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Development of a computational model for optimal sourcing of LNG

Israt Mustary, Harun Chowdhury*, Bavin Loganathan, Firoz Alam

School of Engineering, RMIT University, Melbourne 3000, Australia

Abstract

Recent data indicates that there is an increasing global demand of natural gas in many countries. They want to enter into the international LNG market to meet their shortfalls. In order to minimize the transport cost the potential country needs to select the optimum strategy for importing LNG. However, for the prospective buyers of LNG, there is no such computational model available for sourcing LNG from the optimizing exporting locations at present. Therefore, the primary objective of the research is to develop a universal computational model which can be used to estimate total LNG price including transportation cost for any potential importing country for any given exporting terminal. A detailed transportation costing model was formulated to calculate the shipping cost based on the geographical locations of LNG terminals, types of shipping vessel and other shipping associated costs. A case study was performed to utilize the developed model for a prospective LNG importing country like Bangladesh.

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Keywords: computational model; optimal sourcing; LNG; shipping.

1. Introduction

Natural gas is a conventional but cleanest fossil fuel and considered as an enviro-friendly energy source. It is usually transported from the production facility to end users via pipelines. However, long distance transportation via pipeline is not only expensive but also sometimes impossible. Therefore, in order to store or transport natural gas to a distant location, it is converted to liquid form called Liquefied Natural Gas (LNG). As the energy demand is increasing day

* Corresponding author. Tel.: +61399256103; fax: +61399256108.
E-mail address: harun.chowdhury@rmit.edu.au

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by day, more and more countries are investing on exporting and importing LNG. Fig. 1 shows the LNG Trade volumes in million tons per annum (MTPA) from 1994 to 2014 [1]. Recent data indicate that until 2014, 19 countries exported LNG whereas 29 countries imported. New countries like Jordan, Egypt, Pakistan and Poland joined the list in early 2015 [1-2].

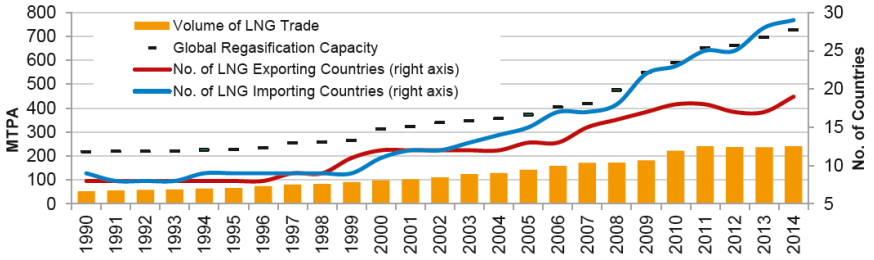

Fig. 1. LNG Trade volumes from 1994 to 2014 [1].

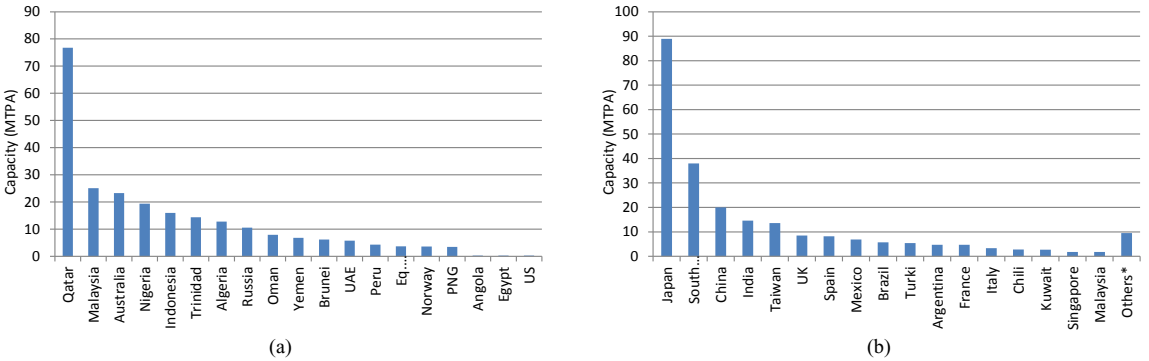

Fig. 2. Countries in 2014 (a) LNG Imports; (b) LNG Exports (adapted from [1]).

*where "Other" includes Belgium, Canada, the Dominican Republic, Greece, Israel, Lithuania, the Netherlands, Portugal, Puerto Rico, Thailand, the UAE and the US

Christiansen *et al.* [3] reviewed research on ship routing and scheduling and provided four basic models. Dinwoodie *et al.* [4] studied to synthesize maritime specialists' perceptions of changing patterns of maritime oil freight flows to 2050. Lin & Tsai [5] developed a model for carriers provide daily pickup and delivery service to customers at major ports along the Pacific Rim. They investigate the ship routing and freight assignment problem for daily frequency operation of liner shipping. Halvorsen-Weare & Fagerholt [6] studied a real-life ship routing and scheduling problem from the LNG business, with both inventory and berth capacity constraints at the liquefaction port. Maxwell and Zhu [7] examined the empirical relationship between U.S. LNG imports, the Henry Hub price of natural gas relative to U.K. and Asia gas prices, and a proxy for LNG transportation costs using monthly data from 1997 to 2007. Biresselioglu *et al.* [8] developed a mathematical model for Turkey's future LNG supply security strategy. They formulate and solve a mixed integer programming model that determines the optimal sourcing strategy for Turkey's increasing LNG demand. Their model demonstrates a number of alternative policy options for LNG supply. However, none of these models can be used for calculating the optimum sourcing strategy for other countries who want to buy LNG with a minimal cost from the international market places. Therefore, the primary objective of the research is to develop a computational model to determine the suitable exporting ports for minimum transportation cost for a given import location in a country. In this study, the global shipment model by sea routing has been implemented. A typical LNG transportation network is illustrated in Fig. 3.