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Multi-Period Integrated Procurement and Production Problem for Perishable Products – An Extension of Traveling Purchaser Problem with Integrated Production and Distribution Systems

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Abstract

In today's intensely competitive industrial landscape, firms are under constant pressure to innovate and minimize operational costs. Traditional approaches that focus separately on production, inventory, procurement, and distribution are proving insufficient. This paper addresses the growing need for an integrated supply chain framework, particularly for perishable products, where shelf life constraints impose critical planning challenges. We propose a novel integrated model that simultaneously optimizes the procurement of perishable raw materials, production scheduling, and distribution planning to ensure timely delivery before product spoilage. The model accounts for the cumulative time from raw material storage through production and multi-echelon distribution, ensuring it remains within the product's lifetime. A Mixed-Integer Linear Programming formulation is developed to capture these complex interdependencies, and alternative metaheuristic approaches are explored to address computational scalability for larger instances. The results from computational experiments demonstrate the effectiveness and efficiency of the proposed approach, revealing substantial cost savings and improved service levels compared to disjointed strategies. Our model not only minimizes wastage and cost but also enhances customer satisfaction—offering significant promise for industries dealing with short-life products. This research contributes a novel optimization framework with practical relevance for perishables-based supply chains.

Keywords
Perishable Products, Integrated Procurement, Integrated Production and Distribution

Biographies
Somu Gorai is currently working as an Assistant Professor in the Operations and Supply Chain department at Indian Institute of Management, Jammu. He has done is Ph.D from IIM Calcutta in Operations Management. He did his Bachelors in Engineering and Technology from the National Institute of Technology(NIT) Jamshedpur . He has also worked in Tata Steel Jamshedpur as a Manager-IT . His responsibilities included looking after the various modules like Forecasting and demand management, Production planning ; Supply capacity planning for the Flat product supply chain at Tata Steel. His research areas include Integrated production and distribution, Perishable products inventory, and Vehicle routing problems.

Bodhibrata Nag is a renowned academic and operations expert, currently serving as Professor of Operations Management at the Indian Institute of Management (IIM) Calcutta. He holds a B.Tech in Electrical Engineering from IIT Madras and a Ph.D. (Fellow) in Operations Research and Systems Analysis from IIM Calcutta.
Before joining academia, Professor Nag held senior leadership positions in Indian Railways and the Central Electricity Authority, including Director at RDSO, Ministry of Railways. His industry experience has significantly enriched his teaching and research, particularly in areas such as transportation systems, infrastructure planning, and energy management. At IIM Calcutta, he has held key administrative roles, including Acting Director, Dean (Academic), Chairperson of Doctoral Programs, and Director of the IIM Calcutta Innovation Park. He played a leading role in launching the PGPEX-VLM program and several executive education initiatives in supply chain management. His research interests include operations research applications in supply chains, energy systems, and cybersecurity. He is the author of two books: Optimal Design of Timetables for Large Railways and Business Applications of Operations Research, and co-author of the Indian edition of Introduction to Operations Research by Hillier & Lieberman. His work is widely published in reputed journals and conferences.