Editorial

Reverse supply chains: A source of opportunities and challenges

Reverse supply chains consist of a series of activities required to collect used products from consumers and reprocess them to either recover their leftover market values or dispose of them. Strict environmental regulations and diminishing raw material resources have intensified the importance of reverse supply chains for industry. In addition to being environment friendly, effective management of reverse supply chain operations leads to higher profitability by reducing transportation, inventory and warehousing costs. Moreover, reverse supply chain operations have a strong impact on the operations of forward supply chain such as the occupancy of the storage spaces and transportation capacity [1].

From research perspective, the introduction of reverse supply chains has created many challenges in the areas of network design, transportation, selection of used products, selection and evaluation of suppliers, performance measurement, end-of-life (EOL) alternative selection, remanufacturing, and disassembly planning to name a few.

This special issue presents a compilation of the recent work done in a variety of topics within reverse supply chains. The fourteen papers included in this special issue demonstrate the wide variety of fronts where research activity is taking place in the general area of reverse supply chains.

The first paper, "A Reverse Logistics Network Design" [2] by Ahmed Alshamsi and Ali Diabat, presents a mixed-integer linear program to address the network configuration of a reverse logistics system for optimal selection of sites and capacities of inspection centers and remanufacturing facilities. In addition, they consider transportation options that either uses an in-house fleet or outsourced trucks for delivering the products across the reverse supply chain within budget limitation.

The next paper, "Integration of AHP-TOPSIS Method for Prioritizing the Solutions of Reverse Logistics Adoption to Overcome its Barriers under Fuzzy Environment" [3] by Chandra Prakash and Mukesh Kumar Barua, presents a methodology based on fuzzy AHP (analytical hierarchy process) and fuzzy technique for TOPSIS (the order performance by similarity to ideal solution) to identify and rank the solutions of reverse logistics adoption to overcome its barriers. The robustness of the proposed methodology is illustrated by applying it to a case in Indian electronics industry.

The third paper, "Reverse Logistics Network Design for a Biogas Plant: An Approach Based on MILP Optimization and Analytical Hierarchical Process" [4] by Daniel Galvez, Auguste Rakotondranaivo, Laure Morel, Mauricio Camargo and Michel Fick, integrates MILP (Mixed Integer Linear Programming) optimization and AHP to evaluate possible scenarios for the implementation of an anaerobic co-digestion logistics network in order to facilitate the integration of the preferences of the stakeholders involved in the project. The proposed approach is demonstrated in the framework of a project to improve waste management in the city of Nancy, France.

The fourth paper, "A Closed Loop Supply Chain under Retail Price and Product Quality Dependent Demand" [5] by Tarun Maiti and Bibhas C. Giri, uses game theory to investigate the effect of the decision-making structure variation (manufacturer, retailer and third party making their decisions jointly or independently) on the quality of manufactured and remanufactured products, each individual member's profit and the system profit in a hybrid manufacturing and remanufacturing process within a closed loop supply chain framework.

The fifth paper, "Disassembly Line Balancing under High Variety of End of Life States using a Joint Precedence Graph Approach" [6] by Robert J. Riggs, Olga Battaïa and S. Jack Hu, develops and validates a disassembly joint precedence graph creation method for line balancing that is able to simultaneously consider all possible end of life conditions and states of a product. They also extend their approach to consider stochastic task times and develop a method for generating a stochastic disassembly joint precedence graph.

The sixth paper, "Competitive Closed-Loop Supply Chain Network Design under Uncertainty" [7] by Hamed Fallah, Hamidreza Eskandari and Mir Saman Pishvaee, studies the competition between two closed-loop supply chains including manufacturers, retailers and recyclers in an uncertain environment. Like in the fourth paper mentioned above, here also a game theoretic approach is used to investigate the impact of simultaneous and Stackelberg competitions between the two closed-loop supply chains on their profits, demands and returns.

The seventh paper, "Stochastic Models and Numerical Solutions for Manufacturing/Remanufacturing Systems with Applications to the Printer Cartridge Industry" [8] by Annie Francie Kouedeu, Jean-Pierre Kenne, Pierre Dejax, Victor Songmene, Vladimir Polotski, investigates the production rate control of a hybrid manufacturing/remanufacturing system in a closed-loop environment, with application to the printer cartridge industrial sector. Here a non-homogeneous Markov process is used to describe the dynamics of the overall production system. Then the optimal production policies for both factories are obtained for a real European business case study producing printer cartridges.

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The eighth paper, "Multi-Objective Fuzzy Disassembly Line Balancing using a Hybrid Discrete Artificial Bee Colony Algorithm" [9] by Can B. Kalayci, Arif Hancilar, Askiner Gungor and Surendra M. Gupta, presents a fuzzy extension of the disassembly line balancing problem with triangular fuzzy task processing times. A hybrid discrete artificial bee colony algorithm is used to solve the problem whose performance is studied over well-known test problems demonstrating the superiority of the algorithm.

The ninth paper, "Efficient Multi-Objective Optimization of Supply Chain with Returned Products" [10] by Matthieu Godichaud and Lionel Amodeo, proposes a supply chain model based on simulation and multi-objective optimization to optimize control policies for multi-echelon supply chain with returned products. The method is tested on three inventory policies which correspond to different ways of making decision.

The tenth paper, "Allocation of External Returns of Different Quality Grades to Multiple Stages of a Closed Loop Supply Chain" [11] by Rabindranath Bhattacharya and Arshinder Kaur, formulate a nonlinear profit function for a closed loop supply chain for the system with a price dependent demand for n-stages with the 'selling price of product' and the 'percentage return of graded used products entering into different stages' as the decision variables. A three stage numerical example is used to illustrate the method the managerial insight obtained from its solution.

The eleventh paper, "Optimal Production Scheduling for Hybrid Manufacturing – Remanufacturing Systems with Setups" [12] by Vladimir Polotski, Jean-Pierre Kenne and Ali Gharbi, considers a hybrid system that uses both raw materials and returned products in their production processes. The system consists of one facility and therefore, switches back and forth from manufacturing mode to remanufacturing mode, making setups necessary every time switching takes place. For these types of systems, analytical solutions for production, setup strategies and feasibility conditions are obtained, and the sensitivity of results over system parameters is investigated.

The twelfth paper, "Decision Evaluation Process in End-Of-Life Systems Management" [13] by Yasmina Bouzarour-Amokranea, Ayeley Tchangani and Francois Peres, considers dismantling site location problem as multi-criteria/multi-objectives decision making problem and solves it using an AHP-BOCR (Analytic Hierarchy Process – Benefits, Opportunities, Costs, and Risks) approach based on qualitative and quantitative evaluations. A bipolar structuring framework is considered to distinguish positive and negative aspects in the elicitation/evaluation process to avoid compensation and satisficing game theory is used as suitable mathematical tool for recommendation process. An example is considered to illustrate the utility of the framework.

The thirteenth paper, "Understanding Value Creation in Closed Loop Supply Chains – Past Findings and Future Directions" [14] by Maren Schenkel, Marjolein Caniëls, Harold Krikke, Erwin van der Laan, presents a literature review of 144 articles in green, reverse and closed loop supply chains to organize existing knowledge on value creation. Four types of value, viz., economic, environmental, information and customer value, are identified. Value adding concepts from the forward- and reverse supply chains are classified into six subclasses, namely partnerships and collaboration, product design characteristics, service concepts, IT solutions, supply chain processes and organizational characteristics.

The final paper, "Use of MCDM Techniques in Environmentally Conscious Manufacturing and Product Recovery: State of the Art" [15] by Mehmet Ali Ilgin, Surendra M. Gupta and Olga Battaïa, presents over 190 Multi Criteria Decision Making (MCDM) studies in environmentally conscious manufacturing and product recovery (ECMPRO) by classifying them into three major categories, viz., multi-objective optimization, multi-criteria analysis and the integration between them. Insights from the review and future research directions conclude the paper.

It is our hope that this volume will inspire further research in Reverse Supply Chains and motivate new researchers to get interested in this all too important field of study. This special issue would not have been possible without the devotion and commitment of the authors. Each one has been very patient in preparing and revising their manuscripts. We thank the reviewers for providing constructive and timely reviews. We would also like to document our appreciation to Professor Neil A. Duffie, Editor-in-Chief of *Journal of Manufacturing Systems*, for encouraging us and giving us the opportunity to edit this special issue.

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