

Correia, Isabel; Melo, Teresa; Péton, Olivier

Article

Introduction to the special issue on advances in facility location and logistics

EURO Journal on Transportation and Logistics (EJTL)

Provided in Cooperation with:

Association of European Operational Research Societies (EURO), Fribourg

Suggested Citation: Correia, Isabel; Melo, Teresa; Péton, Olivier (2022) : Introduction to the special issue on advances in facility location and logistics, EURO Journal on Transportation and Logistics (EJTL), ISSN 2192-4384, Elsevier, Amsterdam, Vol. 11, Iss. 1, pp. 1-2, <https://doi.org/10.1016/j.ejtl.2022.100093>

This Version is available at:

<https://hdl.handle.net/10419/325171>

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Contents lists available at ScienceDirect

EURO Journal on Transportation and Logistics

journal homepage: www.sciencedirect.com/journal/euro-journal-on-transportation-and-logistics

Introduction to the special issue on Advances in Facility Location and Logistics

In recent years, advances in technology have had a tremendous impact on transportation and logistics systems. Digital transformation, data analytics, cloud computing, and new business models are creating new challenges and opportunities, also for Operational Researchers. At the same time, social and environmental sustainability are also affecting how logistics systems and supply chain networks are configured and operated. Operational Research can make a valuable contribution to improving the quality of decision-making through developing new optimisation models and solution techniques that capture the complexity of the new problems and interactions among different parts of the supply chain. This special issue presents innovative research and addresses theoretical achievements, algorithmic development and real-world applications in the context of logistics, with a special focus on facility location.

Since the seminal papers on the p -median problem sixty years ago, the scientific community has made significant progress in developing both exact and heuristic methods for solving facility location problems. Over the past few years, new paradigms (e.g., matheuristics) have emerged, and “pure” facility location models and algorithms have been extended and generalised to solve larger, more complex problems that increasingly integrate real-world features. Facility location has natural links to a variety of other application areas in Operational Research and Management Science (OR/MS). With this special issue of the EURO Journal on Transportation and Logistics (EJTL), we also wish to highlight the role of facility location decisions in transportation and logistics systems.

In total, 32 papers were submitted to this special issue. We have selected five original contributions, which represents an acceptance rate of 15.6%. The selected articles address multiple facets of facility location problems, with strong connections to other applications frequently encountered in EJTL.

- Jaehyeon Ryu and Sungsoo Park study the robust single-source capacitated facility location problem under demand uncertainty. The single-source capacitated facility location problem is a classical facility location problem that has attracted the interest of many researchers over the last decades. In this paper, a robust version of the problem is considered where uncertainty is associated with customer demand. The authors develop an allocation-based formulation, derived from the Dantzig-Wolfe decomposition, which is solved by a branch-and-price algorithm. Using four sets of instances, the latter is compared to the branch-and-cut procedure available in the commercial solver CPLEX. The results indicate that the branch-and-price algorithm performs better than CPLEX in many cases.
- Youcef Mechouar, Vincent Hovelaque, and Carl Gagné model a facility location problem in the Euclidean space, in which a single production facility is to be located and various types of raw materials must be purchased from multiple suppliers. The raw materials are transformed into a final product, which is distributed to a set of markets with known demands. Procurement and transportation costs are minimised, whereby the latter are subject to carbon taxation. A special feature of the problem is the possibility of raw material substitution, whose impact is modelled by a production function that considers different degrees of elasticity substitution. The problem is solved with the generalised reduced gradient algorithm on a discretised solution space. The numerical results suggest that the location of the production facility is greatly affected by the degree of raw material substitution due to trade-offs between the transportation cost and the production cost.
- In the context of omnichannel distribution for online grocery retailers, Christian Dethlefs, Manuel Ostermeier, and Alexander Hübner study the use of stores in addition to conventional distribution centres (DCs) for order fulfillment when fast deliveries are required. This integrated problem involves multiple types of decisions: location of depots (i.e., stores and DCs) that will serve customers, assignment of customer orders to selected depots, and vehicle routing. The authors develop a specially tailored heuristic based on a cluster-first-route-second approach. Managerial insights reveal that integrated rapid order fulfillment can reduce costs by an average of 7.4% by adequately combining the use of depots and stores.
- Miriam Stumpe, David Rößler, Guido Schryen, and Natalia Kliewer study another integrated optimisation problem that arises in the design of fully electrified bus systems. A new mathematical model, which jointly determines the location of charging infrastructure and vehicle schedules, is presented. The authors propose a variable neighbourhood search heuristic and conduct comprehensive computational experiments based on real-world bus networks. Several parameter values are varied in order to control the robustness and sensitivity of the results. The experiments show that the location and scheduling problem are mutually dependent and that the configuration of electric bus systems in terms of charging infrastructure, bus fleet, and vehicle schedules is very sensitive to technological parameters such as battery capacity, charging power, and energy consumption as well as various economic parameters.
- Finally, Farnaz Farzadnia and Jens Lysgaard address the service-oriented single-route school bus routing problem. This problem and its multiple variants are challenging problems that have been widely studied in the literature due to their impact on the daily lives of many students. The problem examined in this paper considers a

<https://doi.org/10.1016/j.ejtl.2022.100093>

Received 1 September 2022; Accepted 2 September 2022

Available online 7 September 2022

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single bus that starts its route at the school, picks up students at the stops, and returns to the school without exceeding a pre-specified limit on the driving distance. The objective function is “service-oriented”, since it considers the minimisation of the total distance travelled on foot from the students’ homes to the pick-up points. Since these pick-up points must be selected from a large set, the mathematical formulation falls into the class of location-allocation-routing problems. The authors present an integer linear programming formulation and an exact solution method. In addition, a two-phase heuristic is developed. The performance of the proposed methods is tested on both real-life instances and randomly generated instances with up to 200 students.

This special issue is the result of the work of many people. We would like to acknowledge the efforts of all the reviewers who contributed their time to evaluate the 32 submissions. We would also like to sincerely thank Dominique Feillet for giving us the opportunity to prepare this issue and for his valuable assistance and guidance throughout the process.

Researchers and practitioners interested in the topics addressed in this special issue may also be interested in the various research groups and related conferences. EWGLA is the Working Group dedicated to Locational Analysis¹ within EURO, the Association of European Operational Research Societies. A wide range of topics of interest is covered by the group: discrete and continuous location problems, theoretical and applied research, pure and integrated location models. Through its regular meetings and mailing list, EWGLA has become a vehicle for communication between all researchers and practitioners interested in

facility location and related topics within Operational Research, in Europe and beyond. SOLA is the INFORMS section on Location Analysis.² Similar to EWGLA, its mission is to promote the development of analytical methods, techniques and tools for the study of facility location problems. Various approaches to OR/MS are used to solve problems arising in the private and public sectors. The International Symposium on Locational Decisions (ISOLDE)³ is a conference held every three years where researchers from different fields such as Mathematics, Operational Research, Management Science, Economics, and Engineering, among others, present their newest work in modelling, theory and applications in Location Science.

Isabel Correia*

*Center for Mathematics and Applications (NovaMath) FCT NOVA and
Department of Mathematics, FCT NOVA, Universidade NOVA de Lisboa, P
2829-516, Caparica, Portugal*

Teresa Melo

*Saarland University of Applied Sciences, Business School, Saarbrücken,
Germany*

E-mail address: teresa.melo@htwsaar.de.

Olivier Péton

IMT Atlantique, LS2N, UMR CNRS, 6004, France

E-mail address: olivier.peton@imt-atlantique.fr.

* Corresponding author.

E-mail address: isc@fct.unl.pt (I. Correia).

¹ <https://www.euro-online.org/websites/ewgla/>.

² <https://connect.informs.org/sola>.

³ <https://uwaterloo.ca/isolde-conference/>.