

Preface

The new competition is a major upheaval affecting every aspect of how enterprises organize and operate. The evolution from single enterprise with a high vertical range of activities toward enterprise networks offers new business opportunities especially for small and medium enterprises (SMEs) that are usually more flexible than larger companies. However, in order to make a successful commitment to an enterprise network, expected performance and benefits have to be carefully evaluated and balanced for a company to become a partner of the right network and for the right tasks. All these issues have to be taken into account in order to find an efficient, flexible, and sustainable solution.

In the area of manufacturing and logistics, supply chain networks involve transformation processes from raw materials to finished products, through several stages of manufacturing, assembly, distribution, and delivery to customers. They also rely on information and monetary flows in addition to material flows. Each stage of material transformation or distribution may involve inputs coming from several suppliers and outputs going to several intermediate customers. Furthermore, each stage may involve information and material flows connected with some intermediate and distant stages.

The underlying logistic networks are complex and their analysis requires a carefully defined approach. As technological complexity has increased, logistic networks have become more dynamic and complex to handle. Consequently, there is a strong risk for practitioners and managers to get lost in details and spend a large amount of effort for analyzing the logistic network without meaningful results. Another issue coming along with the design and management of logistic networks is the great variety of possible policies and alternatives for each of these problems (design, management, and operations), and the need to assess complex trade-offs between conflicting criteria such as cost, quality, delivery, flexibility, robustness, etc. Moreover, world class supply chains typically involve different enterprises sharing common information and logistic networks. Due to the distributed nature of the network and the decisional autonomy of heterogeneous decision centers, organization of tasks and activities raises specific problems of coordination and integration. Enterprises can be seen as players in a game defined by a common goal, but separate constraints and conflicting objectives.

Multi-criteria approaches have been put to use in many segments of manufacturing and logistics. They have taken a prominent role to integrate people,

information, and products in manufacturing, warehousing, and distribution of goods and services. Decisions involving customer profiling, new product development, retail marketing, and sales patterns can be greatly refined using innovative multi-criteria approaches. Also, as such decisions have an impact on the overall integrated logistic network process, it is important to link the innovative multi-criteria-based tools to most integrated supply chain management applications.

Game theory provides a mathematical background for distributed systems and generating solutions in cooperative, competitive, or conflicting situations. Much effort has been recently devoted to constructing game theory models of supply chains and using them for better design, organization, and performance. One of the contributions of the book will be to describe those achievements in game theory that are particularly relevant and useful in the modern manufacturing world.

This book aims to align latest practice, innovation, and case studies with academic frameworks and theories covering the broad area of multi-criteria and game theory applications in manufacturing and logistics. Sixteen chapters were selected after a peer review process. They were revised in accordance with the suggestions and recommendations from the reviewers. The book comprises two main parts. Part I contains ten chapters (Chaps. 1–10) dedicated to “Multi-criteria Applications”. Part II is dedicated to “Game Theory Applications”. It contains six chapters (Chaps. 11–16).

Chapter 1, by N. Labadie and C. Prodhon, provides a survey on multi-criteria analysis in logistics with a focus on vehicle routing problems. The chapter highlights most recent key references dedicated to multi-criteria studies in transportation logistics and especially on vehicle routing problems. Moreover, it presents some interesting research directions for future works.

Chapter 2, by X. Delorme et al., deals with the use of multi-objective approaches in the field of assembly line design. The design of assembly lines is a very important industrial problem that involves various difficult and interconnected optimization problems. A review of the main multi-objective optimization methods used for these problems is presented and discussed. A case study is also described in order to highlight some interesting properties associated with such multi-objective problems.

Chapter 3, by E. Çevikcan et al., proposes a multi-objective decision-making approach to select the best storage policy with respect to the company’s requirements. After providing background information about storage policies as well as storage assignment models, a fuzzy information approach is proposed for storage policy selection. The approach is validated with the help of an illustrative case study from the automotive industry.

Chapter 4, by S. Mungle et al., develops a thermodynamically inspired high performance multi-objective evolutionary algorithm (TDHP-MOEA) incorporated with quality function deployment (QFD) and fuzzy-analytic network process (FANP) to resolve the product technical requirements (PTRs) selection problem in product design. The proposed approach considers goals such as new product development (NPD) time and cost, technological advancement, and manufacturability for selection of the most suitable PTRs. A case study of software development is presented to demonstrate the effectiveness of the proposed approach.

Chapter 5, by F. Belmecheri-Yalaoui et al., presents two multi-objective meta-heuristic methods based on ant colony algorithm to simultaneously optimize the storage problem and the quayside transport problem observed during resolution of the container terminal problem. The container terminal has to manage container traffic at the crossroads of land, road, and railway. The results of both meta-heuristics are compared with those obtained by a complete enumeration of the solutions.

Chapter 6, by Y. L. Chong et al., proposes an exploratory study to predict the most important factors that can lead to successful mobile supply chain management adoption for manufacturing firms. The results show that some of the strongest predictors for mobile supply chain management adoption are senior management support, security perceptions, technology integration, financial, and technical competence. Moreover, the study shows that firm size and environmental factors have less predictive power than technological and organizational factors on mobile supply chain management adoption decisions.

Chapter 7, by L. Berrah and L. Foulloy, deals with the problem of computing performance expressions in modern industrial companies. Performance expressions are the results of performance indicators and performance measurement systems—PMSs. By revisiting previous works in this field, the authors aim to define a unified framework for such a computation, by integrating the industrial context data. Three parameters are considered, respectively, the declared objective, the acquired measurement, and the performance expression that results from the comparison of the measurement to the objective.

Chapter 8, by I.U. Sari et al., proposes a multi-criteria decision-making approach called fuzzy decision-making trial and evaluation laboratory (DEMATEL) to prioritize the supply chain performance measures. The authors first attempt to prioritize the key performance criteria of the performance measurement system using fuzzy DEMATEL and then investigate the effect of fuzzy linguistic scale in the prioritization of the criteria. Two different scales are tested. The results obtained with the use of different scales are similar to each other showing that fuzzy DEMATEL is robust to minor changes in linguistic variable scale.

Chapter 9, by R. A. Kumar et al., focuses on selecting the route in international intermodal freight transportation network. The problem is complex and comprises the following characteristics: (1) multi-objective: minimization of travel time and travel cost, (2) schedules and delivery times of every service provider in each pair of location, and (3) variable cost must be included in every location. First, they formulate the problem into mixed integer linear programming (MILP) model. Second, they develop two different methods, respectively, ‘NP’ (nested partition) method and ‘MADM’ (multi attribute-decision making) method to obtain the optimal route. To show the performances of both methods, they present several numerical experiments and discuss the results.

Chapter 10, by N. Labadie et al., addresses the bi-objective multiple traveling salesman problem with profits (BOMTSPP), generalizing the classical TSP with profits (TSPP). This new problem generalizes the TSPP in two directions: a true bi-objective treatment and the construction of multiple tours. Two criteria are

considered: the length of the tour, like in the classical TSP, and profits which can be collected at customers. An evolutionary algorithm based on NSGA-II, reinforced by a post-optimization procedure based on path-relinking (PR), is developed. To demonstrate its efficiency, rich experimental results are presented and discussed.

Chapter 11, by D. Xu et al., presents a hybrid simulation-based framework to address duopoly game under the scenario of product adoption process considering multiple decision variables and detailed payoffs. In the proposed hybrid simulation framework, system dynamics (SD) models are used for simulating the activities of duopoly companies on production, logistics, and price determination, where agent-based simulation (ABS) is used for modeling consumer purchasing behaviors at the market side. To illustrate the applicability of the proposed framework, a hypothetical case scenario involving soft-drink duopoly on Coke and Pepsi is presented and numerical results discussed.

Chapter 12, by M. Mateo and E. H. Aghezzaf, discusses the problem of integrating inventory and distribution optimization together with game theory to effectively manage supply networks. The problem is known as the inventory routing problem (IRP) and is an underlying optimization model for supply networks implementing a vendor managed inventory (VMI) strategy. The authors concentrate on the stream of literature focusing on cooperative game theory in the inventory routing problem. Moreover, they present and discuss two applications issued from cooperation in the wine distribution and cost allocation in the gas distribution.

Chapter 13, by D. K. Verma et al., considers the problem of determining an optimal set of winning suppliers in a single buyer procurement auction scenario. The buyer wishes to procure high volumes of a homogeneous item in a staggered way in accordance with a predefined schedule and the suppliers respond with bids that specify volume discounts and also delivery lead times. The authors show that the winner determination problem, which turns out to be a multi-objective optimization problem, cannot be satisfactorily solved by traditional methods of multi-objective optimization. They formulate the problem first as an integer program with constraints capturing lead time requirements and show that the integer program is an extended version of the multiple knapsack problem. Moreover, they discover certain properties of this integer program and exploit the properties to simplify it to a 0–1 mixed integer program (MIP), which can be solved more efficiently. Next, they explore a more efficient approach to solving the problem using a linear relaxation of the 0–1 MIP in conjunction with a greedy heuristic. Using extensive numerical experimentation, the efficacy of the 0–1 MIP and the proposed heuristic are demonstrated.

Chapter 14, by S. Mahjoub and J. C. Hennet, analyzes the process of forming a coalition within a corporate network. The objective of the partner companies is to create a multi-stage manufacturing system, which generates a chain of increased value from raw materials to end-user market. This process is studied by cooperative game theory, through the key problems of maximizing the total profit and distributing it among the members of the coalition. To construct a pay-off policy

that is both stable and fair, the chapter proposes to represent the productive resources of the companies not only by their capacity, but also by the work in progress (WIP) generated by product flows. The proposed profit sharing rule is then constructed from the dual of the profit maximization problem. It is both efficient and rational, with more fairness than the Owen set policy of classical linear production games.

Chapter 15, by A. El Omri et al., deals with the coalition formation problem in supply chains. The coalition formation problem has a profit maximizing objective, that is, increasing the benefit or the savings a supply chain agent (player/partner) can make by coordinating his activities with other agents. Cooperative game theory setting is used to analyze supply chain situations where a set of independent and freely interacting agents can benefit by working jointly. The authors consider the hedonic settings to study the formation of stable coalition structures in inventory games with general cost function. The goal is to focus on the problems of (i) coalition structure generation, i.e., formation of coalition structures, such that agents inside a coalition coordinate their activities, but agents of different coalitions will work independently; and (ii) worth sharing, i.e., distribution of the worth generated by the coalition to its agents.

Chapter 16, by T.S. Chandrashekar and Y. Narahari, models the multiple units, single item procurement network formation problem as a surplus maximizing network flow cooperative game. The buyer has a demand for a certain number of units. The agents in the network must coordinate themselves to meet this demand. Each edge is owned by a rational utility maximizing agent, where each agent has a capacity constraint on the number of units that he can process. The authors first investigate the conditions under which the core of this game is non-empty, and then, construct an extensive form game to implement the core whenever it is non-empty.

We hope that you will enjoy the results of these efforts.

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Applications of Multi-Criteria and Game Theory
Approaches

Manufacturing and Logistics

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