Transport Policy 40 (2015) 36–48

Contents lists available at ScienceDirect

Transport Policy

journal homepage: www.elsevier.com/locate/tranpol

Investigating infrastructure, superstructure, operating and financial efficiency in the management of Turkish seaports using data envelopment analysis

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ARTICLE INFO

Article history:
Received 21 July 2014
Received in revised form
6 February 2015
Accepted 24 February 2015
Available online 13 March 2015

Keywords:
Turkish
Seaport
Efficiency
Data envelopment analysis

ABSTRACT

The purpose of this study is to measure the management performance of thirteen Turkish seaports by undertaking the simultaneous investigation of four dimensions of management performance, namely, infrastructure, superstructure, operating and financial efficiencies. Based on their pure technical and scale efficiency scores, short and long term managerial implications were provided. Results show that low labor productivity and high expenses are the major sources of inefficiency of Turkish seaports. Public seaports exhibit better performance in infrastructure efficiency, whereas private seaports are superior in superstructure, operating and financial efficiency. While private seaports suffer from inappropriate scale size, public seaports suffer from managerial incompetency.

1. Introduction

Almost 80% of the total global trade volume is facilitated by ocean transportation (Shan et al., 2014). Dependence on ocean transportation makes seaports vital links in the overall trading chain and thus their performance has an important impact on the economy of the host port city (Shan et al., 2014), development of domestic and international trade of countries (Onut et al., 2011; Steven and Corsi, 2012; Zeng and Negenborn, 2014) and nations' competitiveness (Tongzon, 1995).

The current study concentrates on the investigation of managerial performances of a number of Turkish seaports. Turkey is a contiguous transcontinental country and located between Asia and Europe. Its larger part is in Western Asia and the smaller part is in Southeastern Europe. This geopolitical position makes Turkey a strategic linkage between two continents. In addition to its strategic location, Turkey, which is a peninsula, has a coastline of approximately 8300 km and it is surrounded by four seas, the Black Sea (to the north of Turkey), the Sea of Marmara (an inland sea within the Marmara region and connects Black Sea and Aegean), the Aegean Sea (to the west of Turkey) and the Mediterranean Sea (to the south of Turkey) (see Fig. 1). Furhermore, Turkey has two strategic straits; the Dardanelles and Bosphorus which separate Europe and Asia. These straits play an important role in the geopolitical, geographical and strategical situation of Turkey (Yercan, 1998).

Depending on its geographical position, Turkish shipping has been one of the most significant industries in Turkey with a direct impact upon the economy (Yercan, 1998). Today, 174 private, public, municipal and affiliated owned ports are operating in Turkey (Oral et al., 2007). Along with the increasing foreign trade volume in recent years, ocean transportation constitutes a major component of the Turkish economy accounting for approximately 90% of the nation's foreign trade. Furthermore, Turkey has more than 29 million DWT (deadweight tonnage) and is the 13th rank in the world as of the end of 2013 (UNCTAD, 2013).

In spite of these improvements in shipping industry and its geographical advantages, various academic researches indicate the poor management of Turkish seaports which negatively affects the efficiency of Turkish seaports in relation to their international counterparts (Akarsu and Kumar, 2002). Seaport inefficiencies have direct negative impacts on the overall efficiency of the movement of goods and result with higher costs for all parts of international trade (Steven and Corsi, 2012). As Wu and Goh. (2010) demonstrated Turkish seaports performed at a weak efficiency level (0.34 under DEA-CRS and 0.39 under DEA-VRS) compared to a number of emerging and more advanced countries. Similarly, Cullinane and Wang. (2006) put forward the inefficiencies of a number of Turkish seaports, namely Haydarpasa (0.20), Izmir (0.71) and Kumport (0.39) compared to several container seaports across the world.

As Oral et al. (2007) noted Turkish seaports have insufficient capacity in terms of infrastructure, superstructure, equipment, etc.

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http://dx.doi.org/10.1016/j.tranpol.2015.02.006
0967-070X/

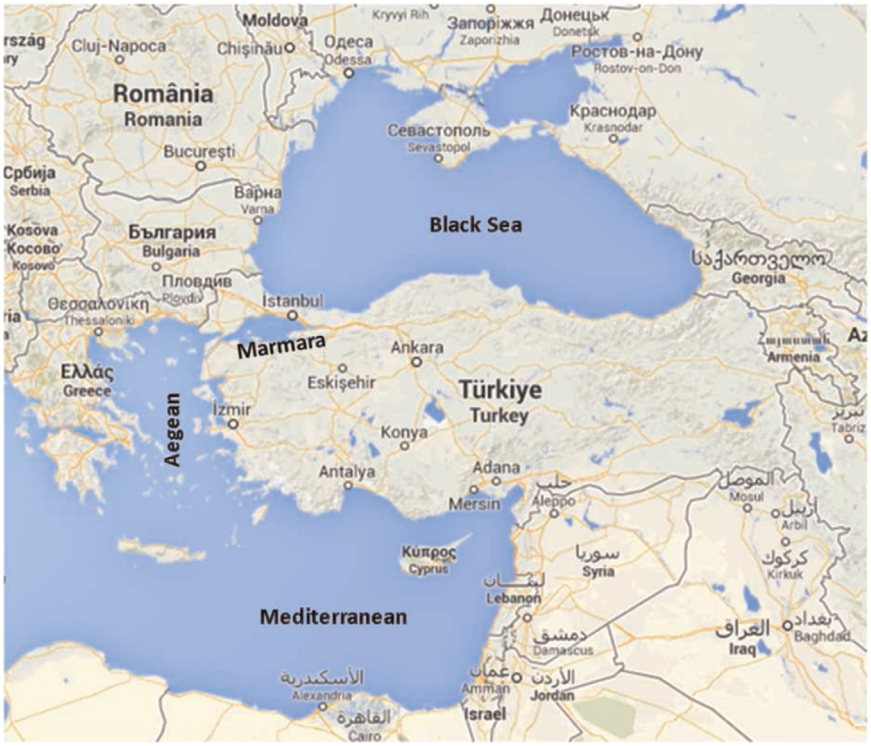

Fig. 1. Seas of Turkey.

for transit cargo. This situation weakens their competitiveness compared to the regional seaports. Demirel et al. (2012) supported this assertion with an empirical study which was conducted in the Eastern Mediterranean region. Based on the results, they revealed the inefficiencies in several Turkish seaports and demonstrated that Turkey's container ports are generally less efficient than the regional average.

In this study, the researcher aimed to estimate the overall efficiency and evaluate the various aspects of managerial performances (namely, infrastructure, superstructure, operating and financial) of a number of Turkish seaports and provide some insights and suggestions to decision makers to improve their efficiencies. Once the efficiency scores were obtained, various managerial implications were provided for seaports based on their pure technical and scale efficiency scores.

The paper is organized as follows. In the following section, a brief introduction to port efficiency measurement literature is presented. Section 3 outlines the methodology of the research. The data set is introduced at Section 4. Empirical results (including the efficiency analysis, managerial implications, comparison of the managerial performances of private and public ports and sensitivity analysis) are presented in Section 5, and finally, in the last section, a summary and the conclusions are presented.

2. Literature review

Due to its vital role in the overall trading chain and economy, economic and operational issues of seaports have attracted much attention from transportation and logistics scholars. As Odeck and Brathen (2012) noted, the increasing rate of seaborne trade has led researchers to investigate whether the seaports are managed efficiently. In literature, most researchers tend to estimate the overall efficiency of seaports which gathers two or more efficiency dimensions in an aggregated model. Overall efficiency is a combination of two or more efficiency types and consists of various efficiency aspects like infrastructure, superstructure, operating and financial efficiency. As can be seen from Table 1, most seaport efficiency models consist of multiple objectives rather than a single objective. Although Liu (1995), Martinez-Budria et al. (1999) and Valentine and Gray (2001) evaluated seaports with only financial indicators, most studies in literature have included various input factors that represent different performance dimensions. Roll and Hayuth (1993), for example, proposed a model which includes both operating and financial variables. Similarly, Coto-Millan et al. (2000), Cullinane and Song (2003), Barros and Athanassiou (2004) and Barros (2006) considered both operating and financial inputs in an aggregated model. Estache et al. (2004) considered both infrastructure and operating variables in an aggregated model. Tongzon (2001), Itoh (2002) and Tongzon and Heng (2005), on the other hand, incorporated operating, infrastructure and superstructure related input factors and evaluated them in a single model. Additionally, a number of recent studies have focused on the assessment of seaports' efficiency with an input combination of infrastructure and superstructure indicators (Cullinane et al., 2002; Wang et al., 2003; Cullinane et al., 2005a; Cullinane et al., 2005b; Cullinane et al., 2006; Al-Eraqi et al., 2008; Cullinane and Wang, 2010; Wu and Goh, 2010; Hung et al., 2010, Cheon et al., 2010, Medda and Liu, 2013; Schoyen and Odeck, 2013).

Referring to this background, four types of efficiencies in seaport literature were determined; infrastructure efficiency, superstructure efficiency, operating efficiency and financial efficiency.

(1) *Infrastructure efficiency* concerns land utilization and measures whether or not terminal land is used efficiently. An infrastructure efficiency model includes unmovable inputs which are related with port property such as terminal area, terminal length, quay length, berth length, number of berth, yard space etc.
(2) *Superstructure efficiency* concerns equipment utilization and considers the effective use of terminal equipment.