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Editorial note for the special issue on 'Advanced metaheuristics for integrated supply chain management'

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Introduction

Supply Chain Management (SCM) has become a critical aspect in today's fiercely competitive business environment. Under the expanded heading of logistics, SCM is now an integral part of company activities covering areas such as purchasing management, transportation management, production management, warehousing management, inventory management, etc. Today's consumers demand cheaper, high quality products, on-time delivery and excellent after-sale services. Hence, companies are under intense pressure to cut product and material costs while maintaining a high level of quality and after-sale services. In 2002, American companies spent $910 billion, or about 8.7% of the United States gross domestic product (GDP), on business logistics systems, which contained the warehousing costs, transportation costs, shipper related costs and logistic administration costs. In Singapore, the transport and communication industry sector contributed about 10.8% of the GDP in year 2003. Considering the importance and the influence of SCM, manufacturers and retailers have paid great efforts to handle the flow of products efficiently and coordinate the management of supply chain smoothly.

Although the resulting integrated supply chains are more competitive, the tasks for planning, managing and optimizing are much more difficult and complex. They involve the solution of a set of divers' decisions problems, differing in hierarchical levels and objectives. Efficient management of integrated supply chain requires both powerful technological tools and human competences and experience in order to compete. Indeed, the increasing role of the integration between purchasing, production and distribution activities is demonstrated by the evolution of commercial software packages and the number of tools present in the market.

Metaheuristics have been put to use in multiple segments of the supply chains. They have taken a prominent role to integrate people, information and products across integrated supply chain boundaries including management of various manufacturing, logistics and retailing operations such as in manufacturing, warehousing and distribution of goods and services. Decisions involving customer profiling, new product development, retail marketing, and sales patterns are immensely refined using innovative metaheuristics. Also, as such decisions have an impact on the overall integrated supply chain processes, it is important that innovative Metaheuristic-based tools also be linked to integrated supply chain management applications. This special issue aims to align latest practice, innovation and case studies with academic frameworks and theories. It will include the latest research results and efforts at different levels including quick-response system, theoretical performance analysis, performance and capability demonstration, hoping to cover the role of emerging metaheuristics in optimising integrated supply chain activities.

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Overview of the papers included in the special issue

Total thirteen papers were selected after a peer review process. These thirteen papers were revised in accordance with the suggestions and recommendations from the reviewers. They address prominent concepts and applications of

advanced metaheuristics in managing integrated supply chains activities:

Celik, Nageshwaraniyer and Son present a comprehensive framework for the analysis of the impact of information sharing in hierarchical decision-making in manufacturing supply chains. The process plan selection and real-time resource allocation problems are formulated as hierarchical optimization problems, where problems at each level in the hierarchy are solved by separate multi-objective genetic algorithms. The considered multi-objective genetic algorithms generate near optimal solutions for NP-hard problems with less computational complexity when compared to genetic algorithms and simulated annealing. Moreover, a four-level hierarchical decision structure is considered, where the decision levels are defined as enterprise level, shop level, cell level, and equipment level. Using this framework, the sources of information affecting the achievement of best possible decisions are then identified at each of these levels, and the extent of their effects from sharing them are analyzed in terms of the axis, degree and the content of information. The generality and validity of the proposed approach have been successfully tested for diverse manufacturing systems generated from a designed experiment.

Li, Prins and Chu consider a multi-type transshipment point location problem with multi-commodity flow which aims at locating transshipment points (TPs) and determining the type for each open TP. As an extension of the classical two-stage capacitated facility location problem, the problem allows flows of commodities to move among TPs and does not impose restrictions on the number of TPs traversed by flows going from plants to customers. In order to obtain high-quality feasible solutions, they propose a clustering-based scatter search in which the seed solution generation, the diversification technique and the local search are designed using the clusters generated by a data mining technique, the K-means method. The computational results show that the scatter search performs efficiently over different kinds of instances. Moreover, the solution quality is also good since the average gaps to lower bounds range between 1 and 3%.

Kim and Son propose a simple particle swam optimization (PSO) approach for solving the capacitated vehicle routing problem (CVRP). The proposed PSO approach uses a probability matrix as the main device for particle encoding and decoding. While existing research used the PSO solely for assignment of customers to routes and used other algorithms to sequence customers within the routes, the proposed approach applies the PSO approach to both simultaneously. The computational results show the effectiveness of the proposed PSO approach compared to the previous approaches.

Tavakkoli-Moghaddam, Ranjbar-Bourani, Amin and Siadat present a novel multi-criteria cell formation model with alternative process routes (APR). The considered manufacturing system consists of several parts required a number of operations on different machines with limited capacities according to a given sequence. Each machine can process different operations based on the tooling available and it can be considered as alternative route for part processing. They consider four objectives simultaneously: (1) minimizing the total fixed and variable cost including costs of purchasing, operation, and maintenance; (2) minimizing cost of intercellular movements; (3) maximizing the utilization of machines in the system; and (4) minimizing deviations among the levels of the cell utilization (i.e., balancing the workload between cells). These objectives are first weighted by their relative importance and then a new mathematical model is presented. To solve this model, a scatter search (SS) algorithm is proposed to select a process plan for each part with the minimum cost along with forming the part family and machine grouping simultaneously. A number of test problems are carried out to verify the good ability of the proposed SS in terms of the solution quality and computational time.

Chaube, Benyoucef and Tiwari propose a new approach to generate the dynamic process plan for a reconfigurable manufacturing system (RMS). There are various modules available with each machine providing different degrees of freedom. The functionality of the machine can be changed depending upon the capacity and the design requirement of the product. Initially, the requirements of the products are assessed and compared with the functionality offered by machines. If the production plan is feasible an optimal process plan is generated, otherwise the system shows an error message showing lack of functionality. Using an adapted non-dominated sorting genetic algorithm (NSGA-2), a multi-objective scenario is considered with the aim of reducing the manufacturing cost and time. With the help of a numerical example, the efficacy of the proposed approach is demonstrated.

Bessenouci, Sari and Ghomri present two metaheuristic algorithms, namely taboo search and simulated annealing, applied to the control of a flow rack automated storage retrieval system (AS/RS). The two algorithms are developed to control the retrieval machine of the AS/RS in order to minimize the retrieval cycle time. Results of these metaheuristic algorithms are compared to classical heuristics and analytical models found in literature and used to control the storage and retrieval of items in the AS/RS. On the other hand, analytical models were conceived to bring a bottom line for comparison of different control techniques. To carry out this comparative study, simulations were performed on a wide range of system configurations. Furthermore, a sensitive analysis on the heuristics parameters was achieved and the best parameters were selected for comparative study.

Sauvey and Sauer consider a flow-shop scheduling problem with a special blocking RCB (Release when Completing Blocking). This flexible production system is prevalent in some industrial environments like waste treatment plants or aeronautics parts fabrications. Genetic algorithms are first

proposed for solving these flow-shop problems and different initial populations are tested to find which is best adapted. Then, a method is developed for further improving genetic algorithm found solutions, which consists in marking out recurrent genes association occurrences in an already genetic algorithm optimized population. The proposed idea is that populations well adapted to a problem have an adapted genetic code with common properties. They propose to mark out these properties in available genetic code to further improve genetic algorithm efficiency. Computational results and performance evaluation are presented to illustrate the efficiency of the proposed method.

Li, Yalaoui, Amodeo and Chehade present an identical parallel machine scheduling problem with release dates, due dates and sequence dependant setup times. The goal is to minimize the makespan and the total tardiness. A mixed integer linear program is proposed first to model the problem. Known as NP-hard in the strong sense, an adapted non-dominated sorting genetic algorithm (NSGA-2) based method is proposed next. Since for a genetic algorithm, setting the parameters is difficult, a fuzzy logic controller coupled with the NSGA-2 (FLC-NSGA-2) is therefore proposed. The role of the controller is to better set the crossover and the mutation probabilities in order to update the search ability. The computational results confirm first the advantage of FLC-NSGA-2 over the NSGA-2 on 960 tested problem instances. Moreover, an exact method based on the two phase method (TPM) is developed and compared with the FLC-NSGA-2 method. Using four measuring criteria, the experimental results show the advantages and the efficiency of FLC-NSGA-2.

Gomez-Gasquet, Rodriguez-Rodriguez, Dario Franco and Ortiz-Bas consider the problem of order management within extended collaborative selling chains, and identify the objectives, requirements and solutions of scheduling in this environment. The main issue to be considered in this context is the production scheduling, whose final goal is to satisfy the delivery dates agreed with final customers by using a collaborative strategy among the suppliers. The problem of collaborative scheduling is formally defined by means of a mathematical model with the objective to minimize the total weighted tardiness of the package of products acquired by the clients to be delivered in a specific date. The delivery date of each Product-Package is conditioned by the latest date established by each supplier for each product that forms part of the same one. Besides, having different process times for each product and different penalties for each Product-Package, each supplier can offer a different mix of additional products with different due date. Due to the complexity of the problem a genetic algorithm based approach is developed. In order to validate the obtained solutions, diverse configurations are presented and the results obtained by means of the GA and some heuristics rules such as earliest weighted due date (EWDD), Processing Weighted Shortest Time-Product (SWPT-P) and Processing Weighted Shortest Time-Product-Package (SWPT-PP) are compared.

Rebai1, Kacem and Adjallah consider the problem of scheduling a set of M preventive maintenance tasks to be performed on M machines. The machines are assigned to execute production tasks. The objective is to minimize the total preventive maintenance cost such that the maintenance tasks have to continuously be run during the schedule horizon. Such a constraint holds when the maintenance resources are not sufficient. Two exact methods (linear programming and branch and bound) and two metaheuristic algorithms (local search approach and genetic algorithm) are proposed. Performed on randomly generated instances, the experimental results show that the proposed methods produce appropriate solutions for the problem. Moreover, the deviation of the metaheuristic solutions to the optimal one is very small, which confirms the effectiveness of the two metaheuristics as new approaches for solving hard scheduling problems.

Lin and Wang develop a hybrid genetic algorithm to optimize the periodic preventive maintenance model in a series-parallel system. The intrinsic properties of a repairable system, including the structure of reliability block diagrams, maintenance priority of components, and their maintenance periods, are considered. The importance measure of components is employed to account for these properties, identify important components, and determine their maintenance priorities. The optimal maintenance periods of these important components are then determined to minimize total maintenance cost given the allowable worst reliability of a repairable system using the genetic algorithm search mechanism. An elitist conservation strategy is applied to retain superior chromosomes in the iterative breeding process to accelerate the approach toward the global optimum. Furthermore, the response surface methodology is utilized to systematically determine crossover probability and mutation probability in the genetic algorithm instead of using the conventional trial-and-error process. The effectiveness and practicality of the proposed hybrid genetic algorithm are demonstrated using a case study.

Kubat and Yuce propose a hybrid intelligent approach, which combines analytic hierarchy process (AHP), fuzzy AHP and genetic algorithm (GA) to deal with the supplier selection and order allocation problem. Fuzzy AHP is used to determine the linguistic expressions while the fuzzy weight is used to transform the crisp weights of each supplier criterion. By using the crisp weights, the best suppliers are determined. Moreover, under the capacity, demand, quality, and delivery constraints, the optimal order quantities that should be allocated to the selected suppliers are obtained using the GA. The efficiency and applicability of the approach is demonstrated via experimental results.

Yedes, Chelbi and Rezg deal with an integrated supply chain management problem in the context of a single vendor-single buyer system for which the production unit is assumed to randomly shift from an in-control to an out-of-control state. At the end of each production cycle, a corrective or preventive maintenance action is performed, depending on the state of the production unit, and a new setup is carried out. Two different integrated production, shipment and maintenance strategies are proposed to satisfy the buyer's demand at minimum total cost. The total integrated average cost per time unit corresponding to each strategy is considered as the performance criterion allowing choosing the best policy for any given situation. The experimental results show how one or the other policy could turn out to be more cost-effective depending on the values taken by the different input parameters.

As mentioned, the contributions cover both aspects of theoretical and practical development regarding the use of advanced metaheuristics for supply chains management. It is hard to draw precise conclusions and trends across the papers included in this special issue, but there is no doubt that the papers elaborate and refine many of the existing challenges in supply chain management. As guest editors, we are very satisfied both with the quality of the papers presented in this issue, and with the relevance on the themes we hoped to put focus on via this special issue. We hope you will enjoy the result of the efforts.

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