**Abstract**

Over the past few years, the expansion of seaports has swelled rapidly and as a result, operational efficiency in container terminals has become very essential. This increase in container terminals has resulted in huge global container traffic which led to an upsurge in carbon emission of vessels and quay cranes and drastic deterioration of global climatic conditions. This paper aims to give a comprehensive account on the integrated planning decisions of Dynamic Berth allocation problem (DBAP) in which a continuous berth is considered, Yard Assignment problem with carbon emission considerations during port operations, handling operations and sea operations. A multi-programming non-linear model has been constructed to minimise handling (loading/ unloading) operations, waiting time cost at the anchorage, demurrage costs, costs incurred due to the deviation in preferred position of vessels, carbon taxation costs. This also determines berthing times and positions for each incoming vessel, speed with which a vessel should travel in order to reduce the fuel consumption. The model has been solved using meta-heuristics such as particle swarm optimization (PSO), advanced PSO, shuffled complex evolution (SCE), shuffled frog leaping algorithm (SFLE) and compared in a large-scale.

The significance in operational efficiency of maritime transportation with an increased complexity regarding terminal management operations has become very crucial as its role in the global trading system has become increasingly important over the last decades. The expansion of container terminals has resulted in huge global container traffic which led to an upsurge in carbon emission of vessels and quay cranes. A carbon emission tax has been imposed on seaports by the International Maritime Organization (IMO) which would concern the port operators to downturn carbon emission. This paper aims to give a comprehensive account on the integrated planning decisions of Dynamic Berth allocation problem (DBAP) in which a continuous berth is considered and Yard Assignment problem with carbon emission considerations during port operations, handling operations and sea operations. Multi-programming non-linear model has been constructed to minimise handling (loading/ unloading) operations, waiting time cost at the anchorage, demurrage costs, costs incurred due to the deviation in preferred position of vessels and carbon taxation costs. This also determines best berthing times and positions for each incoming vessel and speed with which a vessel should travel in order to reduce the fuel consumption. As DBAP is a Np-Hard problem, some meta-heuristic algorithms such as particle swarm optimization (PSO), advanced PSO (APSO), shuffled complex evolution (SCE), shuffled frog leaping algorithm (SFLE) are suggested for solving the model. Numerical experiments are performed to validate the effectiveness of the proposed model and the efficiency of the proposed solution algorithm. The computational experiments compare the robust formulated model with all the four meta-heuristic approaches in computational time and feasible solution. Sensitivity analyses has also been validated to evaluate the robust nature of the solution. This study finds a method that can derive a near optimal solution in a fast way.

Some meta-heuristic algorithms are suggested for solving the models. Numerical experiments are performed to validate the effectiveness of the proposed models and the efficiency of the proposed solution algorithms. The experiments also compare the above stochastic programming formulation and the robust formulation models, as well as evaluate their potential benefits in practice. This study finds that the robust method can derive a near optimal solution to the stochastic model in a fast way, and also has the benefit of limiting the worst-case outcome of the tactical BAP decisions.

The International Maritime Organization (IMO) has proposed to impose carbon emission tax on ports in the long-term, which would definitely enhance the willingness of ports to reduce the carbon emission.

This is now a mature field which is now being spun out into commercial applications

an increased complexity with regard to terminal management operations

as its role in the global trading system has become increasingly important over the last decades.