



Operations research applications in the Middle East and Africa

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Promoting economic growth and sustain the development of people and institutions is now a primary concern for every country in Africa. This special issue includes 15 papers highlighting operations research models and techniques that have helped economic developers to sustain development in Middle East and Africa (MEA). This special issue dedicated, but not limited to, papers presented in the 2018 conference of the African Federation of Operational Research Societies (AFROS) dealing with applications of operations research in the MEA region. The main purpose of this special issue is to engage MEA researchers to solve developing countries real problems using operational research models and techniques. The focus of the special issue was on applications without ignoring the importance of theoretical contributions.

The 2018 conference of the AFROS was organized by the Tunisian Decision Aid Society, with a financial support from IFORS and EURO, in Tunis, Tunisia, from 2 to 4 July 2018. Several papers presented in this conference highlighted recent applications in the Operation Research and Management Science (OR/MS) field. The AFROS is a Non-profit Organization that aims to support African researchers and to promote the operations research education in Africa. AFROS vision is to be known as the Africa's leading contributor to the promotion of operations research for the benefit of African countries. AFROS was initiated through the efforts of the International Federation of Operational Research Societies (IFROS) President, Michael Trick and Chair of developing countries committee, Sue Merchant in November 2016 in Kenya.

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The accepted papers in this special issue are related to financial applications, supply chain management applications, waste collection applications, optimization applications and the operations research status in Africa.

1 Financial applications

In their paper entitled “A Fuzzy Analytic Hierarchy Process Model for Customers’ Bank Selection Decision in the Kingdom of Bahrain”, Minwir Alshammari and Mehdi Mili evaluated six criteria in five Bahraini retail commercial banks. The developed model assists decision makers in developing suitable bank development strategies based on customers’ priorities. The results revealed that the most selected banks place a greater emphasis on the pricing strategy rather than the quality-of-service strategy. In addition to that, the proposed approach was proven to be a robust tool to address various decision-making problems.

As for the paper entitled “Deterministic Goal Programming Approach for Islamic Portfolio Selection”, Noushin Bagheri built a Shariah compliant multiple goals program that tackles the portfolio selection problem. Four goals were considered: maximizing returns, minimizing risk, minimizing P/E ratio, and minimizing P/B ratio. To evaluate the model, monthly equity data from 60 financial institutions in the Gulf Cooperation Council (GCC) economies from 2006 to 2016 was used. The results showed that, when compared to conventional portfolios, the Shariah compliant portfolios provided investors with higher returns. Thus, investors can make high profits while meeting their ethical considerations.

2 Supply chain management applications

In the paper entitled “A New Network Data Envelopment Analysis to Measure the Efficiency of Natural Gas Supply Chain”, Kaveh Khalili-Damghani developed a Network Data Envelopment Analysis (NDEA) model to assess the performance of the NSGSN during a 5-year planning horizon based on monthly data. Conventional DEA models cannot be used in this context due to the complexity of the problem. The proposed model has been tweaked so it can always reach exact and global optimal solutions. Also, the obtained results showed that the model is always feasible and bounded. Therefore, this model is applicable to real life problems.

The paper entitled “Strategic optimization of wheat supply chain network under uncertainty: A real case study” and developed by Seyyed-Mahdi Hosseini-Motlagh, Mohammad Reza Ghatreh Samani and Firoozeh Abbasi Saadi proposed a mixed-robust and stochastic model to optimize the total cost of the wheat supply chain network. While the existing literature ignores the uncertain nature of the wheat supply chain network, the proposed model takes for this. The results showed that the perturbation and reliability levels along with the uncertainty in demand and supply, have a direct influence on the network cost. The proposed model was found to outperform the deterministic model. Possible extensions of the model were suggested to consider other aspects of the network.

Mohammad Reza Ghatreh Samani and Seyyed-Mahdi Hosseini-Motlagh wrote a paper entitled “A robust framework for designing blood network in disaster relief: A real-life case”. The framework proposed in this paper accounts for: (i) the blood donors’ preferences measured by a Logit model, (ii) an estimate of the number of injured individuals based on many factors, (iii) the uncertainty in input parameters (such as blood supply and demand) and (iv) the capacity of available blood facilities. The last two points were handled by a new two-stage stochastic approach. Real data associated was used to apply the proposed framework. The results showed that the concerned blood supply chain managers should consider the preferences of donors, the number of injured people and the effect of disruption of the network design. The developed methodology outperformed the deterministic model. Furthermore, some research directions were proposed.

In their paper entitled “Reliable Cross-docking Location Problem under the Risk of Disruptions”, Asefeh Hasani Goodarzi, Seyed Hessameddin Zegordi, Gülgün Alpan, Isa Nakhai Kamalabadi and Ali Hussein Zadeh Kashan developed a recovery plan consisting in the reallocation of suppliers to alternative cross-docks or serving the supplier by a direct shipment. For this purpose, a mixed integer nonlinear programming formulation was advanced to identify the optimal cross-duck location design and capacity of opened cross-ducks that minimize the transportation cost and disruption consequences. The model was applied on an auto-making company in the Middle East. The recommendation was to combine cross-ducking and direct shipment since it was proven to be cost-effective.

3 Waste collection applications

“A Bi-Objective Stochastic Programming Model for the Household Waste Collection and Transportation Problem: Case of the City of Sousse” was proposed by Haifa Jammeli, Majdi Argoubi and Hatem Masri. The model helps to determine the routes of the vehicles and the number of bins to be assigned to each potential location, while minimizing the collection costs and the environmental impact. A hierarchical approach was used to find an optimal solution. Different transformation approaches were applied such as chance-constrained, resource and goal-programming. The results demonstrated that the model diminishes the environmental impact and reduces the economic costs.

The goal of Khalid Mekamcha, Mehdi Souier, Hakim Nadhir Bessenouci and Mohamed Bennekrouf was to plan the tours in a way that minimizes the total distance traveled in their paper entitled “Two metaheuristics approaches for solving the traveling salesman problem—an Algerian waste collection case”. Tabu search algorithm and a simulated annealing algorithm were used to solve the salesman problem and assist Algerian managers in the decision-making process. The results demonstrated that the adopted methodology achieves a good performance in terms of distance traveled. The model can be further extended by including more constraints to the problem.

4 Optimization applications

Mouhamadou A.M.T. Baldé, Serigne Gueye and Babacar M. Ndiaye worked on a model to optimize the location of the activities and the road network design of an urban area such as the routing and network costs are minimized. The paper entitled “A Greedy Evolutionary Hybridization Algorithm for the Optimal Network and Quadratic Assignment Problem” aims to develop a mixed-integer program and a hybrid algorithm (greedy and evolutionary heuristic models) to address the location problem. Although numerical experiments proved the effectiveness of the proposed method, the model could be further improved by modifying the assumptions made so it is closer to the reality.

Ali Shahabi, Sadigh Raissi, Kaveh Khalili-Damghani and Meysam Rafei assessed the resiliency of the train timetable in the rapid rail transit system in the paper “Designing a resilient skip-stop schedule in rapid rail transit using a simulation-based optimization methodology”. Accordingly, they provide an optimized schedule which is resilient against uncertainties in passenger flow and training running times. Numerical experiments were conducted using real data associated with the Line No. 1 of an underground metro system. The results showed that the simulation–optimization approach improves the resiliency of the train timetable.

In the paper entitled “Designing Modular capacitated Emergency Medical Service using information on ambulance trip”, Sondes Hammami and Aida Jebali provided the optimal location and capacity of modular ambulance stations in such a way that minimizes the cost of the EMS system, while abiding by a pre-defined response time. For this purpose, two mixed integer linear programs were developed. Information related to the ambulance trip such as the ambulance busy fractions and final destination of the patient was considered. Numerical experiments of both models were conducted using a real-life data. Compared to other methods, the proposed approach reaches better results in terms of cost and ambulance round-trip time savings.

To minimize the number of cranes used in the quay and yard sides for berthing ships with trans-shipment containers, Nabil Nehme, Bacel Maddah and Isam A. Kaysi developed an integer linear programming model in their paper entitled “An Integrated Multi-Ship Crane Allocation in Beirut Port Container Terminal”. Constraints associated with capacity, space and time were considered. During a finite period, the number of containers to be unloaded, the designated storage location and the number of cranes needed were determined. Results confirmed the findings associated with the single ship case: restricting the number of cranes at the yard side requires an increase in this number at the quay side and vice-versa. Using a counter example, the authors argued that single ship solutions are not easily adaptable to multi-ship cases.

In the paper entitled “Efficient Implementation of the Genetic Algorithm to Solve Rich Vehicle Routing Problem”, Bochra Rabbouch, Foued Saâdaoui and Rafaa Mraïhi proposed a genetic algorithm to address the multi-deposit heterogeneous limited fleet with time windows. The algorithm was applied to a real-life bus routing problem in Tunisia and was found to present good computational effectiveness.

5 OR status in Africa

Hans W. Ittmann investigated the current state of the operations research domain in the African continent in the paper entitled “The Current State of OR in Africa”. He pointed out the efforts have been made by the International Federation of Operations Research Societies (IFORS) and the European Association of Operational Research Society to boost the operations research field in Africa, over the last twenty years. However, the desired results have not been achieved yet. The creation of the AFROS was a major step toward the prosperity of the operations research field in Africa.

The second paper related to the OR status in Africa is entitled “A Scientometric Analysis of Operations Research and Management Science Research in Africa” by Majdi Argoubi, Emna Ammari and Hatem Masri. The authors conducted a Scientometric analysis of 3186 Operations Research and Management Science papers published by African authors between 1990 and 2018 and indexed in the Web of Science. The aim of this analysis is to investigate the role of the African countries and their contribution in the field of operations research and management science. It was found that the most promoted communities are maintenance optimization, metaheuristic, and vehicle routing. This investigation can guide African researchers and societies to exchange knowledge and realize new topics.

We hope that this special issue will provide readers with an overview regarding the various OR application in the Middle East and Africa. We would like to thank Professor Nikolaos F. Matsatsinis, Editor-in-Chief of the journal, for offering us the opportunity to edit this special volume and we look forward to more interesting application and research activity in the field of Operational Research.

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