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Transportation Science Special Issue on Freight Transportation and Logistics, Part II

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This is the second group of papers making up the Special Issue the journal dedicates to the topic, inspired by the 5th edition of the *ODYSSEUS International Workshop on Freight Transportation and Logistics*, held May 2012 in Mykonos, Greece.

Twenty-one papers were selected following an enthusiastically-answered call to the international scientific community and a thorough refereeing process. Eleven appeared in the May 2016 issue, 10 others making up this issue. The selected papers present original, cutting-edge contributions illustrating, through methodological developments and innovative, insight-provoking applications, the diversity and richness of problems encountered in the modeling, planning, and management of freight transportation and logistics systems.

While well-established for passenger-oriented transportation systems, revenue management for freight transportation is significantly less studied and implemented. The paper by Barz and Gartner contributes to filling this gap by addressing the network revenue management issue for air cargo. The authors propose for this very difficult problem, more difficult than the corresponding one for passenger transportation, a dynamic programming formulation and several solution methods to compute tight bounds and design efficient decomposition-based heuristics.

Vehicle routing is a core family of problems within operations research and transportation science. The next three papers make significant contributions to the large literature on vehicle routing by proposing well-performing solution methods to complex problem settings capturing important aspects of actual applications. The first paper, by Dell'Amico, Díaz Díaz, Hasle, and Iori, treats the mixed capacitated general routing problem, in which the demands may be located on nodes, edges, and arcs. This setting generalizes core vehicle routing problems, the capacitated VRP, the capacitated arc routing problem, and the general routing problem, in particular. The authors propose

an adaptive iterated local search for the problem that includes new operators and search strategy. The paper reports excellent results on several benchmark instance sets for the studied problem and the ones it generalizes. Gounaris, Repoussis, Tarantilis, Wiesemann, and Floudas study the capacitated VRP but in the context of uncertain demand and the requirement for a robust solution. As emphasized by the authors, a major challenge in developing metaheuristics for robust formulations is the verification of the feasibility of a candidate route with respect to the robustness characterization. The paper presents efficient strategies to address the issue, as well as several enhancements to the adaptive-memory meta-heuristic framework. The resulting procedure produces high-quality results on a broad range of benchmark instances.

Routing is also central to the next contribution, by Pérez-Rodríguez and Holguín-Veras, where it appears as a component of a novel integrated inventory-allocation-routing model aimed at maximizing the benefits of the distribution of critical supplies to populations after a disaster. Humanitarian logistics is an increasingly important topic in this era of widespread conflict and man-made disasters compounding the nature-induced ones. This paper illustrates the major contributions operations research and transportation science may make in this context by explicitly considering the balance between the logistical costs of providing relief and the social cost of receiving it or not. The paper discusses the modeling of these deprivation (social) costs, presents integrated formulations, proposes and numerically evaluates heuristic solution methods, and discusses insights and policy implications.

Gendron, Khuong, and Semet study two-level transportation and telecommunication systems, where flows travel from first-level facilities ("depots") to second-level ones ("satellites"), and from there to customers. The authors address the uncapacitated facility location problem in such contexts where the decisions

must be made on which facilities to open on each level and to which depot-satellite pair to assign each customer; fixed costs and design decisions are also associated to the arcs linking depots and satellites. The authors study the mixed-integer formulations for the problem and derive a Lagrangian-based heuristic yielding tight bounds. The quality of the bounds and the efficiency of a specialized branch-and-bound algorithm embedding the Lagrangian heuristic are supported by numerical experiments on both data from an actual transportation application and on large and hard generated instances.

The next two papers address issues related to the management of transshipment terminals where loads are unloaded from incoming vehicles, are sorted, and prepared for loading on outbound vehicles. The two papers differ in the type of loads, equipment, and services involved, but both address the need to optimize the timely handling of freight and the utilization of expensive material-handling equipment. The first paper, by Jin, Lee, and Cao, is concerned with the daily management of a maritime container terminal. More precisely, the joint optimization of the space allocation, the crane deployment, and the traffic congestion in the yard. The authors propose an integer programming formulation and a heuristic approach combining a divide-and-conquer strategy, harmony search, and constraint-satisfaction techniques. Computational experiments support the accuracy of the formulation and the efficiency of the heuristic method. A different type of terminal is studied by Jarrah, Qi, and Bard. The authors focus on package sorting centers that perform a very large number of automated sorting operations daily. The objectives are several in aiming to minimize handling of loads and equipment used, as well as to equilibrate equipment utilization. The problem and its components are characterized, and a novel mixed-integer formulation is proposed, together with a hierarchical solution method based on decomposing the problem along the objectives indicated above and solving a series of mixed-integer formulations. High-quality solutions were obtained in relatively short computing times on large real-case data.

The last group of three papers addresses various issues related to the planning of operations and the management of resources of consolidation-based freight carriers. Balakrishnan, Kuo, and Si study the problem of assigning crews to trains in double-ended districts in U.S. freight railways, with the added requirement of fast solution times. The authors address the complex crew assignment and dispatching requirements and propose modeling strategies appropriate for inclusion in optimization models. They also propose procedures exploiting the particular structure of the problem, resulting in an efficient heuristic solution method. It is noteworthy that, even though the

authors exploit the rules proper to U.S. railways, the proposed methodology could be extended to other contexts where crews located at different bases could be assigned to the same set of tasks.

Lindsey, Erera, and Savelsbergh study the tactical planning problem of a less-than-truckload motor carrier operating a network of consolidation terminals linked by direct line-haul trailer movements. The studied load plan problem consists in determining for each shipment the path in this network from its origin to its destination through a series of intermediate terminals where transfer and consolidation operations may occur. The objective is to minimize the total handling and transportation cost while meeting customer constraints of service. The authors draw on insights on characteristics of “good” solutions in terms of asset utilization to propose a matheuristic based on two particular neighborhoods explored by solving suitably reduced (e.g., by focusing on particular origin-destination flows) versions of the full integer programming formulation of the problem. To further speed up computations, the authors also replace the equipment balancing constraints (empty-trailer repositioning) with lower bounds, periodically adjusted, on the number of trailers operating a given lane. Computational experiments on data from a large U.S. national LTL carrier show the efficiency of the proposed method. Crainic, Hewitt, Toulouse, and Vu, also address the tactical planning problem of consolidation-based freight carriers. They study the general scheduled service network design problem with resource constraints that aims to simultaneously select the services and their schedules, the routes of the resources required to support the operation of the selected services, and the shipment itineraries on the resulting time-space network. Resources are in limited quantity, are distributed among the terminals of the system, and must return to their terminal within a given time length. The objective is to minimize the total cost of setting up and operating the services and the associated resources, while delivering the shipments on time and enforcing conditions on resource utilization. The authors introduce a mixed-integer formulation for the problem and propose a matheuristic solution method combining slope scaling enhanced with long-term memories, column generation, and the resolution of suitably-restricted versions of the original formulation to perform intensification and diversification. A comprehensive computational study shows the efficiency of the methodology proposed.

I take this opportunity to thank all authors for their contributions and all referees for their dedication. My sincere thanks go to Professor Michel Gendreau who, as Editor-in-Chief of *Transportation Science*, invited me to guest edit this special issue, as well as to Ms. Frances Moskwa, Managing Editor, INFORMS, for her kind and helpful support.