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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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## **Solution Manual Operation Research Transshipment Model:**

**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. *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. *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. *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.

**Encyclopedia of Operations Management, The ; A Field Manual and Glossary of Operations Management Terms and Concepts** Arthur V. Hill, 2011-07-19 This is the perfect field manual for every supply chain or operations management practitioner and student. The field's only single-volume reference, it's uniquely convenient and uniquely affordable. With nearly 1,500 well-organized definitions, it can help students quickly map all areas of operations and supply chain management and prepare for case discussions, exams, and job interviews. For instructors, it serves as an invaluable desk reference and teaching aid that goes far beyond typical dictionaries. For working managers, it offers a shared language with

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*Defense Transportation: Algorithms, Models and Applications for the 21st Century* Robert T. Briggant, Jean Mahan, 2004-07-22 Defense Transportation Algorithms Models and Applications for the 21st Century contains papers divided into three general sections according to the title of this text algorithms models and applications The first section on algorithms contains papers that are theoretical in nature or contain new techniques that relate to Defense Transportation System DTS processes A sampling of the papers contained in this section deals with group theoretic tabu search techniques shortest path sailing distance algorithms and strategic airlift model validation methods The second section contains papers on various transportation models used throughout the DoD and transportation industry as well as some newly developed transportation modelling methods that may eventually find their way into larger scale transportation models A review of the major strategic mobility models is also contained in this section The third section contains papers on various transportation applications that have been used to support various DTS studies and analyses This section also contains a diverse set of topics with articles ranging from a paper on North Atlantic Treaty Organization NATO strategic lift requirements to an

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tools necessary to thrive in today's evolving global business environment

*Transportation Systems Analysis* Ennio Cascetta, 2009-08-22 Science is made of facts just as a house is made of bricks but a collection of facts is no more science than a pile of bricks is a house Henri Poincaré The aim of the disciplines of praxis is not theoretical knowledge It is to change the forms of action Aristotle 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 owns 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

*Computer-aided Systems in Public Transport* Mark Hickman, Pitu Mirchandani, Stefan Voß, 2008-01-23 This volume consists of selected papers presented at the Ninth International Conference on Computer Aided Scheduling of Public Transport Coverage includes the use of computer aided methods and operations research techniques to improve information management network and route planning vehicle and crew scheduling and rostering vehicle monitoring and management and practical experience with scheduling and public transport planning methods

*Report on the High Speed Ground Transportation Act* United States. Department of Transportation, *PRODUCTION AND OPERATIONS MANAGEMENT, SECOND EDITION* KHANNA R.B., 2015-06-01 This well balanced text with its fine blend of theory and applications gives an in depth understanding of production and operations management in an easy to understand style Employing an innovative approach the author shows how the use of modern advanced technology gives a boost to production processes and significantly helps production and operations management The book clearly demonstrates the use of special software packages to solve actual problems Retaining the original contents the book divided into six parts explains following in its second edition WHY Necessity of production and operations management WHAT Product service design product quality and other issues HOW Process design and related issues WHERE Plant location layout and capacity WHEN Planning and control of production operations WHO Human relations issues that affect production and operations Key features Learning objectives at the beginning of each chapter enable readers to focus on important points of a chapter A concept quiz at the end of each chapter helps the reader to evaluate his understanding of the concepts explained in a chapter Numerous solved examples

and answers to all chapter end numerical problems have been provided Covers Service Operations in almost every chapter in addition to the traditional manufacturing operations A section with 10 progressive short case studies gives real world experience Chapter end summary helps readers to review and recapitulate the key concepts The students of management and engineering mechanical production and industrial engineering will be benefited with the book An instructor manual containing PowerPoint slides and solutions to chapter end problems is available The book is recommended by AICTE for PGDM course The link is [www.aicte-india.org/modelsyllabus.php](http://www.aicte-india.org/modelsyllabus.php)

### **Centrality in Strategic Transportation Network**

**Design** Anne Lange, 2019-03-01 Efficient and effective transportation networks are backbones to modern societies Methodologically their design has mainly been driven by optimization approaches oftentimes with a strong cost focus Their strategic planning however should go beyond detailed cost 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 *Scientific and Technical Aerospace Reports*, 1985

## **Solution Manual Operation Research Transshipment Model** Book Review: Unveiling the Magic of Language

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