Sustainable operations modeling and data analytics

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ABSTRACT

This editorial introduces the unique attributes of this special issue in the era of climate change, modern slavery, and big data. This special issue envisages the depth of penetration of sustainability, from strategy to the operations level, to understand the extent to which sustainability has attracted researchers and practitioners in dealing with various facets of operations management. Overall, it is encouraging to notice the research developments in all facets of operations management except process type, layout type, forecasting, and queuing. Out of three sustainability dimensions, this special issue received substantial contributions on economic and environmental aspects. All the contributions had at least two sustainability components in their decision models as well as newer analytical solutions. At the end, this piece outlines future research challenges and potential research opportunities.

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1. Introduction

Operations management growth is incredible, and it is amazing to see the contributions of researchers from the early nineteenth century to today in applying scientific methods to integrate firms globally to manage production and services, along with the unprecedented growth of technology. Today's business environment expects firms to be flexible and agile to deal with uncertainties in decision-making. Recently, in addition to conventional performance objectives (cost, quality, flexibility, dependability, and reliability), business operations are in a position to incorporate socially and environmentally responsible objectives in decision-making. Fortune 500 firms are green washing to leverage sustainable operations and navigating to turn socially responsible strategic competitive priorities into dominant objectives, in addition to conventional performance objectives. On the research front, the development of sustainable decision models is sporadic, and it is not obvious how far social and environmental objectives are incorporated into the various facets of operations management.

Some of the potential ways in which different operations facets can incorporate social and environmental objectives are as follows. In product and services design, conventional operational research models are available to check for economic feasibility, design feasibility, and technical feasibility. So far, sustainable objectives are not

well taken in the design phase of operations management. Similarly, all facets of operations management mandate sustainability decision models. A few potential research avenues to develop sustainable models within facets of operations management are given below.

This special issue aims to portray how proactive future operations management should be in the twenty-first century to design their competitive strategy based on social and environmental aspects. In response to our call, researchers contributed their perspective on how to build social and environmental decision models in different facets of operations management.

Most often, recent studies have developed decision models considering environmental and economic aspects without due attention to social aspects. In addition to an economic dimension to achieve ambidexterity in sustainability, coordination between the environmental and social dimensions is essential. Hence, this issue attempts to capture the developments in sustainable decision models in operations management.

Based on our call, we received 44 papers for the special issue. We had a tough time shortlisting the papers, because all the papers submitted were of good quality. Out of 44 papers, 50% of them—that is, 22 papers—were rejected at the end of first round of review. Finally, the special issue accepted 36.3%—that is, 16 papers—after two or three rounds of review. We engaged more than 100 reviewers to assess the contributions of the papers submitted to the special issue. We sincerely thank the reviewers for their timely reports and support, which were instrumental for us to successfully complete this special issue.

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Process type	How to include a sustainability dimension in addition to variety and volume while classifying process types.
Layout types	What are the models and methods suitable for incorporating sustainability aspects in layout design?
Logistics	Sustainable decision models for forward logistics, models that incorporate the influence of technology in decision-making.
Capacity planning	Sustainable capacity decision models that make trade-offs between productivity and utilization.
Forecasting	Effect of social and green effects in qualitative and quantitative forecasting.
Production planning and control	How to incorporate sustainability factors while developing automated material requirement planning and manufacturing resource planning. Development of rules to schedule operations based on social and environmental objectives in addition to time and cost.
Operations excellence	Trade-off model to include sustainable practices similar to quality practices to take care of triple bottom line performance.
Zero hazardous waste	Models and methods to achieve zero hazardous waste, similar to lean methods.
Job design	Human fair practices decision models in supply chain, benefit-cost models for trade-off between triple bottom line performance and productivity.
Queuing	Queuing models considering social and environmental aspects.
Project management	Multi-objective sustainable models and methods.

This editorial is organized as follows: section 2 summarizes the contributions to the special issue as per the operations management facet; section 3 analyses the contribution in terms of sustainable models and data analysis; and finally, section 4 narrates potential future research directions.

2. Summary of contributions

We classified the accepted papers as per our call in terms of the following operations facets: process type, layout type, logistics, capacity planning, forecasting, production planning and control, operations excellence, zero hazardous waste, job and work design, queuing, and project management.

2.1. Logistics

Two papers selected under this operations management facet focused on environmental and economic aspects in forward logistics, and the third paper focused on social aspects. The first two papers attempted to develop sustainable decision models considering economic and environmental aspects and relied on standard solvers. However, the third contribution in this facet focused on analytics by proposing a newer neighborhood method. The contributions included food distribution, semiconductor manufacturing, and generic services. Brief introductions to the three articles are as follows.

Soysal et al. illustrated the benefits of horizontal collaboration in reducing total logistics cost and greenhouse gas emissions. The authors developed a decision support model for a food sector involving multiple suppliers and customers considering perishability, energy use of transportation operations, and logistics cost in inventory routing. The authors demonstrated the applicability using a case study from the food sector with two suppliers. The overall outcome of their study indicates that the total reduction of total logistics cost varies from 4-24% and the emissions vary from 8-33% depending on supplier size, shelf life, and degree of horizontal collaboration.

Madankumar and Rajendran proposed green vehicle routing problems with pickups and deliveries in semiconductor supply chains. The authors proposed two mixed integer linear programming models, with the first model's objective being to select a set of minimum cost routes and schedules for alternative fuel vehicles that satisfies vehicle capacities and demand requests. In addi-

tion, the authors also scaled the model to include the scenario of varying fuel prices at different refueling stations with the objective of operating alternative fuel vehicles with routing and refueling costs. The authors compared the betterment of solution quality and time required to solve the proposed models with conventional models.

Bai et al. have proposed novel efficient neighborhood strategies considering the constraints of a service network design problem (SNDP). Solving a SNDP is a typical challenge, due to the complexity of the constraints and the scale of real-world problems. Hence, the authors derive an efficient transportation network and its corresponding schedules using their new neighborhood strategies based on paired route flipping. The authors compared the superiority of the proposed method in terms of solution quality with other high-level meta-heuristics strategies and other generic strategies.

2.2. Capacity planning

Two contributions selected under this operations management facet include services with contrasting capacity challenges in the food and maritime industries. The sustainable model in both contributions includes uncertainty and social issues. One paper out of the two selected under this facet proposed a procedure for fair allocation of capacity during competition. Summaries of the two studies are given below.

Hosseinifard and Abbasi discussed the sustainability and resilience issues of a blood supply chain. The authors considered a full-fledged blood chain, including suppliers, blood bank, and hospitals, as two echelons—first on the supply side, with stochastic arrivals of blood from donors, and the second on the demand side, considering the transfusion at hospitals with the role of inventory of perishable products. In particular, the authors show that inventory centralization for perishable products can lead to reduction in waste and shortage. The authors claim their model as novel due to the consideration of uncontrollable replenishment and perishable items in a two-echelon inventory system.

Parthibaraj et al. addressed challenges in the maritime industry by considering flexible freight rates and the coordination of market players with social interest. Hence, the authors developed a sustainable decision model for allocating ship capacity to satisfy shipping demand and generate a feasible route plan. In terms of analytics, the authors proposed multi-agent system modeling and an iterative enumerative combinatorial auction mechanism with Vickrey-Clarke-Groves payments to deploy ships at economically efficient prices. The authors evaluated the models using standard data from the literature.

2.3. Production planning and control

Two out of three articles selected under this facet discuss production planning and control issues in manufacturing, and the third one is on aquaculture. All three papers developed sustainable decision models including economic and environmental dimensions. In terms of analytics, the first paper by Elaouf et al. uses simulation, the second paper by Fahimnia et al. proposes meta-heuristics algorithms, and the third paper derives policies. Summaries of the three articles are as follows.

Elaouf et al. developed an optimization model to maximize the annual profit of recirculating aquaculture systems, a capital-intensive setup based on construction, equipment, and energy. The authors used a simulation model to replicate the real setup and proposed an optimization procedure using response surface methodology that includes the design of simulation experiments, stepwise regression, and a nonlinear objective function and constraints. The authors' major intention is to develop an effec-