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Science in Traffic and Transport
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THE OPERATIONAL PLANNING MODEL OF TRANSHIPMENT PROCESSES IN THE PORT

ABSTRACT

Modelling of a traffic system refers to the efficiency of operations for establishing successful business performance by examining the possibilities for its improvement. The main purpose of each container terminal is to ensure continuity and dynamics of the flow of containers. The objective of this paper is to present a method for determining the amount of certain types of containers that can be transhipped at each berth, with the proper cargo handling, taking into account minimum total costs of transshipment. The mathematical model of planning the transshipment and transportation of containers at the terminal is presented. The optimal solution, obtained with the method of linear programming, represents a plan for container deployment that will ensure effective ongoing process of transshipment, providing the lowest transshipment costs. The proposed model, tested in the port of Rijeka, should be the basis for making adequate business decisions in the operational planning of the container terminal.

KEY WORDS

operational planning; transshipment processes; optimal plan of container transshipment;

1. INTRODUCTION

An increased competition between seaports, especially between geographically close ones is a result of development of the container traffic, that imposes the necessity of better quality process for handling and storage of containers and impeccable organization of tasks at container terminals. The container terminal is a dynamic, open system with stochastic and unpredictable external factors. For this reason, systematic approach is required in the process of planning. The terminal should elaborate a plan for the process of container transshipment. The oscillations of transshipment of goods in ports are conditioned by unequal arrival of container ships and uneven duration of operations with containers. Due to unevenness of container traffic, the efficient planning for transshipment of container operations is recommended for shorter periods of time, not for longer terms (e.g. a year). This type of planning is considered as operational planning that

comprises the plan of taking over operations, layout of human resources and means necessary to perform these chores.

The problem is defined by two types of cargo loaded on two different berths of the container terminal. Three different modes of cargo handling have been applied.

The basic objective of this paper is to show the efficient way of organizing the transshipment process. In other words, to determine the quantity of certain type of cargo being transhipped at each berth and in the appropriate way. This will be conducted in the observed period of time, providing the lowest possible transshipment costs. The need for optimization using methods of operations research in container terminal operation has become more and more important. In order to accomplish this objective, a mathematical model is presented, so called multi-index transportation problem. The mentioned problem has been solved by applying the method of linear programming.

The optimal solution represents a plan for container deployment that will ensure effective ongoing process of transshipment at a port, taking into consideration the lowest possible costs. Based on the mentioned plan, it is possible to determine which means of transport is capacitated or has insufficient capacity. In operational planning, the application of the chosen model enables achieving the maximum of the mutual compatibility of adequate utilization of berths, port mechanization and employees of the terminal [1, 2].

One of the most important tasks for the successful operation of the container terminal is the selection of an appropriate process of transshipment and the type of transshipment means. The results here obtained can be a good base for decision-making in order to determine the optimal capacity of the necessary transshipment means. The model was tested at the port of Rijeka, taking into account the existing resources, available transshipment means and workers who participate in the process of transshipment.

There are many research papers in the observed field, primarily noted a survey of methods for

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Roberta S. Russell, Bernard W. Taylor



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Handbooks in Operations Research and Management Science: Transportation Cynthia Barnhart, Gilbert Laporte, 2006-12-08 This book contains eleven chapters describing some of the most recent methodological operations research developments in transportation. It is structured around the main transportation modes and each chapter is written by a group of well recognized researchers. Because of the major impact of operations research methods in the field of air transportation over the past forty years, it is befitting to open the book with a chapter on airline operations management. This book will prove useful to researchers, students, and practitioners in transportation and will stimulate further research in this rich and fascinating area. Volume 14 examines transport and its relationship with operations and management science. 11 chapters cover the most recent research developments in transportation. Focuses on main transportation modes: air travel, automobile, public transit, maritime transport, and more. *Operations Research Proceedings 2024* Lukas Glomb, 2025-09-12 This book contains a selection of peer-reviewed papers presented at the International Conference on Operations Research OR 2024 held at the Technical University of Munich, Germany, from September 3 to 6, 2024. Over 650 scientists from all over the world attended the OR 2024 in Munich. Three plenaries and nine semi-plenaries covered theoretical aspects of Operations Research applications and real-world practices. In addition, more than 500 presentations were held over three days in up to 23 parallel sessions. Covering a wide range of topics, the book highlights cutting-edge research and practical applications across various domains of modern operations research. It places a special emphasis on the theme Data Learning and Optimization, exploring how data-driven approaches, machine learning techniques, and optimization strategies are shaping decision-making processes and operational efficiency. The contributions in this book reflect the diversity and innovation in the field, making it a valuable resource for researchers, practitioners, and academics alike. **Operations Research** P. Mariappan, This book elucidates the basic concepts and applications of operations research. Written in a lucid, well-structured, and easy-to-understand language, the key topics are explained with adequate depth and self-explanatory flow charts. A wide range of solved examples and end-of-chapter exercises makes this book an ideal companion for active learners. **Research Techniques in Maritime Transportation** *Proceedings of the Third Symposium Convened by the Maritime Cargo Transportation Conference 13 May 1959, Washington, D.C.* National Research Council (U.S.), 1959 *Handbook of Transportation Science* Randolph Hall, 2006-04-11 Over the past thirty-five years, a substantial amount of theoretical and empirical scholarly research has been developed across the discipline domains of Transportation. This research has been synthesized into a systematic handbook that examines the scientific concepts, methods, and principles of this growing and evolving field. The Handbook of Transportation Science outlines the field of transportation as a scientific discipline that transcends transportation technology and methods. Whether by car, truck, airplane, or by a mode of transportation that has not yet been conceived, transportation obeys fundamental properties. The science of transportation defines these properties and

demonstrates how our knowledge of one mode of transportation can be used to explain the behavior of another Transportation scientists are motivated by the desire to explain spatial interactions that result in movement of people or objects from place to place Its methodologies draw from physics operations research probability and control theory

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Transportation systems consist not only of the physical and organizational elements that interact with each other to produce transportation opportunities but also of the demand that takes advantage of such opportunities to travel from one place to another This travel demand in turn is the result of interactions among the various economic and social activities located in a given area Mathematical models of transportation systems represent for a real or hypothetical transportation system the demand flows the functioning of the physical and organizational elements the interactions between them and their effects on the external world Mathematical models and the methods involved in their application to real large scale systems are thus fundamental tools for evaluating and/or designing actions affecting the physical elements e.g. a new railway and/or organizational components e.g. a new timetable of transportation systems This book discusses the mathematical models that are used to analyze transportation systems presenting them as the result of a limited number of general assumptions theory It also deals with the methods needed to make these models operational and with their application to transportation system project design and evaluation This field of knowledge is known as transportation systems engineering

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analysis and identify other key decision drivers Transportation network centrality describes the appearance of a network hence is crucial for network design Anne Paul develops a strategic approach to transportation network design by conceptualizing transportation network centrality and relating it to the performance and quality of transportation networks Consequently the concept of network centrality serves to support decisions in strategic network design A practical implementation of this approach is provided demonstrating its feasibility Potential readers include scholars and practitioners from logistics supply chain management and operational research with an interest in strategic transportation network design

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