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Optimizing logistics operations in a country's currency supply network

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ABSTRACT

We optimize a large country's currency supply network for its central bank. The central bank provides currency to all branches (who in turn serve consumers and commerce) through its network of big vaults, regional vaults, and retail vaults. The central bank intends to reduce its total transportation cost by enlarging a few retail vaults to regional vaults. It seeks further reductions by optimizing the sourcing in the updated currency network. We develop an optimization model to select the retail vaults to upgrade, so that the total cost is minimized. Optimally choosing which retail vaults to upgrade is strongly NP-hard, so we develop an efficient heuristic that provides solutions whose costs average less than 3% above the optimum for realistic problem instances. An implementation of our methodology for a particular state has generated a total cost reduction of approximately 57% (equivalently, $2 million). To optimize the sourcing, we

propose an alternative delivery process that further reduces the transportation cost by over 31% for the actual collected data and by over 38% for randomly generated data. This alternative optimizes the sourcing within the new currency network and requires significantly less computational effort.

KEYWORDS:

Financial services | currency network | sourcing optimization | mixed-integer programming | minimum cost flow

Additional information

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Yiwei Huang is currently a Visiting Assistant Professor in the Smeal College of Business at Pennsylvania State University (2016–2017). Her research interests lie in the general areas of logistics, supply chain management, and healthcare management. She received her Ph.D. (2016) in Supply Chain Management from Texas A&M University, M.S. (2009) in Operations Research from Southern Methodist University, and B.S. (2005) in Electronics and Information Engineering from Huazhong University of Science & Technology, Wuhan, Hubei, China.

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H. Neil Geismar is an Associate Professor in the Mays Business School at Texas A&M University. He was recently awarded a Center for Executive Development Professorship. He has a Ph.D. degree from the University of Texas at Dallas in Operations Management. His research addresses production scheduling, especially in the field of robotic cell scheduling; supply chain management, focusing on the coordination of the manufacturing and delivery functions through scheduling; currency supply chains in different countries; and remanufacturing. He has served as a consultant to industrial clients to improve their productivity and profitability. His papers have appeared in many journals, including Production and Operations Management, INFORMS Journal on Computing, Manufacturing and Services Operations Management, SIAM Review, and IIE Transactions. He was named Outstanding Senior Editor for Production and Operations Management for 2015 and serves on the Editorial Board for Surveys in Operations Research and Management Science. He is a member of INFORMS and of POMS.

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Divakar Rajamani is a Clinical Professor and Managing Director of the Center for Intelligent Supply Networks (C4ISN) in the School of Management, University of Texas at Dallas. His research interests include lean systems, product lifecycle management, supply chain management, factory planning, and transition planning. He has had a ten-year career in industry at such companies as i2 Technologies and General Motors, where he worked in a consulting capacity. He has provided consultation for companies such as Compaq, esi, Ericsson, FedEx Office, L3-Communications, and SAP. He also served as a tenured faculty and Associate Head of Industrial Engineering at the University of Manitoba. He has published in the operations management field and co-authored a book, Cellular Manufacturing Systems: Design, Planning and Control. He received his Ph.D. (1990) in Industrial Engineering from the University of Windsor, Canada; M.Tech. (1988) in Industrial Engineering from IIT- Delhi, India; and B.Tech. (1985) in Mechanical Engineering from IT-BHU, Varanasi, India.

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Marcelo Carlos is a Solutions Architect for Fiserv Cash & Logistics, responsible for creating and improving the mathematical optimization models behind all of Fiserv's cash management products. His main interests lie in product design, innovation, mathematical optimization, and user experience design. He has over 16 years of experience applying artificial intelligence and operations research tools to successfully solving problems in the discrete manufacturing, steel and financial industries. He holds a B.Sc. in Electronics Engineering from the Technological Institute of Aeronautics (ITA) in Brazil.

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