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PREFACE

Data driven operational risk management

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Abstract
Operational risks exist everywhere. With fast changes in the real world, traditional risk management measures become insufficient. Instead, the importance of data-driven approaches increases dramatically. In this special issue, we collect high quality papers on different aspects of operational risk management with data analytics. Both theoretical issues and application results are included. The publications collected cover a wide range of research topics, like the value of blockchains towards risk management in high-tech manufacturing, the convex risk measures for solving risk-averse multistage stochastic programs, the balanced weighted extreme learning machine method for imbalance learning of credit default risk and manufacturing productivity, etc. The insights generated from this special issue can provide crucial guidelines for both the academia and the industry regarding risk management with the support of data analytics.

The world is full of turbulence, which brings great operational risks (Choi et al., 2016; Chung et al., 2017; Wallace, 2000). For example, a vehicle route based on pre-determined orders and travelling times could easily be disrupted due to unforeseen new orders, bad weather, traffic jams, or absent drivers. A factory may have to stop operations if the electricity supply is suddenly suspended. More seriously, disturbances in medical services could lead to disastrous consequences, as seen in the recent global outbreak of Coronavirus Disease 2019 (COVID-19) (Queiroz et al., 2022). Many districts in the world faced chaos at the early stage of the pandemic due to a surge in the number of patients, which imposed a great

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challenge for the daily operations of governments and medical organizations (Baveja et al., 2020; Ivanov, 2022). Owing to the fast development and explosive expansion of digital technologies like Internet-of-Things, blockchains, and mobile phones, data are generated in large amounts in daily operations for every organization (Hazen et al., 2018). Besides, advances in big data analytics grant people the capability to analyse massive amounts of data and generate insights (e.g., make predictions, identify anomalies). Therefore, although humans cannot control and avoid many sources of risks, it is feasible to learn from large amounts of data and respond quickly to the operational disturbances, thus bringing the disrupted operations back to schedule as soon as possible and minimizing losses (Araz et al., 2020). This way, it is possible to achieve real-time data driven operational risk handling. On the other hand, decision makers can manage the potential risks through data analytics at the tactical and strategic planning stages, which can enhance the robustness and resilience of operations at the operational stage (Smith & Merritt, 2020; Wen et al., 2020). Both approaches are valuable for operational risk management, which require new OR solutions and mindsets. It is thus crucial and necessary for academia and industry to explore how to advance operational risk management in the big data era.

This special issue of *Annals of Operations Research* on Data Driven Operational Risk Management collects high quality papers on different aspects of operational risk management with data analytics. Both theoretical issues and application results are included. All submissions have gone through stringent peer-review evaluation processes to guarantee that the contributions made are of top international standards required by *Annals of Operations Research*. In total, 11 papers are published in this special issue. Now, we are pleased to close this special issue and present the collection of articles to the community, covering a wide variety of topics including:

- The use of blockchain in risk management.
- Convex risk measures in stochastic programming algorithms.
- Imbalance learning in credit default risk and manufacturing productivity.
- Vehicle route planning in modular integrated construction transportation.
- Strategic risk control in airline schedule building process.
- Risk profiling in food security impediments.
- Integrated decisions in multi-stage mine production timetabling.
- Key components reservation in new product development.
- Financing risk management in green supply chain.
- Impact of unused baggage capacity on air cargo delivery efficiency.
- Hub location for integrated urban and rural logistics networks.

The publications collected in this special issue are briefly summarized as follows.

Choi (2022) investigates the value of blockchains for risk-averse high-tech manufacturers operating under government-imposed carbon target environmental taxation policies. The author develops the basic models with and without blockchain by considering whether the government is aware of the real level of the manufacturer's risk aversion. The impact analyses of blockchain integration reveal several insightful theoretical findings, including when it is advantageous for the high-tech manufacturer and the government to implement blockchains.

Dowson et al. (2022) study how to incorporate convex risk measures into stochastic dual dynamic programming algorithms for solving risk-averse multistage stochastic programs. The authors provide a derivation under the entropic risk measure. Numerical experiments, including two small-scale examples from transportation and finance as well as a large-scale hydro-thermal scheduling problem, are conducted to examine the advantages of employing the entropic risk measure for operational risk management.

Khan (2023) proposes a balanced weighted extreme learning machine for imbalance learning of credit default risk and manufacturing productivity. The proposed method integrates various sampling techniques with a weighted extreme learning machine in k-fold learning, thereby reducing data complexity and enhancing class distribution. Experimental analyses indicate that this method achieves superior classification performance compared to its original version and other widely used machine learning algorithms.

Eltoukhy et al. (2025) develop a sustainable vehicle route planning problem for modular integrated construction transportation, called a multi-trip time-dependent vehicle routing problem with time windows, uncertain unloading time, and environmental and social considerations. This problem is mathematically formulated as a mixed integer linear programming model and solved using an ant colony optimization algorithm.

Deveci et al. (2022) construct a multi-expert multi-criteria decision analysis approach capable of determining the ideal schedule structure for a new frequency in a network carrier airline, considering commercial and operational constraints. This approach combines the Best-Worst Method and the Technique for Order Preference by Similarity to Ideal Solution. The flexibility and applicability of the proposed method are demonstrated through its application to a real-world problem at a Turkish network carrier airline.

Gupta et al. (2023) introduce a risk profiling method for food security impediments with decision maker's behavioural preference in operational risk management. The proposed method presents a continuum of scenarios reflecting the relative importance of social, economic, and operational dimensions. By altering the importance of these dimensions, some risks exhibit robustness in their severity, while others are sensitive to minor changes. The authors provide valuable insights into risk profiling based on these dynamic shifts in risk perception.

Liu et al. (2022) design a novel integrated planning-scheduling problem for multi-stage mine production timetabling by leveraging the theory of parallel-machine flow shop scheduling with lot streaming. The authors devise an innovative math-heuristic approach, which integrates decomposed mixed integer programming models with heuristic algorithms under a three-level divide-and-conquer framework, to address this problem. The effectiveness of the proposed methodology in enhancing mining productivity is validated through theoretical analysis and extensive computational experiments.

Li et al. (2023) investigate the problem of reserving key components for new product development to manage risks, considering the suppliers' production plans and uncertain lead time. The authors formulate a two-stage distributionally robust optimization model based on a demand unsatisfied index, where demand is characterized by a scenario-wise ambiguity set. Experimental results show that the proposed model possesses a lower probability and magnitude of demand shortage compared to other benchmark models.

Lai et al. (2023) examine two types of single-dimensional suppliers' green strategies (i.e., green supply and green manufacturing) and determine the preferred green strategy of suppliers. By integrating green marketing into these two strategies, the authors further explore

two types of dual-dimensional supply chain green strategies to analyse the benefits and drawbacks of dual-dimensional versus single-dimensional green strategies.

Ma et al. (2023) study how much efficiency can be achieved by utilizing passenger unused baggage capacity for air cargo delivery. The authors formulate an air cargo demands-to-flights assignment problem and develop a hybrid genetic algorithm, where the uncertain remaining capacity is expressed using an exponential distribution function based on historical passenger baggage capacity data. Numerical experiments conducted with real flight data indicate the improvement in air delivery efficiency.

Li et al. (2023) propose a hierarchical hub location model for the integrated design problem of urban and rural logistics networks with demand uncertainty. This model accounts for the interactions among logistics hubs and among hub-and-spoke connections. The authors develop a demand scenario-based branch-and-Benders-cut solution approach. A case study in China demonstrates the advantages of the proposed methodology in reducing the expected total cost for the urban-rural logistics system.

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