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Volume 49, 2017 - Issue 2

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Optimizing logistics operations in a country's currency supply network

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Pages 223-237 | Received 20 Feb 2014, Accepted 17 Jul 2016, Accepted author version posted online: 23 Aug 2016, Published online: 18 Dec 2016

Cite this article <https://doi.org/10.1080/0740817X.2016.1224958>

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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

Notes on contributors

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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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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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Suresh Sethi is Eugene McDermott Professor of Operations Management and Director of the Center for Intelligent Supply Networks at The University of Texas at Dallas. He has written seven books and published nearly 400 research papers in the fields of manufacturing and operations management, finance and economics, marketing, and optimization theory. He teaches a course on optimal control theory/applications and organizes a seminar series on operations management topics. He initiated and developed the doctoral programs in operations management at both the University of Texas at Dallas and University of Toronto. He serves on the editorial boards of several journals, including Production and Operations Management and SIAM Journal on Control and Optimization. He was named a Fellow of The Royal Society of Canada in 1994. Two conferences were organized and two books edited in his honor in 2005-2006. Other honors include: IEEE Fellow (2001), INFORMS Fellow (2003), AAAS Fellow (2003), POMS Fellow (2005), IITB Distinguished Alum (2008), SIAM Fellow (2009), POMS President (2012), INFORMS Fellows Selection Committee (2014-2016), Alumni Achievement Award, Tepper School of Business, Carnegie Mellon University (2015).

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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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