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Editorial

Planning and Scheduling Optimization

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Optimizing the performance of services and industrial systems is a real lever for creating value for companies and society. However, this target requires significant research efforts. This optimization phase is one of the major steps that make it possible to guarantee optimized productivity while respecting numerous constraints, such as quality standards, safety of manufacturing processes, environmental impact and other economic constraints. These constraints are linked to the type of products, the type of manufacturing systems and their environment.

In most industries, the main objective is to guarantee an optimized use of workshops, plants and other logistics resources in order to be reactive to market changes and disturbances. From this perspective, industrial systems must be as flexible as possible in order to be able to adapt in terms of resources allocation, workshop reorganization, capacities allocation, etc.

This special issue is devoted to recent research and current developments on complex systems' planning and scheduling. This includes the principles and practice of the design, implementation and analysis of exact and approximate optimization methods to tackle the challenges of modern manufacturing, engineering and healthcare systems. The topics of interest of this issue include:

- Heuristic and metaheuristic algorithms for planning and scheduling problems in manufacturing, engineering and healthcare systems;
- Exact algorithms (brand and bounds, dynamic programming, etc.) for planning and scheduling problems;
- Planning and scheduling applications (timetabling, network routing, crew scheduling, production scheduling, resource-constrained project scheduling, etc.);
- Energy-efficient planning and scheduling problems;
- Intelligent optimization approaches for intelligent manufacturing systems;
- Artificial Intelligence and data analytics (manufacturing, services, healthcare, services and industries of the future, etc.).

In response to the call for papers, thirty-nine papers were submitted to this special issue among which sixteen were accepted for publication. One of the accepted works presents a systematic review and future directions for smart manufacturing scheduling approaches [1]. In this review, several papers published recently are analyzed to understand the requirements considered when developing scheduling solutions for manufacturing systems.

Considering healthcare problems, Huvent et al. [2] addresses the generation and development of a benchmark properly fitting different constraints of the Home Health Care (HHC) problem. Consequently, a generator is proposed dealing with all kinds of constraints, such as time window constraints, workload constraints, synchronization and precedence constraints. This generator allows researchers to validate and compare solving methods on a common dataset, regardless of confidentiality issues. The author validate their generator, firstly, by creating a common benchmark available for researchers

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and, secondly, by proposing a set of instances and a solving method based on an HHC problem found in the literature. In another work, Abderrabi et al. [3] study a real case of an optimization problem derived from a hospital supply chain. Their work focuses on developing operational decision support models and algorithms for the production process scheduling in a hospital catering. The addressed production system is represented as a flexible job shop system. A mathematical model and two metaheuristics for the production scheduling of multi-product and multi-stage food processes are developed to minimize the total flow time. These methods are tested, based on real data, for scheduling the operations of the food production at the hospital center of Troyes in France.

Some of the addressed papers are especially interested on the development of new theoretical properties regarding different contexts. In paper [4], the authors consider the problem of assigning non-preemptive jobs on identical parallel machines to optimize workload balancing criteria. Since workload balancing is an important practical issue for services and production systems to ensure an efficient use of resources, different measures of performance have been considered in the scheduling literature to characterize this problem. This study proposes a theoretical and computational analysis of these criteria. Based on these theoretical developments, the authors propose new mathematical formulations to provide optimal solutions to some unsolved instances in order to enhance the latest benchmark presented in the literature. In [5], a genetic crow search algorithm (GCSA) approach is proposed to deal with the operation sequencing problem in computer-aided process planning. The traditional CSA is improved by employing genetic strategies, such as tournament selection, three-string crossover, shift and resource mutation. Moreover, adaptive crossover and mutation probability coefficients are introduced to improve local and global search abilities of the GCSA. An operation precedence graph is adopted to represent precedence relationships among features. In [6], Oudani is interested in analyzing and solving the Intermodal Terminal Location Problem on incomplete networks. The problem is modelled as a mixed integer linear program. Then, a simulated annealing algorithm is introduced to tackle medium and large instances. The computational results show that the obtained solutions using simulated annealing are competitive and close to the exact solutions found by CPLEX solver for small and medium instances. The same developed algorithm outperforms the best-found solutions from the literature using heuristics for larger instances.

The study addressed by Wisittipanich et al. [7] focuses on a postman delivery routing problem of the Chiang Rai post office, located in the Chiang Rai province of Thailand. In this study, two metaheuristic methods—Particle Swarm Optimization (PSO) and Differential Evolution (DE)—are applied with particular solution representation to find delivery routings with minimum travel distances. The performances of PSO and DE are compared with those from current practice. The results show that PSO and DE clearly outperform the actual routing of the current practice in all the operational days examined. Moreover, DE performances are notably superior to those of PSO. Červeňanská et al. [8] present the results of the wider investigation of common priority rules combined with a discrete-event simulation model applied in a partially flexible job shop system in terms of several conflicting production performance indicators evaluated simultaneously. The results of the optimization experiments also indicate that the evaluation via applying multi-criteria optimization is relevant for identifying effective solutions in the design space when a specific priority rule is applied in the scheduling operations. In the same multiple-criteria optimization context, Lin and Chang [9] present an extended version of the Hadi-Vencheh model for multiple-criteria ABC inventory classification. The proposed model is based on the nonlinear weighted product method (WPM), which determines a common set of weights for all items. The proposed nonlinear WPM incorporates multiple criteria with different measured units without converting the performance of each inventory item, in terms of converting each criterion into a normalized attribute value, thereby providing an improvement over the model proposed by Hadi-Vencheh. This study mainly includes various criteria for an ABC classification and demonstrates an efficient algorithm for solv-

ing nonlinear programming problems, in which the feasible solution set does not have to be convex. The algorithm presented in this study substantially improves the solution efficiency of the canonical coordinates method (CCM) algorithm when applied to large-scale nonlinear programming problems.

The research work proposed by Klimek [10] presents the resource-constrained project scheduling problem with the discounted cash flow maximization criterion from the perspective of a contractor. Cash flows are considered as the contractor's expenses related to the execution of activities and client's payments after the completion of contractual stages. To solve the problem, the author develops dedicated techniques to generate solutions and a simulated annealing algorithm. Finally, the proposed procedures are examined using the Project Scheduling Library (PSPLIB). An experimental analysis identifies the efficient moves and techniques for creating solutions, that is backward scheduling with optimization of completion times of project stages and triple justification.

Viveros et al. [11] address the multi-level storage locations assignment problem for Stock-Keeping Units pallets, considering divisible locations in the first level to improve the picking operation and reduce the travel times associated with the routes of the cranes. A mathematical programming model is developed considering the objective of minimizing the total travel distance and, in the background, maximizing the use of storage capacity. To solve this complex problem, the authors consider its decomposition into four subproblems, which are solved sequentially. To evaluate the performance of the model, two analysis scenarios based on different storage strategies are proposed to evaluate both the entry and exit distance of pallets, as well as the cost associated with the movements.

In the book storage problem, the randomized storage strategy is known as a best practice for storing books of an online bookstore, it simplifies the order picking strategy as to retrieve books in purchase orders from closest locations of the warehouse. However, to be more responsive to customers, many distribution centers have adopted a just-in-time strategy leading to various value-added activities, such as kitting, labelling, product or order assembly, customized packaging, or palletization, all of which must be scheduled and integrated in the order-picking process; this is known as wave planning. Shiau and Huang [12] propose a wave-planning mathematical model by considering, simultaneously, (1) time window from master of schedule (MOS), (2) random storage stock-keeping units (SKUs) and (3) picker-to-order. A conceptual simulation, along with a simplified example for the proposed wave-planning algorithm, is examined to demonstrate the merits of the idea. The result shows that the wave-planning procedure can significantly reduce the waiting time for truck loading of packages and the time that packages are heaping in buffer areas.

The last four papers present different original real case studies in different sectors and different region in the world. In [13], the integration of simulation modeling and the response surface methodology (RSM) is presented to solve an order planning problem in the construction supply chain. The interactions of various factors are examined to observe their effects on key system measurements and a combination of factor levels is determined to achieve the optimal performance. RSM is applied to find the possible values of the optimal setting for system responses, which consists of three main steps: central composite design (CCD), Box–Behnken design (BBD) and a comparison of both designs. The model is tested with a realistic case study of a building material distributor in Vietnam to demonstrate its effectiveness. The developed framework could be applied as a useful reference for decision-makers, purchasing managers and warehouse managers to obtain the most suitable order policy for a robust order planning process. Mejía et al. [14] investigate the problem of sustainable rural supply and urban distribution of fresh food products in central Colombia. Paradoxically, while farmers in the countryside suffer from poverty due to the low profitability of the agricultural activity, inhabitants at urban centers pay high prices for fresh and nutritious foods. In this work, the authors propose a supply chain system and a business model based on food hubs located on existing (and often abandoned) public facilities in the central region of Colombia. They study a business strategy through a

mathematical model which considers both the sustainable and efficient operation of the food hubs and better trading conditions for farmers. The authors also propose a variant of the competitive hub location problem adapted to this case study. They test the model under different scenarios, such as changes in the attractiveness parameters, operation costs and profit margins. The results suggest that, if hubs are able to attract farmers, the model can be both sustainable for the hub concessionaires and for the farmers. As claimed by Klement et al. [15], the management of industrial systems is conducted through different levels, ranging from the strategic (designing the system), to the tactical (planning the activities and assigning the resources) and the operational level (scheduling the activities). In their paper, the authors focus on the latter by considering a real-world scheduling problem from a plastic injection company, where the production process combines parallel machines and a set of resources. Two metaheuristics are tested and compared when used in the proposed scheduling approach: the stochastic descent and the simulated annealing. The method's performances are analyzed through an experimental study and the obtained results show that its outcomes outperform those of the scheduling policy conducted in a case-study company. Moreover, besides being able to solve large real-world problems in a reasonable amount of time, the proposed approach has a structure that makes it flexible and easily adaptable to several different planning and scheduling problems. The aim of the study presented by Ghaithan [16] is to develop an integrated mathematical model for the operation and maintenance planning for both the oil and gas supply chain. The utility of the proposed model is demonstrated using the Saudi Arabian hydrocarbon supply chain. In fact, the Hydrocarbon Supply Chain (HCSC) is a complex network that extends from oil and gas fields to demand nodes. Integrating operation and maintenance activities along this complex network are crucial since the hydrocarbon industry is the most influential sector in the world economy and any disruptions or variations in hydrocarbon product supply affect the whole world economy.

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