

# Preface

A configurable (hence also reconfigurable) system by definition can be redesigned and remodeled for specific applications for the new (or changed) environment, and upgraded rather than replaced. With a reconfigurable system, new products and processes can be introduced with considerably less expense and ramp-up time. Reconfiguration efficiency attributed to such systems can be achieved only by means of intelligent decision-making (i.e., use of system synthesis, analysis, and simulation). The supply chain for this system must also be configured, aided, and supported by information systems that enable all supply chain members to learn about these changes expeditiously and adjust their processes accordingly.

Supply chain management deals with complex interactions among supply chain members and decision-making problems. Whether to establish a supply chain configuration or reconfigure an existing supply chain is one of the major decisions to be made. Configuration defines the operating basis of the supply chain. Other managerial decisions are made using the elaborated configuration as input. Therefore, configuration decisions are subjected to particularly comprehensive evaluation, which in turn, requires utilization of a variety of models and tools. This book covers these models and tools with particular emphasis on model integration and combination.

The supply chain configuration problem in this book is perceived as determining which units (e.g., suppliers, plants) to include in the supply chain, their size and location, and establishing links among the units. In the wider sense, the configuration problem may also include designing and modifying supply chain control structures, information systems, and organizational structures. Such a focused approach allows for thorough coverage of problems, issues, and solutions such as configuration under demand uncertainty, impact of the supply chain power structure, and hybrid modeling.

Explicit focus on the configuration problem, in-depth coverage of configuration models, emphasis on model integration, and application of information modeling techniques in decision-making are distinguishing characteristics of this book.

The primary objectives of this book are:

- To establish a focused scope definition of the supply chain configuration problem.
- To develop a supply chain configuration framework supporting development of configuration models for specific cases.
- To discuss models and tools available for solving configuration problems.
- To emphasize the value of model integration to obtain comprehensive and robust configuration decisions.
- To propose solutions for supply chain configuration in the presence of stochastic and dynamic factors.
- To illustrate application of techniques discussed in applied studies.

An illustrative supply chain configuration case study is introduced in Chap. 2 of the book and is further elaborated in the subsequent chapters. The case study is used to exemplify utilization of various decision-making techniques discussed in the book.

## **Book Organization**

This book is divided into four parts, which are devoted to:

- Defining the supply chain configuration problem and identifying key issues.
- Describing solutions to various problems identified.
- Proposing technologies for enabling supply chain configuration.
- Discussing applied supply chain configuration problems.

The contents of the book are organized in a 16-chapter format as follows:

## **Part I. Supply Chain Configuration Problem and Issues**

### ***Chapter 1. Configuration***

This chapter describes the general nature of configuration. It talks about configurable (reconfigurable) systems, their need, focus, motivation, properties (or characteristics), and general issues and problems faced by configurable systems. Basically, this chapter is intended as an introduction to the “nature of configuration” before delving into the more specific supply chain configuration systems.

## ***Chapter 2. Scope of Supply Chain Configuration Problem***

Supply chain configuration is one of the principal supply chain management decisions. It has profound impact on other subsequent managerial decisions. This chapter aims to position supply chain configuration decisions as part of the overall supply chain management decision-making process and to define the scope of the configuration problem. The positioning is described by analyzing the typical sequence of decisions made in the supply chain environment: definition of strategic objectives → product selection → establishing the supply chain → strategic supply chain management → tactical supply chain management → operational supply chain management. The scope definition describes objectives of supply chain configuration, questions being answered, and parameters and costs involved. Alignment of configuration objectives with strategic objectives of enterprises involved in a supply chain, and the supply chain as a whole, is also analyzed.

## ***Chapter 3. Literature Review***

The supply chain configuration has been widely studied by both academicians and practitioners. This chapter reviews these studies and identifies common characteristics of the supply chain configuration problem. The existing research is categorized according to data used in decision-making and several criteria characterizing the decision-making problem and its environment. These criteria include the modeling approach used, application area, problem size, and others. Results of the literature review are used in defining focus areas of remaining chapters in the book.

## ***Chapter 4. Reconfigurable Supply Chains: An Integrated Framework***

The purpose of this chapter is to describe “reconfigurable supply chains,” their need, and their advantages. Then, we lay out an integrated framework for their implementation that maps problems and issues with suggested methods and techniques (either published in the literature or those laid out in later chapters). Basically, it lays the foundation for methodology in Chap. 5 and solutions described in Part II of the book.

## ***Chapter 5. Methodology for Supply Chain Configuration***

Supply chain configuration is a multiple-step process. This chapter identifies methodological steps involved in this process and provides guidelines for accomplishing these steps. The methodology relies on the integrated reconfiguration framework introduced in Chap. 4 and the methods used for performing various steps of the methodology are elaborated in Part II of the book.

## **Part II. Solutions**

### ***Chapter 6. Knowledge Management as the Basis of Crosscutting Problem-Solving Approaches***

The importance of this chapter is to highlight that solutions to supply chain configuration problems must integrate complex modeling and analysis techniques drawn from a host of disciplines, such as systems science, management science, decision sciences, operations research, systems engineering, industrial engineering, and information systems. A proper knowledge of management support to decision-making is required to handle such a cross-sectional approach. Taxonomical and ontological approaches to knowledge management are described.

### ***Chapter 7. Conceptual Modeling Approaches***

Information modeling is used to gain understanding about a decision-making problem, to formalize the decision-making problem, and to prepare input data for quantitative modeling. Enterprise modeling techniques representing complex organization using an interrelated set of modeling views are used for conceptualization purposes. Process modeling is used to gain understanding of a decision-modeling problem by describing entities involved and their interactions. Data modeling is used to describe decision variables, parameters, and constraints.

### ***Chapter 8. Mathematical Programming Approaches***

Mathematical programming is the most prominent tool used in supply chain configuration, specifically for establishing the supply chain network, because of its ability to deal with spatial issues effectively. This chapter presents the generic mixed-integer programming model used in configuration. Application of this

model, computational issues, and modifications of the generic model are also discussed. This chapter also briefly discusses nonlinear, dynamic, and stochastic programming formulations of the configuration problem.

## ***Chapter 9. Simulation Modeling and Hybrid Approaches***

Simulation models are used in evaluating supply chain configuration decisions because of their ability to represent the problem realistically and to capture a wide range of factors. They can also be applied to select the most appropriate configuration from a limited set of alternative configurations. This chapter describes the characteristic features of simulation models used in supply chain configuration. Issues of validation of simulation models in the context of supply chain configuration are raised. An approach for automated model building in the framework of integrated decision modeling is discussed.

The integrated application of mathematical and simulation models leads to hybrid modeling, combining optimization and simulation aims to inherit advantages and to avoid disadvantages. Application of hybrid modeling in supply chain configuration is described. Two important hybrid modeling approaches are described: (a) optimization and simulation models are used sequentially, where optimization is used to establish the configuration and simulation used for comprehensive evaluation of this configuration; and (b) simulation-based optimization procedures, where the optimization model receives input data from the simulation model at each iteration. An automated approach to building hybrid models on the basis of common data models is presented.

## **Part III. Technologies**

### ***Chapter 10. Information Technology Support for Configuration Problem Solving***

Information Technology (IT) has a major impact on supply chain configuration. IT services are used to find the most appropriate supply chain configuration (decision support), as well as to ensure operations of the established configuration (infrastructural support). The decision support side is implemented on the basis of the supply chain configuration conceptual model. The integrated supply chain configuration framework developed in Chap. 4 is implemented using an integrated supply chain configuration decision support system.

### ***Chapter 11. Data Integration Technologies***

Supply chain configuration problem-solving relies on availability of accurate data. The modern web and data mining technologies allow for accumulation and processing of vast amounts of data. The chapter describes the application of data integration technologies by bringing together data from heterogeneous sources and structuring these data in a way suitable for supply chain decision-making. It also illustrates possibilities for data driven supply chain configuration, if there is limited upfront structural information about the supply chain.

### ***Chapter 12. Mobile and Cloud Based Technologies***

Information processing velocity in supply chains has increased dramatically thanks in part to mobile and cloud based technologies. This chapter demonstrates that many modern supply chains are a combination of physical and virtual supply chain units. It proposes methods for evaluating the combined supply chains and introduces a new concept of cloud chains.

## **Part IV. Applications**

### ***Chapter 13. Application in Hi-Tech Electronics Industries***

Supply chain configuration decision-making techniques are applied in many different industries. This chapter is one of the three chapters discussing supply chain configuration applications. It follows the supply chain configuration methodology and investigates supply chain configuration challenges at a contract manufacturing company, manufacturing electronic circuits and boards. The supply reliability is the main challenge explored in this case study.

### ***Chapter 14. Application in ICT Distribution***

The supply chain configuration methodology is also applied to study a case of an ICT Wholesaler and Distribution company. The main challenge analyzed is finding an appropriate configuration when entering a new market. Configuration decisions involve selection of the appropriate delivery contracts.

## ***Chapter 15. Application in Health Care***

Health care supply chains have a lot of potential for their continuous improvement, especially in the light of cost pressures. This chapter analyzes opportunities for applying supply chain management best practices in the health care industry. An e-health care supply chain model is discussed and an example of the hospital laboratory supply chain is investigated.

## ***Chapter 16. Future Research Directions in Supply Chain Configuration Problem***

The concluding chapter, which lays out the agenda of future research directions for the field as seen by the authors, is presented.

## **Changes in the Second Edition**

The second edition has been largely rewritten. Although the flavor of earlier edition has been retained, added emphasis has been placed on the most recent theoretical developments and empirical findings in the areas of supply chain management and related topics.

Chapter 9 “Simulation Modeling Approaches” and Chap. 10 “Hybrid Approaches” in the first edition have been combined into Chap. 9 “Simulation Modeling and Hybrid Approaches” in the second edition, where techniques for simultaneous and integrated application of simulation and optimization approaches have been described.

A new part (Part III: Technologies) has been introduced whose focus is to introduce readers to various technologies being utilized for supply chain configuration. Chapter 11 “Information Technology Support for Configuration Problem Solving” in the first edition has been moved as Chapter 10 of this part in the second edition. In addition, this part has two new chapters: Chap. 11 “Data Integration Technologies” and Chap. 12 “Mobile and Cloud Based Technologies.”

Part III: Applications in the first edition has been renumbered as Part IV. In addition, this section has been entirely rewritten with applications in hi-tech industries, ICT distribution, and health care described in Chaps. 13, 14, and 15, respectively.

Finally, various illustrations and references have been updated to reflect the current state of the art in research, throughout the new edition.

## Target Audience

The book is targeted to a broad range of professionals involved in supply chain management. It is modularly structured to appeal to audiences seeking a discussion of theoretical and qualitative supply chain configuration problems or a description of more technical quantitative and computational problems, as well as those interested in applied supply chain configuration problems.

The main target group is graduate students in industrial engineering, systems engineering, management science, decision analysis, logistics management, operations management and applied operations research, and practitioners and researchers working in fields of supply chain management and operations management who aim to combine mathematical aspects of problem-solving with the use of modern information technology solutions.

*Professional/technical readers.* This category includes research directors, research associates, and institutions involved in both the design and implementation of logistics systems in manufacturing and service-related projects. Examples include the National Center for Manufacturing Sciences and the Southwest Research Institute.

Managers, product and process engineers, logistics coordinators, and production planners within the product design, manufacturing, and logistics departments of various companies will also find the book a useful resource.

*Academic readers.* Professors and research associates within universities and colleges in industrial engineering, manufacturing engineering, mechanical engineering, automotive engineering and engineering management, management science, and production and operations management will find the book interesting to read.

This book may be used for teaching in graduate and professional development courses. It is also a valuable reference material for research in the area of supply chain management, logistics management, and operations management. The professional societies interested in these areas are:

- Institute of Industrial Engineers (IIE).
- Society of Manufacturing Engineers (SME).
- IEEE.
- INFORMS and Engineering Management Society.
- Production and Operation Management Society (POM).
- Decision Sciences Institute (DSI).
- American Production and Inventory Control Society (APICS).

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Concepts, Solutions, and Applications

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