cargo throughput, shipping traffic including (conventional and gas fuelled vessels) accordingly that are used to be increased demand of bunkering and ships' products, and seaport-related components which affect seaport attractiveness from a seaport organisation point of view.

The review from the literature and the output derived from interviews with dominant shippers and bunker suppliers in the Persian Gulf indicate that efficiency, seaport reputation, capacity of the infrastructure, seaport charges, shipping frequency, responsiveness, and location of the seaports are the critical determinants for the seaport selection criteria in this region. From liner perspective feeder connectivity, environmental issues, seaport's total portfolio (Wiegmans et al. 2008), cost competitiveness (Lam & Yap 2006) and supply chain (Magala & Sammons 2008) are considered important factors which influence seaport competitiveness.

This MARPOL Annex VI entitled 'Regulations for the Prevention of Air Pollution from Ships' planned to reduce nitrogen oxide (NOx) and sulphur oxide (SOx) emission especially from shipping activities. This regulation has been implemented to forbid any substances from fleets which contribute to deliberate emissions that cause ozone depletion or aggravate environmental pollution (Notteboom 2011). The new MARPOL Annex VI became officially effective from 1 January 2015. Many ports in Emission Control Areas (ECAs), as shown in Figure 1, urgently need to adapt to the upcoming emission regulations and, at the same time, seaports need to retain their competitive advantage among their main shipping companies. The demand for natural gas has dramatically increased in the ports located in ECA area since severe restrictions have been implemented through Annex VI of the MARPOL. Moreover, attractive financial aid has increased the number of fleets shifting from liquid fuel oil to LNG (Vaferi 2014). However, from the beginning of January 2012 the global sulphur cap reduced initially from 4.5% to 3.5%, and it will gradually further reduce to 0.5%, effective from 1 January 2020 (Wang & Notteboom 2010). This phenomenon indicates that the issues associated with adapting to the new IMO regulations is not only restricted to ECA nations but will affect all nations around the globe.

LNG demand likely increase with increasing restriction pattern of emission. Established bunkering infrastructure and supply chain network for LNG delivery have become a critical aspect of the development of LNG as a fuel to generate effective ocean transportation as well as to protect the environment from ozone-depleting substances. Most fleets which used East-West or Persian Gulf-Europe as their main trade route exposed around 44% by ECAs and 65%, respectively (Vaferi 2014). In recognition of this fact, seaports in Dubai (UAE) and Sohar (Oman) took the initiative to go beyond the traditional approach for LNG bunkering by developing their own infrastructure, IT system and effective management system to facilitate the shipping lines in adapting to the IMO's regulations.

Dubai and Sohar seaports, which are located in the Persian Gulf and adjacent to the Strait of Hormuz, were selected in order to analyse the necessity of LNG bunkering and the implications for seaport competitiveness. This article develops a framework and a method

for assessing the competitiveness between these two seaports as bunkering hubs. Moreover, potential strategies will be recommended for improving the seaports' competitiveness which originated from the supply of LNG fuel to their respective clients.

This paper is divided into eight sections. First, this introduction addresses the background and research problem. Section II is about the IMO requirements for low-sulphur fuel, and Section III is a literature review on seaport competitiveness. Section IV discusses the research methodology adapted in this paper, and Section V examines low-sulphur fuel supply and the implication for competitiveness in Dubai and Sohar seaports. The results of the findings will be discussed in Section VI. The implication of GCC competitive model for seaport competitiveness will be discussed in Section VII and section VIII is a conclusion.

<Figure 1> Low Sulfur Surcharge (LSS) Emission Control Area Enforcement


Source: IMO official site (2014)

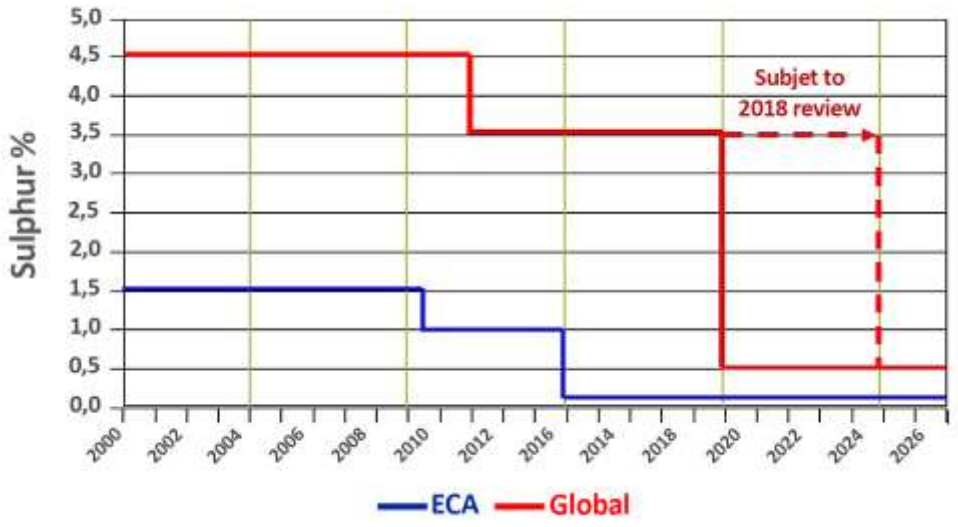
## II. IMO Requirements for Low-Sulphur Fuel

Shipping companies are mandated to undertake major investments in fulfilling the requirements imposed by IMO to implement low-sulphur marine gas oil (MGO). A distillate oil product costs several times more than heavy fuel oil (HFO) due to the sophisticated refining methods. The IMO regulations article also introduces the possibility for countries to enact more restrictive rules. Moreover, there is the potential for new areas to become ECA areas, such as the Mediterranean Sea, the Central American coast, Singapore and others are considered to be encompassed in this option. The ECA provisions put the competitive

situation of shipping under pressure and a strategic plan for innovation based on LNG needs to be created (Haezendonck et al. 2006).

The pattern of increasing restrictions on emissions means that the demand for LNG is likely to increase. Before 1 January 2015 and the first step of SOx limitation enforcement in Emission Control Areas (ECAs), ship owners who wanted to run their fleets in ECAs kept an eye on LNG as a future ship fuel. The maximum sulphur content in ECA areas was limited to 1% from 1 July 2010 to 1 January 2015, as indicated at stage 1 and 2 in Figure 2. The only possible option when facing the IMO regulations as depicted at stage 3, and to keep costs down, is by seeking alternative solutions that will sustain shipping's competitive edge.

<Figure 2> Stages in IMO Emission Regulations




Source: European Commission, LNG as Marine Fuel (2016)

There are a few alternatives in the market but the recent studies into using LNG as ship fuel has appealed to many shipping companies throughout the world (Vaferi 2014). There are three important factors which make LNG as ship fuel one of the proactive future technologies for shipping lines. Firstly applying LNG as ship fuel reduces sulphur oxide (SOx) emissions considerably and within the mandated level of the ECAs by 2015. Secondly, the carbon content of LNG is lower than that of HFO, therefore CO2 emissions will be reduced. Finally, LNG is expected to be less expensive and more accessible. Current low LNG prices in Europe and the new explored resources in USA show that the price of LNG is comparatively cheaper than that of HFO.

Providing LNG or low-sulphur fuel bunkering as a new seaport activity has a considerable environmental impact not only at the local level but also on the entire region (Dooms et al. 2015). Seaports are affected by new competitive forces as a result of changes in global competitiveness, and this is experienced more acutely by seaports in the one region. Thus, the seaport managers and strategic decision makers constantly try to improve their seaport's position in terms of services and facilities by aiming at bunkering services as this has gained strategic importance in seaports and shipping business.

The other alternatives should not be out of sight, by the other mean; if exhaust gas cleaning system (scrubber) becomes more feasible than LNG and widely in use, it could reduce the demand for LNG as fuel. Hence, conversely, if the price of scrubbers becomes more feasible than LNG and widely in use, it could reduce the demand for LNG. However, providing LNG as maritime fuel in seaports or fleets to other fleets is not a new paradigm in maritime business. As a clear example, boil off gas LNG has been used as fuel in LNG carriers for the past 40 years. Fortunately, the classifications have issued their own guidelines in accordance to the IMO Codes; International Gas as Fuel Code (IGF) which is planned to implement with the SOLAS 2014 edition. Another designed code that has started in parallel is ISO TC 67 which emphasises the standards for LNG bunkering.

## III. Problem statement

Before 1 January 2015 is the date of first step of SOx limitation enforcement in Emission Control Areas (ECAs) and the times running up, so many ports in ECAs are seen not only find it their responsibility to quickly adapt to the upcoming emission regulations, but the other ports specially the main shipping companies keep an eye to shipping's environmental needs for obtaining competitive advantage. Previous study proof that LNG as maritime fuel is feasible technically and highly attractive financially if LNG bunkering be available. However, January 2020 is the date that shipping industries will meet the global sulphur cap (less than0.5%), the mentioned problem in above is not limited to only ports in ECAs. A critical aspect of the development of LNG as a fuel is the lack of an established bunkering infrastructure and supply chain network for delivering LNG as a marine fuel.

The concept of competitiveness consists of many characters of an organisation which include distinctive assets or competencies which result from cost, size or innovation capabilities that provide a substantial strength for an organisation to compete and be sustainable in a competitive environment. Moreover, offering a service or product which is difficult to replicate or be imitated by the competitors provides a competitive strategy for any organisation (Cavusgil et al. 2007). From the resource based view (RBV), competitiveness is described as the ability of an organisation to provide low cost with optimum efficiency during the provision of a certain type of service or product (Thomson

2004). However, competitiveness from Porter's (1985) perspective indicates that the attractiveness and competitive intensity of an organisation is by means of five main forces including bargaining power of customer and suppliers, threat of substitution, rivalry level in competition and finally government influences. In this study, the definitions from both RVB and Porter perspectives will be utilised to assess how seaports can be sustainable in a competitive market.

This empirical research assesses bunkering ports within the context of supply management. The supplier evaluation criteria were drawn from the literature, in particular Lam et al. (2011), Talluri and Baker (2002), Wang and Notteboom (2014) and Doom et al. (2010) due to their approach and application in supply chain management. This review helped to develop a set of assessment attributes, including quality, delivery, price, service and management.

However, Dubai (UAE) as a large world class gateway port and Sohar (Oman) operate according to the 'landlord' model while they intend to go beyond the traditional approach for LNG bunkering by developing infrastructure and superstructure, IT system as well as management and with more facilitating and flexible regulations in terms of local and international cooperation. The study attempts to clarify the necessity of LNG bunkering and impact of LNG facility on their position in port competitiveness. Moreover, it is crucial to know what the best strategy is for future to link these activities to sustainable port competitiveness.

## V. Research Methodology and Framework

In general, the methodological approach in this paper consists of primary data supported by secondary data. For primary data, telephone interviews with people with expertise from respective seaports and other stakeholders have been conducted to gain information on the bunker supply chain, in particular in seaports. Some of the respondents could not be contacted via telephone; therefore personal emails were used to receive their feedback. Although email interviews are time consuming, this endeavour was worth pursuing as the output from them was deemed useful for this research. To ensure the validity of the data, the respondents were selected from middle and top management because they make the decisions in each respective organisation in order to certify the utilisation of resources to achieve optimum competency. The primary data were supported by secondary data to provide wide-ranging findings. Secondary data were obtained by accessing seaport traffic data, annual reports and publicly available web pages. To ensure a holistic and balanced perspective, the datasets were selected from reputable international organisations.

Interviewees were chosen on the basis of areas in the conceptual context of this report and henceforth, of the questions addressed to them. The interviews were conducted over a period of five months, from December 2014 to April 2015. The main reasons for increasing the period of interview was the late response from interviewees and volatility in the market which could influence the results of the research. The aimed interviewees selected from middle or top managers in the maritime companies. The initial interviewees provided names of relevant people in the field who could potentially provide further information and sources of information. Nevertheless, several initial interviews either provided directly or led to the identification of sources that would comprise the section of secondary research, as well as what has formed the literature review of this report and recommendations for further study.

We attempted to identify the different interests in the shipping industry and eventually bridge them together. With the use of a cross checking and heuristics approach, all information was welcomed until no further or new information was added or made relevant connections to the research purpose. It was deemed essential not to limit the interviews to marketing or sales professionals, rather to include ideas and suggestions from other more technical departments, which eventually appeared to be critical to the research. Interviews were mostly conducted in English; those interviews in Farsi were translated into English by the researchers in order to consolidate the research findings into a homogeneous format and language.

## 1. Survey Subjects

- The recent agreements (research, training, development, shipping)
- Review the strategies, new players and stakeholders in the market
- Future plans for the development of LNG bunkering at the seaports
- Development of rules with the assistance of classification societies and other related organisations (SIGGTO, IAP&H).
- Timeline for the development of processes and investment

## 2. Interviewing Analysis

As mentioned above, we reached out to a large number of relevant professionals who could answer specific and non-specific questions and were knowledgeable about LNG as related to marine fuel. The distance, time and budget were taken into account and influenced whether interviewees could be reached. More flexible and accessible in nature, the response to the telephone interviews was larger and the percentage of professionals agreeing to be interviewed reached about 70% (14 of 23). Obviously the quality of the answers relied on the discretion of the interviewees. Due to the limitations of time (approximately 15 minutes per interview), many of the interviewees were contacted again in order to provide more information, and others agreed to spend more time on the phone to cover all queries. Semi-structured interviews included from six (6) up to ten (10) focused questions, and some time

were allocated for further discussion. Additionally, a formal survey was created in order to identify the needs of the industry, current and future projects and was addressed to some 30 companies, mostly in the Persian Gulf and Oman Sea, of all segments and sizes. The response rate has been relatively low: only 23 (76.6%) agreed to answer the questions in the required fields of the survey.

## 3. Competitiveness model for Persian Gulf seaports

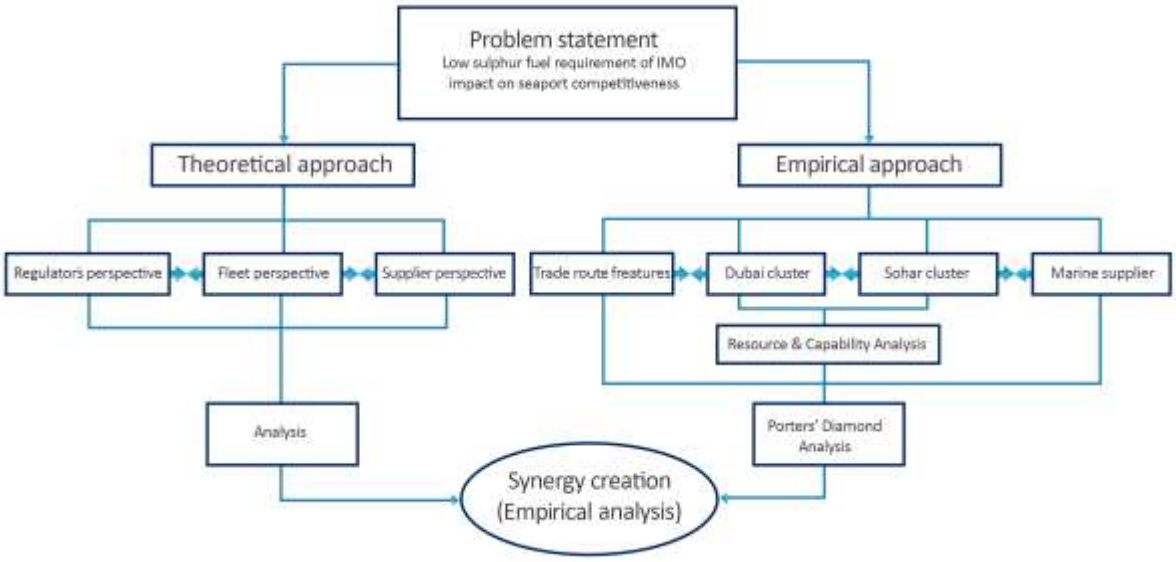
The resource based view (RBV) and Michael Porter's Diamond strategic modelling were used to evaluate the competitiveness of seaports. A central aim of RBV is that the organisation is to compete on the basis of their resources and capabilities (Peteraf & Bergen 2003). RBV analyses the organisation's capacity, right down to the factor of the market conditions with which the organisation (or seaports in this paper) must contend, and also searches for some possible causes of sustainable competitive advantage by holding all external environment factors constantly (Peteraf & Barney 2003).

Since the RBV model does not emphasise external environment factors, Michael Porter's Diamond strategic model with its five forces framework has been integrated with the former model to provide a thorough evaluation of resources and the environment. Moreover, the RBV model and Michael Porter's Diamond model complement each other in explaining the sources of firm performance (Peteraf & Bergen 2003). In nutshell, RBV is long-term oriented and focuses on the internal environment while Porter's model is short-term oriented and focuses on the external environment (Foss 1996, p. 19).

This study attempts to establish the vision to which the problem is directed to identify the starting point of the research problem. Figure 3 provides a visualised framework which incorporates RBV and Porter's models and theoretical approach. It aims to clarify concepts and propose relationships among the concepts in the study to provide a context in which to synthesise and interpret the research findings.

The theoretical approach is to refine the goal and development procedure realistically and relevant to the research questions. At the end it also suggests the limitations, appropriate methods, and predicts threats and synergies so that the reader will be able to understand the necessity of conversion and shifting to any feasible alternative. The theoretical framework development includes desk research and information provided by port authorities, ship owners, classification societies, bunker companies and ship builders, convention books, guidelines and reference books. The empirical approach consists of interviews, questionnaires and technical observations.

<Figure 3> Research structure




Source: Author

## 4. Persian Gulf Seaports: The Empirical Study Framework

The Strait of Hormuz is a narrow waterway that connects the Persian Gulf and the Gulf of Oman. This strait is the only passage from the oil-rich Gulf to the Indian Ocean for maritime traffic (Figure 4). The strait is among the world's most important oil chokepoints and approximately 88% of the oil from the Persian Gulf is transported through the Strait of Hormuz. Most of the oil and petroleum products, mainly from Saudi Arabia, Qatar, United Arab Emirates, Iraq, Iran and Kuwait, transit through the Strait of Hormuz (Barnes & Jaffe 2006).

## 5. Strait of Hormuz

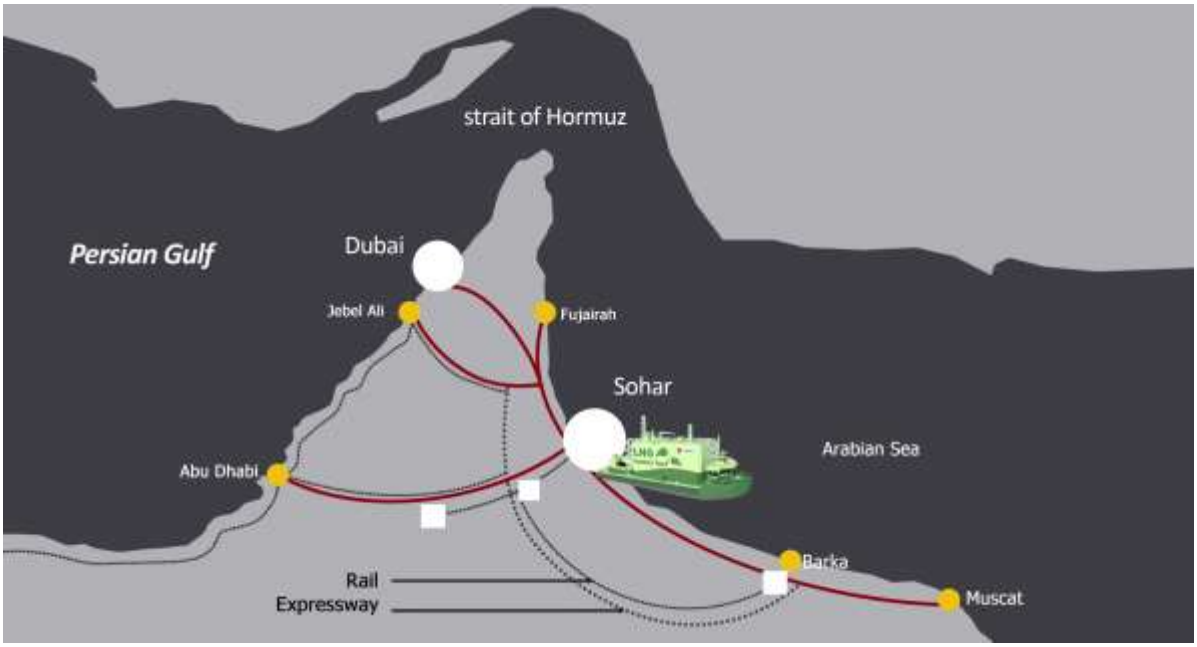
The Strait of Hormuz is a sensitive narrow waterway that connects the Persian Gulf and the Gulf of Oman the only passage from the oil-rich gulf to the Indian Ocean for maritime traffic. The Strait is among the world's most important oil chokepoints. Approximately 88 percent of all oil leaving the Persian Gulf goes via the Strait of Hormuz. (Barnes & Jaffe 2006) . The Straits of Hormuz as one the most important international waterway watch about 20 to 25% of the world’s daily crude oil production move through it , and were they to be shut in, the immediate impact on crude oil prices and some of the direct economic consequences on world's energy security.

## 6. Sohar Seaport

Sohar seaport is a deep-sea port and adjacent free zone in the Middle East, located in Sohar, Oman, around 200 kilometres northwest of the capital Muscat. With current investments exceeding $15 billion, it is one of the world's largest seaport and free zone developments. It lies at the centre of global trade routes between Europe and Asia making it a strategic location for business (Sohar Port 2015). Sohar seaport provides unequalled access to booming Gulf economies while avoiding the additional costs of passing through the Strait of Hormuz (Oxford Business Group 2010). The existing road network and the future rail and

airport system provide direct connectivity to the UAE and Saudi Arabia which are classified as the biggest consumer market in the region (EIA 2011).

<Figure 4> Location of Sohar and Dubai seaports




Source: EIA (2011)

Moreover, Sohar seaport is currently home to logistics, petrochemicals and metal clusters that feed downstream industries with iron and steel, plastics and rubber, ceramics and chemicals. The abundance of low-cost energy, raw materials and world-class logistics support, coupled with Sohar's business incentives and one-stop-centre for all documentation clearances procedures provide a significant advantage for business development (Jaskiewicz 2012).

Sohar seaport is located in the cluster of the Northern Omanis' seaports because of its strategic location which is in the Gulf of Oman, Persian Gulf and Strait of Hormuz. Sohar seaport is to join the growing group of other seaports in the Persian Gulf in supplying LNG by ship-to-ship transfer services. Ability to provide a ship-to-ship LNG transfer service will be an opportunity to establish the competitiveness by attracting additional shipping lines to this particular seaport. In addition to this, Sohar seaport has introduced a development plan to establish LNG bunkering facilities in Sohar's region (NGV Global 2014). Moreover, owning a licence for a ship-to-ship (STS) LNG transfer service has become an important stepping stone for this seaport to move simultaneously with IMO regulations.

## 7. Dubai Seaport

Dubai seaport is located in the UAE seaport cluster. The ability of this seaport to compete with other seaports as well as cooperate with the members of the cluster increases the strength of network for this particular seaport. Dubai Port Authority is the main seaport in Dubai and this seaport is operated by Jebel Ali Port and Port Rashid. Jebel Ali Port has handled 13,010,000 TEUs and was ranked the world's 9th busiest seaport in 2011 (DP World 2015). Meanwhile, Port Rashid dominates the shipping activities in the UAE and has been categorised as the most efficient and the leading seaport in the whole of the UAE (DP World 2015). Dubai Port Authority is in proximity to other UAE ports and is considered a leader for particular social relationships with other Emirates seaports. The development of cluster activities in this region possesses potential to amplify the significant benefits not only to this seaport but also to its respective stakeholders (Notteboom & Rodrigue 2009).

## VI. Development Stages of LNG Fuel Bunkering in Dubai Seaport

Since the IMO regulation on emissions was announced, Dubai seaport has undertaken some drastic action to conform to the new rules. Firstly, UAE received approval for the land-based LNG regasification facility in 2013. The terminal will have a projected throughput capacity of 1.2 billion cubic feet (34 million $m^3$) of natural gas per day and will be constructed and operated by Emirates LNG which is a joint venture of International Petroleum Investment and Mubadala Petroleum. Secondly, a venture between Shell and Dubai Maritime City was announced. Sharjah in the UAE is planning to convert heavy vehicles such as forklifts and cranes at compressed natural gas (CNG) construction sites at Dubai.

These moves to comply with the IMO regulations has also seen Sydney-based AGL Energy Limited announce their plan to roll out CNG refuelling stations across Australia's east coast. Det Norske Veritas Germanischer Lloyd (DNV GL) and Nakilat-Keppel Offshore and Marine (N-KOM) shipyard have agreed to jointly promote LNG as fuel within the maritime and offshore industry in Qatar. Additionally, United Arab Shipping Company has increased its order up to 17 LNG-ready new buildings with an investment of more than $2 billion (NGV Global, 2014). QENERGY Europe (QE) and Dubai Maritime City Authority (DMCA) announced their willingness to work closer together on LNG Bunkering Services in GCC and East Mediterranean. Finally, DMCA along with Dubai Supply Authority manage the floating storage and regasification units (FSRU) facilities in Dubai. Both companies aim to share their knowledge and experience to improve the efficiency and development of a sustainable market to substitute LNG as marine fuel in maritime business. Preparation by Dubai seaport indicates the anticipation given by this seaport to conform to the MARPOL Annex VI regulation which is exceptional. The collaborations which consist of inter- and intra-regional planning moves this seaport to be fully equipped to cater LNG fuel to the shipping lines as well as improve its level of competitiveness.

## VII. Results and Discussion

The incorporation of the RVB model and Porter's Diamond model is expected to provide clear guidance for Sohar and Dubai seaports in order to improve their competitiveness by providing LNG bunkering services to the clients. In this case, the capability and resources in each seaport will be analysed and the results from this stage will be integrated in the following stage to provide a clear picture of the advantages and opportunities both seaports have to cater for their clients in LNG bunkering as well as developing their competitiveness level.

### 1. Theoretical Concept

Changes in the logistics system to pursue efficiency in logistics improvements have induced the development of global supply chains and have forced seaports to focus more on hinterland locations to sustain or increase their competitiveness (Notteboom & Rodrigues 2005). Seaport competition is focusing increasingly on the development of hinterland connections because the inland logistics costs are crucial to ensuring the price of goods remains competitive at the final consumption point (Wilmsmeier et al. 2014).

Logistics integration, new patterns of freight distribution and the dynamic role of seaports lead to an increasing network orientation (Notteboom & Rodrigue 2005). The emergence of extending gateways resonates with an on-going clarification and elaborations of the hinterland concept increasingly develop into seaport networks (Notteboom et al., 2009b). To complete an appraisal modelling, this paper proposes to adapt Porter's Diamond model to provide a framework for both seaports to evaluate the spatial competition of these seaports in the region. Seaports in this region are linked through horizontal relationships, collaborating with each other as well as sharing the available resources in the region to gain competitive advantages.

Adapting the RBV model may provide a clear position of the ports' competitiveness in this region by transforming a short-run competitive advantage into a sustained competitive advantage in the future. These facts can shows the impact of increasing the demand of LNG as marine fuel, boost the seaports' productivity and emphasise their functionalities as main LNG bunker providers. Hence the advantage of seaports in the Persian Gulf which are able to provide LNG bunkering to their respective clients is that they may gain the opportunity to expand their attractiveness among the shipping lines which operate along the Strait of Hormuz.

### 2. Resource and Capability Incorporating with Porter's Diamond Model

An RBV approach to evaluating seaport competitiveness requires the evaluation of the internal resources and capabilities of a seaport cluster. Achieving a competitive advantage in relation to their business rivals is the primary focus of both these seaports. Existing

resources and capabilities have been considered as the fundamental sources to validate competitive advantage within the context of strategic management and sustainability. In order to have a significant understanding of the conditions for growth and competitiveness of bunkering in Sohar and Dubai, Porter's Diamond model was applied to GCC region which is located strategically on the junction of seaborne trade flows. Sohar and Dubai are from different seaport clusters. From a geographical perspective, these seaports are located in two different locations on Hormuz Strait (Figure 4). Therefore, they compete to have more share of regional bunkering demand to attract more clients.

Table 1 shows the significance of the attributes in selecting a bunkering seaport. Bunker quality, market power, and bunker delivery amount, reliability and punctuality of bunker suppliers as well as adequacy and efficiency of bunkering facilities are major concerns for evaluating bunkering in seaports. Indeed all those factors introduced in the first section as influential factors in the bunkering industry cannot be weighted by means of a quantitative method. Partial data are available on websites and the rest collected through interviews. However, the study attempts to compensate for this shortage with inference of the available evidence or secondary data with the primary data to provide a comprehensive result.

Dubai and Sohar seaports are collaborating in bunkering and relevant supply chains with different segments such as value-added logistics companies, distribution companies, haulers, railway companies, barge masters and maritime service companies. From the market perspective, resources in Dubai seaport are more advanced than those in Sohar seaport. In addition, the trend of bunkering delivery in Dubai seaport shows an increasing trend compared to Sohar seaport. From the demography and container throughput perspective, Dubai seaport dominates Sohar seaport by 5.5 million people and 15.4 million TEUs.

On the other hand, Sohar seaport overcomes Dubai seaport especially in terms of the global competitiveness index, government policies and transparency. Finally, in terms of bunkering facilities as well as the location, these seaports are equally strong. Oman, a fast-growing seaport which is a highly strategic node in the supply chain in the GCC, has provided some additional benefits to these seaports including accomplishing an important consortium between Rotterdam, Antwerp and APM-Terminal with Sohar, Doqum and Salale seaports. The summary of the RBV analysis shows that both of these seaports have equal strength and weakness. In term of seaport resources, Dubai seaport possesses adequate capital compared to Sohar seaport. On the other hand, from the seaport capability point of view, Sohar seaport has satisfactory competence compared to Dubai seaport. In nutshell, Dubai and Sohar seaports possess equal potential to utilise their resources and capabilities in order to improve their competitiveness by providing LNG bunkering to their respective clients. Hence, the outcome from the RVB model will be incorporated with the Porter's Diamond model to analyse substantial potential opportunities that will be gained in GCC seaports as a whole.

By the way, many measures of competitive advantage, such as reported profitability, can be misleading. (M. Porters, 1990) therefore we chose as the best indicators the presence of substantial and sustained exports to a wide array of other competitor ports and significant outbound foreign investment based on skills and assets created in both Emirate and Omani's port.

<Table 1> RBV evaluation of resources and capabilities for UAE and Oman

| **Performance appraisal Sohar vs Dubai** | **UAE** | | **OMAN** | |
|---|---|---|---|---|
| **C&R** | Resource | Capability | Resources | Capability |
| **(Market power) ,GDP, billion $** | 402.3 | increasing | 79.66 | Declining |
| **Bunkering delivery amount /Year $** | 13,549,000 | Constant | 640.000 | increasing |
| **Bunker price competitiveness** | Highly competitive (Qatar& Bahrain) | | Highly competitive (Iran & Qatar) | |
| **Population(Demographic profile, HR ) ml** | 9.446 | Accessible | 3.926 | Developing |
| **Market sharing in region GCC** | 61% | Fast improving | 14% | Toward be a big player in GCC |
| **Punctuality , Container Throughput (teu)** | 19 336 427 | Top 10 ports | 3 930 261 | Extended to Rotterdam and Antwerp |
| **Global competitiveness index** | 32 | Improving | 12 | Improving |
| **Government policies**[4] | Flexible | incentives limited | High Flexibility | attractive incentives |
| **Transparency** | High | 2nd pos. in GCC | one of 2 with an FTA with US | Big player in GCC |
| **Bunkering facilities (adequacy and efficacy)** | Available | Enhancing | Available | Enhancing |
| **Location of port** | Center of port cluster | | Highly Strategic in conjunction East-West trade | |

Source: Authors

4 Federal corporate tax and personal taxes are nil and numerous double taxation agreements and bilateral investment treaties are in place.

Porter's Diamond model points out the dominant proficiency and strategic strength of Sohar seaport is its geographical attractiveness in the entire GCC region as it is located at the junction of seaborne trade flows. This competence provides maximum possibilities to increase the demand and dedicates a dominant position to be considered as a gate seaport for the supply chain to the entire GCC seaports' activities. The strength owned by this seaport can be extended to the region's potential market in other geographical positions through factor condition, demand condition, rivalry condition and government condition. In terms of factor condition a potential market could be gained because Sohar seaport possesses well-developed infrastructure and optimum accessibility for continued LNG supply. Moreover, the demand from a new generation of deep sea vessels, and attracting diversified industry based and located at the main logistic clusters provide additional benefits to this seaport. The role of government especially by supporting port investments, providing tax concessions or reductions as well as planning for seaport future development add even more advantages for Sohar seaport to dominate LNG bunkering services and improve their competitiveness (Jansen & Storli 2014).

In order to determine competitive advantage of LNG bunkering in Port of Sohar shipping and relevant logistic industries , and also sketches out some of overall implications for government policy and strategy in national level, we develop a Porter's Diamond Model which is combined with RVB model to evaluate on implications in greater depth and provides dynamic view over the national level and the future prospects for essential issues in LNG bunkering regarding developing port competitiveness. Figure 5 summarises the potential opportunities for seaports in the GCC region from the Porter's Diamond model perspective of Omanis nation's shipping industry as internationally successful if it possessed competitive advantage relative to the best LNG bunker ports competitors.

We explicitly stated based on the synthesis of RVB model that the Duabi has a better performance in bunkering but seems that Post of Sohar might get better position due to strategically geographical location. To evaluate competitiveness of LNG bunkering on Port of Sohar the following design of competitive model is derived from the RVB model and incorporated with Porter's Diamond model provides a reliable model not only for short-term benefits but also considering the long-term potential benefits.

<Figure 5> Applying Porters's Diamond model for dominant proficiency and strategic strength of Sohar seaport


Source: Adapted from Porter (1990)

## VIII. Implications of the GCC Competitive Model for Seaport Competitiveness

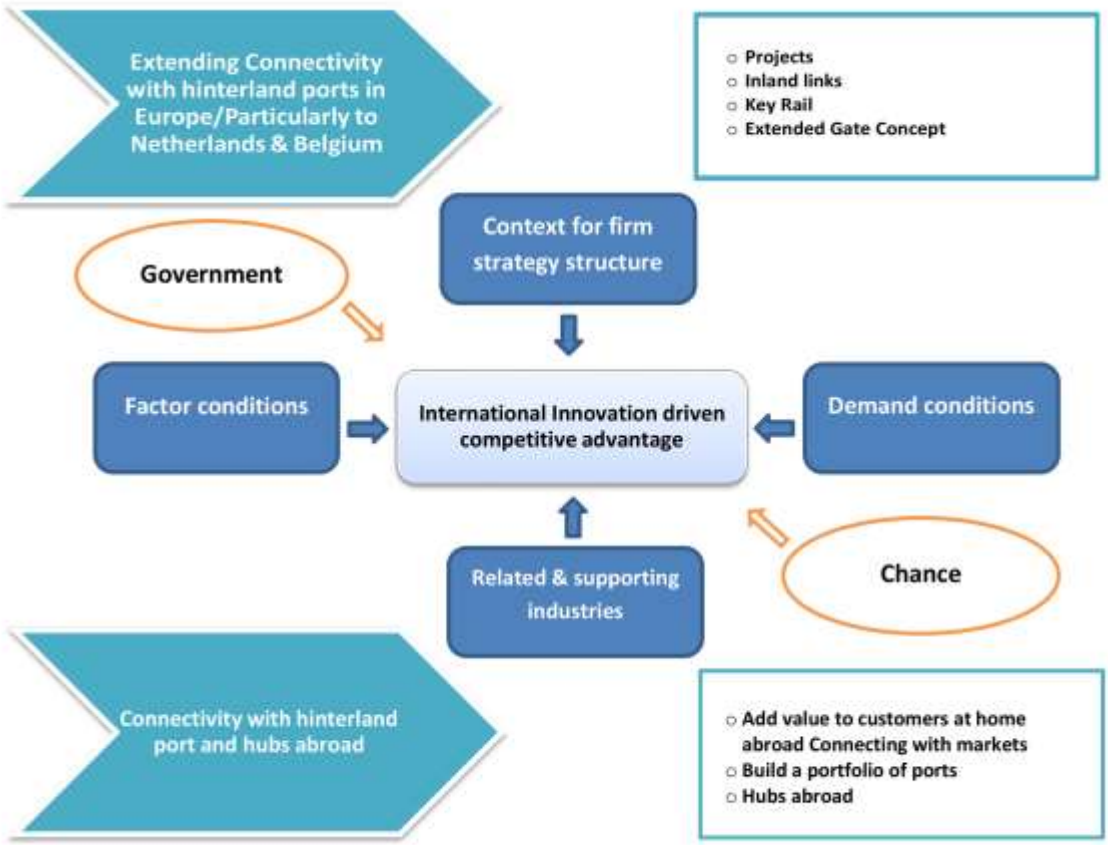
The development of a competitive model generally contributes to the enhancement of competitiveness of the Dubai seaport while providing the LNG bunker services to their customers. The competitiveness elements can be divided into five main sections including price, delivery, quality, service and management. Firstly the government role as a catalyser to improve the demand for the LNG bunker among the shipping lines. Moreover, diversification in economic strategy, tax concessions and other supportive incentives enhance the participation of Dubai and Sohar seaports to be involved in the LNG bunkering services as well as improving their level of competitiveness.

The development of transport infrastructure, strategic location, non-adjacent from Straits of Hormuz, effective road network, location for main logistics clusters, inland links, rail networks and the extended gate concept which generated from the factor conditions may improve the demand of the LNG bunker not only from the foreland but from inland as well. Sufficient transportation networks especially to and from inland areas will develop a paradigm for both seaports to adapt to the IMO regulations effectively.

The existence of rivalry will improve the competition among the seaports to provide a range of services with high quality. Rivalry improves the quality of services by providing new railway and road infrastructure, developing economies of scale and scope, LNG bunkering plan for major Omani seaports, range of value-added services, and connections to markets, building a portfolio of ports and availability of hubs abroad.

Finally the demand condition manages to improve the services and management of seaports. For example existing leading established firms such as Vale, ORPIC, OOTO, OICT, Air Liquid, Safe Alloy and Sohar Aluminium allow the participation of a different range of organisations which increases the involvement of both private and public sectors. Moreover, the development of diversified industry and clustering as well as co-location of the logistics centre in various regions eases the services and management system in the seaports. The combination of the outcome of the GCC competitive model not only provides a guideline to prepare Sohar and Dubai seaport to comply with IMO regulations but also demonstrates the improvement in seaport competitiveness in various dimensions as indicated in Figure 6.

<Figure 6> A competitive model for Sohar port in context of GCC Seaports




Source: Adapted from Porter (1990)

## IX. Conclusion

This article develops a framework for the competitiveness assessment of LNG bunkering port. The capital-intensive nature of the LNG infrastructure and very conservative development causes the 'chicken-and-egg' dilemma. Bunker investors do not want to set up a supply network until there is sufficient supply for shipping, while shipping cannot change their route to other seaports without LNG supply infrastructure.

However, the port managers and strategic decision makers try to improve the port position in terms of services and facility providing constantly. Increasing the port total portfolio can increase cargo throughput, shipping traffic including both for conventional and gas fuelled vessels that are used to be increased demand of bunkering and ships' products, and seaport-related components which affect seaport attractiveness from a seaport organisation point of view while LNG at higher level of oil prices will be interesting for many newbuild and conversion projects in the region.

The overview of the development progress of LNG bunkering projects in the Persian Gulf and Arabian Sea ports indicates that the main investors and operators for LNG

bunkering facilities are private industrial players, but the port authorities have a crucial role in facilitating and promoting the use of LNG as a marine fuel. However, the investigations in this study show that LNG as marine fuel is likely to be increased through incentivization practises in order to motivate the actors within the region.

Strengthening and enhancing Dubai seaport's connectivity between the port and its hinterland would secure its sustainable competitiveness as a gateway for GCC countries. This strategy will secure its capacity to satisfy increasing demand for LNG bunkering from its stakeholders. For Sohar seaport, providing LNG bunkering as the solution to comply with MARPOL, Annex VI is a proactive plan that would make the seaport more attractive for shipping companies. It will cause inflowing of world-class capability as the result of increasing sustainable competitiveness

. Based upon seaport regionalisation, the development of Sohar seaport will not only bring potential benefits to this seaport but also provide substantial benefits to other regional seaports. In perspective of providing LNG as marine fuel, the location was found to be the most important attribute. Dubai was rated a better performer in the assessment. Besides Sohar's naturally better strategic location, planned to attract large cargo volume in the future, the fundamental reason for Dubai's excellent performance is its attractive market structure due to economies of scale, which results in attractive pricing through effective and efficient operations. Both Sohar and Dubai seaports are fast growing at both the GCC region and global level as well as competing with each other by optimising their service efficiency in LNG bunkering services in order to increase their competitiveness level

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