Lecture Notes in Economics
and Mathematical Systems

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Logistics management is concerned with the design and control of efficient and cost-effective flows of material and information through complex networks from point of origin to point of consumption. Increased international competition and an increased need of quickly confirming to customer requirements despite longer distances for distribution and a growing product variety stresses the importance of distribution logistics, that part of logistics management responsible for delivering products to customers at the right place at the right time in the right condition for the right cost. Physical distribution is just a part of the supply chain. Effective distribution management is, however, impossible without taking the strong links to procurement and production as well as the interrelations between other logistic processes and parties involved in the supply chain into account. Therefore, there is no clear-cut dividing line between logistics in general, distribution logistics and supply chain management.

Interest in logistics and supply chain management, both in industry and in academia, has grown rapidly over the past years. On the one hand, this trend is due to the enormous potentials in improving logistics efficiency exploitable by means of intelligent planning techniques and improved coordination of logistic processes. On the other hand, this trend is caused by the development of information and communication systems that are able to provide access to comprehensive data from all components of the supply chain. Vendors of supply chain management software are going to add “business intelligence” components to their systems, which not only allow to access, share and transfer data in the supply chain but also to utilize this information in order to improve decision making with the help of decision-support systems. Such systems heavily rely on quantitative models and techniques developed in the field of Operations Research in the last decades. Today, there is no doubt of the importance of quantitative techniques in our modern business environment. Fortunately, advances in quantitative models and methods and in their applicability to practical logistic problems are still achieved. Trends like e-commerce, the globalization of markets and the need of integrating reverse flows in the supply chain add to the growing complexity of logistic networks and require even more effective models and algorithmic tools. The papers collected in this book contribute to some of these new developments in quantitative approaches to distribution logistics and supply chain management.
The main orientation of the book is not towards the theory underlying the employed methods but towards practical problem solving.

The volume in hand continues a series of books, which are the outcome of the work of a group of researchers who have met at a number of “International Workshops on Distribution Logistics (IWDL)” since 1994. This book includes reviewed papers that were presented and discussed during IWDL 5, at Fontainebleau (France) in October 1999, and during IWDL 6 at St. Gallen (Switzerland) in February 2001.

We have organized the 22 papers in seven Chapters. The first three chapters address general issues in supply chain management, in the relatively new field of reverse logistics as well as new challenges to distribution logistics caused by the evolution of e-commerce. The other four chapters deal with main functions of distribution logistics: strategic and tactical planning of distribution networks; operational, tactical as well as strategic problems related to vehicle routing and transportation; tactical and operational issues internal to the production center or the warehouse; and finally inventory problems.

Chapter 1 is concerned with various important topics in the field of supply chain management. The paper by Vis and Roodbergen first introduces basic supply chain concepts and afterwards analyses the impact of various trends on supply chain performance. The importance of cycle time reductions, the influence of reverse logistics, e-commerce, third party logistics and global logistics and the resulting threats and opportunities are analysed by means of a number of case studies. In his contribution, Blackburn outlines a methodology for valuing response time in supply chains. Using results of inventory theory, he establishes important properties of the marginal value of time, which are at first sight astonishing: Firstly, the marginal value of time increases with decreasing response time. Secondly, for equal response times, the marginal value of time is greater at non-optimal inventory levels than at the optimum. The paper of Fjell and Jernsten concludes Chapter 1. They study the important question, how coordination between supply chain partners can be achieved by means of pricing mechanisms, which result in a locally rational behaviour that is also efficient from a global perspective. They propose a novel negotiated two-part tariff scheme and argue that this pricing mechanism is a good means to achieve channel coordination.

Chapter 2 exclusively addresses managerial problems and solution methods in the field of reverse logistics. Over the past years, environmental problems have reinforced public interest in reuse and recycling. Take-back and recovery of used products leads to additional goods flows from the user back to the producer. Reverse logistics is concerned with the management of these opposite flows. Since product recovery affects product design, procurement, production and forward distribution, the challenge is to integrate forward and return flows and to obtain integral closed-loop supply chains. Guide and Van Wassenhove give an overview of the field of closed-loop supply chains. They summarize various cases of reused products, elaborate the differences between
branches and elicit main managerial problems and success factors. Furthermore, important research issues in remanufacturing are pointed out. The paper by Krikke, Pappis, Tsoulfas and Bloemhof-Ruwaard gives an overview of design principles of reverse logistics, which extend the scope and applicability of design rules for forward supply chains to reverse supply chains. The presented principles are applied in a case study and may provide a checklist for improving closed-loop logistic systems. Mazzarino, Pesenti and Ukovich consider logistic system optimization for a reverse logistic case. In contrast to traditional approaches, they propose, however, a multi-agent approach, which takes actors' behaviour and multiple decision makers into account. The paper by Gotzel and Inderfurth examines an extended MRP approach, material requirements and recovery planning (MRRP), for production control in a system with external stochastic return flows and stochastic demand. They show that the application of MRRP leads to near-optimal results. Bloemhof, van Nunen, Vroom, van der Linden and Kraal describe a practical reverse logistic problem that emerged at a dairy producer in the The Netherlands. A cost evaluation tool based on scenario analysis for selecting between different packaging systems is developed. In addition to traditional costs, environmental costs and aspects are also taken into account.

Chapter 3 addresses the influence of e-commerce on distribution logistics. The papers in this chapter describe threads, opportunities and new problems that have to be solved in order to cope with the challenges resulting from the evolution of e-commerce. The paper by de Koster is concerned with the question of how to organize logistic fulfilment processes in a BtC e-commerce environment. Different alternatives for designing effective distribution structures are pointed out and a model relating a company's objectives to characteristics and choices in distribution is presented. The need of quickly responding to diverse customer needs in BtC e-commerce raises the complexity of delivery processes and timely delivery gets more difficult. Daduna discusses this problem and proposes a heuristic method for solving routing problems with tight time windows that arise in electronic retail trade. The spread of the Internet has also significantly increased the use of Internet auctions for exchanging goods among and between individuals and companies. Bjørndal and Jørnsten consider combinatorial auctions where bidders bid on bundles of items and where the value of an object to a participant depends on what other objects the participant acquires. Bjørndal and Jørnsten employ sensitivity analysis and linear programming duality in order to solve the pricing problem and to derive a feedback mechanism providing information to bidders that may give the bidders incentive to change their bids.

Chapter 4 treats strategic planning of distribution networks as well as allocation problems arising in tactical network planning. The paper by Bauer discusses practical problems of data gathering, data validation and insufficient data quality in distribution system design and gives hints on possible solutions elaborated on two case studies. The paper by Romeijn and Morales considers the problem of assigning plants to warehouses and customers to
warehouses in a multi-level distribution network with time-varying demands. They present a mixed-integer model for the minimization of transportation, production and handling costs, and derive an effective greedy heuristic for solving the model. Klose and Drexl describe assignment type optimisation problems arising in logistic system analysis and propose a solution method based on problem partitioning and column generation.

The topic of Chapter 5 is transportation planning and vehicle routing. The paper by Angelelli and Mansini deals with a vehicle routing problem with time windows and simultaneous pick-up and delivery. A branch-and-price algorithm for computing optimal solutions is proposed. Angelelli and Speranza apply a vehicle routing model to estimate the operational costs of different waste collection systems and to support decision making regarding the type of system to adopt. Although vehicle routing is usually treated as an operational or tactical issue, the determination of efficient vehicle routes can be a strategic problem if stable routes are required. Dillmann summarizes the experiences made when solving a large number of strategic vehicle routing problems for press wholesalers. He addresses important practical problems related to data measurement, data validation and model building in the presence of soft constraints and multiple objectives. For solving large-scale vehicle routing problems a dialog-based procedure is proposed. Furthermore, it is shown how the implementation of computed routes in practice can be supported.

Chapter 6 is concerned with tactical and operational issues of warehousing. The paper by Chevalier, Pochet and Talbot presents analytical results from queuing theory for estimating the number of vehicles needed in an automated material handling system. The model can provide a methodology for designing automated guided vehicle systems and is validated by means of simulation. De Koster and van der Meer compare the performance of on-line and off-line rules for dispatching vehicles in internal transport systems. The authors show that for different layouts of the transportation system off-line optimisation attains high performance if the system is relatively idle; however, in high throughput environments the proposed on-line dispatching rules attain high performance.

Finally, Chapter 7 addresses topics in inventory control. Laan and Teunter compare average cost models with approaches based on the net present value for single-source, multi-source, multi-stage inventory systems and for a system with remanufacturing and disposal. The authors show in particular that for complex inventory systems there is a considerable performance gap between the widely used average cost and the net present value approach. The paper by Wagner treats the problem of determining safety stocks in capacitated single-stage multi-product production-inventory systems. Simple schemes for calculating safety stock levels are proposed and their reliability shown by means of simulation experiments. The paper by Smits and de Kok considers the impact of freight consolidation policies on the lead time, which influences inventory requirements. The authors derive approximations for the
lead time behaviour where items are consolidated according to different types of consolidation policies.

Unfortunately, a tragic event overshadowed the making of this book. In September 2001, one of the authors, Roland Dillmann, died unexpectedly and far too early in the age of 56 years. Roland Dillmann was professor for mathematical methods in Economics at the University of Wuppertal from 1975 until his death. He taught Economics, Statistics, Econometrics and Operations Research. Furthermore, he was engaged in the administration of the faculty and acted successfully for a long time as consultant for press wholesalers in fields like transportation planning and demand forecasting. We have not only lost an excellent researcher with an extremely broad knowledge but also a very good friend. We are grateful to Simon Görtz, University of Wuppertal, and Thomas Bieding, Dillmann&Co GmbH, for their help in reediting parts of Roland Dillmann’s paper that is published in this volume.

Acknowledgement

The editors would like to thank the authors of the papers for their contribution. All papers submitted for publication in this volume have been subject to a refereeing process and we are grateful to the referees whose work was essential to ensure a high quality level of this book.

Last, but not least, the editors are deeply indebted to Prof. Dr. Paul Stähly. Paul Stähly was professor for Operations Research at the University of St. Gallen from 1973 until his retirement in March 2001. Since the first “International Workshop on Distribution Logistics” in 1994, Paul Stähly was an active and leading member of our “IWDL group” who invested his energy in strengthening the cooperation between the group members. Furthermore, he was main organizer of the workshop in St. Gallen. Without his support, this workshop and thereby this book would not have been possible. Therefore, we would like to dedicate this book to Paul Stähly as a recognition for his merits for our “IWDL group”.

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