Batching Decisions for E-Commerce Order Fulfilment: Technology, Models, and Data Insights

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Abstract:

Due to today's customer expectations of fast delivery of a wide-range of products, companies are under pressure to reduce the order fulfilment time, i.e., the time from receiving an order to the time it takes to get an order to a customer's home or to its stores. In this research, we particularly focus on reducing item picking process times for E-Commerce orders by investigating how to design and operate dynamic order batching policies in parts-to-picker systems.

E-commerce orders require piece picking and are special because most of the order sizes are one and there could be item commonalities between orders that can be leveraged for improving throughput times in the picking process. In dynamic batching, multiple orders are processed in parallel but an individual order is released as soon as it is complete. A dynamic batching policy has the advantages of both sequential processing (by meeting individual order deadlines) and static order batching (by fulfilling several orders concurrently thereby reducing the completion time per order). The execution of a dynamic batching policy in a distribution center necessitates investment in a complex and expensive material handling system that enables the release of order totes, which violate the first come first serve queue discipline.

The goal of this research is to understand how best to design and operate a dynamic batching system in a parts-to-picker system. Specifically, we are interested in how the order batch size, item commonalities among orders, wait for items, item pick time and tote-interchange time can affect the performance of static and dynamic batching decisions, and how incoming order profile data can be used to improve performance through sequencing. Specifically, we will answer two research questions:

- What is the difference in throughput of a pick station that uses a static order batching policy versus one that uses a dynamic batching policy? We will explore various environmental factors (such as item commonality between orders, batch size, and order delivery deadline schedules).
- How should orders and items be sequenced to improve throughput performance in dynamic batching systems? Order sequencing algorithms will be developed and the effectiveness of algorithms for dynamic batching will be evaluated using order profile data.

Speaker Profile:

Prof Debjit Roy is an Associate Professor in Production and Quantitative Methods area at Indian Institute of Management Ahmedabad, India. He holds a PhD in Industrial Engineering (with a major in Decision Sciences/Operations Research and a minor in Computer Science) and an MS in Manufacturing Systems Engineering from the University of Wisconsin-Madison besides an M.Sc. (Engineering) from the Indian Institute of Science, Bangalore, India. He is also a part-time appointment with the Rotterdam School of Management, Erasmus University where he is associated with the SmartPort and Material Handling Forum initiative, and supervises thesis for doctoral and MSc students in technology and operations management.

His research focuses on improving system performance using quantitative methods such as stochastic modeling and optimization. His specific research interests are to estimate the performance of logistical and service systems such as container terminals, automated distribution centers, vehicle rental and restaurant systems. He has received several research awards including the IIE Transactions best conference paper award in Facility Logistics (2011) and honorable mention designation in the IIE Transactions best applications paper award competition (2016), and has published in several leading international journals such as Transportation Science, IIE Transactions, Interfaces, European Journal of Operational Research, Computers and OR, and Annals of Operations Research.