

CONCEPTUAL MODEL FOR ANALYSING THE OPERATIONAL PERFORMANCE OF INDIAN CONTAINER TERMINALS

ABSTRACT

Indian container terminals handle 2% (17 million TEUs as of 2021) of the total global container throughput with two terminals listed among the top 100 world container terminals. Various international container ports such as Singapore, Hong Kong container ports handle more than the entire container traffic handled by Indian container terminals. With the advent of Government of India initiatives such as Sagarmala, Unnati project, etc., container terminals are expected to improve their key performance indicators, thereby enhancing operational performance. In the upcoming years, the container terminals in India can attain more substantial throughput targets by exploiting their untapped potential of throughput. As per the Maritime India vision 2030, the Indian container terminals are expected to handle 25 million TEUs by 2025. There is a requirement for huge scope of improvement in its operational performance for the Indian container terminals. Despite the number of studies on the competition, and performance related aspects of container terminals, most studies are of developed nations, and very few are of developing nations, such as India. Indian container ports are very critical due to their location advantage and their ability to handle transshipment traffic. There is a need to understand their market structure and performance at the micro-level, specifically the terminal level rather than that of the whole port.

Numerous factors may affect the existing terminals' ability to perform to their maximum capability. Despite the significance of the factors, no studies are available on the identification of the factors and their influence on the operational performance of the container terminals in India. Therefore, it is critical to identify the enabling and inhibiting factors and develop a conceptual model that indicates how their relationships affect the

operational performance of the container terminals in India.

This study analyses the concentration and deconcentration tendencies of the container terminals of India through empirical analysis, utilising concentration ratios, Herfindahl Hirschman Index (HHI) and the share-shift analysis (SSA) over the period of 2014–2020. Further, the study examines the development of Indian container terminals over the same period. The growth share matrix was plotted to bifurcate the terminals based on their market share and growth rate. The results indicated a deconcentration trend over the period of six years among the container terminals of India. The HHI index has reduced by over 37% in the six-year period considered, indicating that the market is moving towards perfect competitiveness, thereby increasing the scope for the development of new terminals. There were nine container terminals which demonstrated positive shift over the period of six years. The Adani International Container terminal (AICT) and Chennai International Container terminal (CIT) emerged as the star performers in terms of the growth share matrix over the considered period. Competitive positioning of each of the container terminals were presented. This study is the first of its kind related to the Indian container terminals.

To bifurcate into high and low performing terminals, this study evaluates the performance of container terminals using data envelopment analysis and Malmquist productivity index. Based on the analysis, there were two container terminals namely APM Terminals Mumbai, and the Bharat Kolkata container terminal which were consistently efficient over the period of six years. Reasons for inefficiency for each of the container terminal was presented and it was inferred that scale inefficiency was prominently increasing in the Indian container terminals. It was observed that there is a decline in the operational performance of the container terminals located along the West Coast than that of terminals located along the East Coast. Decline in the operational performance of container terminals operated under major ports was observed when compared to the terminals under non major

ports. Based on the Malmquist index, there were five container terminals, namely Kattupalli International Container Terminal, the Adani Mundra Container Terminal, the Adani Hazira Container Terminal, APM terminals Mumbai, and the Visakha Container Terminal, which were categorised under high performing. The low performing terminals were the Dakshin Bharat Gateway Terminal, the Adani International Container Terminal, Jawaharlal Nehru Port Container Terminal, Tuticorin container terminal and Bharat Kolkata Container terminal. Malmquist index and net shift of each of the container terminals were plotted to identify the high performing terminals with a gain in the market share over the period of six years. There were six container terminals namely Visakha Container Terminal, Vallarpadam International Container Transshipment Terminal, Haldia International Container Terminal, Adani Hazira Container terminal, Krishnapatnam Port Container Terminal, and Kattupalli International Container Terminal which gained the market share over the period of six years and were high performing. The analysis inferred that there is a need to identify the factors affecting the operational performance of container terminals of India.

Grounded theory was utilised to identify twenty-one codes as enabler attributes and were classified under six concepts categorized as enabling factors. Fifteen codes were regarded as inhibitor attributes grouped under three concepts categorized as inhibiting factors. Seven codes were regarded as performance indicators classified under performance factors. These identified attributes were grouped using exploratory factor analysis based on 81 responses obtained from 26 container terminals of India. The analysis yielded five enabling factors namely *infrastructure upgrading and system initiatives, terminal facilities and policy, reefer systems and logistics advantage, concessions and cost initiatives, and systems and processes*, three inhibiting factors namely *management and resource related issues, infrastructure issues and market capture, and policy and procedure related issues* and two performance factors namely *handling and storage related indicators and berth and vessel related indicators*.

Hypothesis based on the relationships were established along with a conceptual model. The model was tested using partial least squares structural equation modeling approach. This study yielded a conceptual model consisting of five enabling factors with fifteen enabler attributes, three inhibiting factors with twelve inhibitor attributes and two performance factors with seven performance indicators. The enabling factor titled *infrastructure upgrading and system initiatives* emerged as critical enabling factor with attribute titled *adoption of modern container handling equipment* as the critical attribute. The inhibiting factor titled *management, and resource-related issues* emerged as the critical inhibiting factor with attribute titled *management corruption* emerged as the critical attribute.

Conceptual model was validated using qualitative comparative analysis to understand the combined and interactive effects of three sets of conditions namely the physical characteristics, enabling factors, and inhibiting factors to the operational performance of container terminals. The results indicated that the considered conditions combinedly affect the operational performance. The most commonly occurring conditions identified in the study were *quay infrastructure, yard infrastructure, infrastructure upgradation and system initiatives, reefer systems and logistics advantage*. A conceptual model encompassing all the successful combinations of the conditions was presented in the research.

The outcomes of the study would enable the port authorities, private players, and the port operators to understand the market they are operating in and the strategies to devise for the purpose of improvement of the terminals. This research shall help the port authorities to adopt enabling factors and mitigate the inhibitor factors to improve the operational performance of container terminals. This research and can support the decision makers in improving the operational performance of container terminals by adoption of the supporting conditions identified in the study. This study may help port professionals and port operators incorporate these factors and improve the operational performance of container terminals.

Furthermore, this study contributes to the minimal literature available on the factors influencing the performance of Indian container terminals and adds to the existing literature on Indian container terminals' performance