# DISSERTATION PROPOSAL

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## "Resilient Supply Chain"

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Supply chains are facing imminent threats from disruptions either due to natural or human uncertainties. The need of the hour is to make our supply chains efficient and robust to such threats. The dissertation is a step in this direction. We use data-driven approaches to solve real-world applications while being agnostic to methodology.

In the first chapter, we solve the order fulfillment problem under pick failure. In omnichannel ship-from-store programs, the uncertainty of demand and human inefficiencies lead to pick failures at stores. We model pick failure explicitly to minimize the cost of order fulfillment. We provide a polynomial-time algorithm for single-item order fulfillment and use the structure of the optimal policy to design heuristics to solve the harder multi-item order problem.

In the second chapter, we propose the dynamic version of the fulfillment problem where we aim to learn the pick-failure probabilities on the fly as we fulfill orders from stores. We will model the single-item order problem in a cascading multi-armed bandit framework and hope to derive bounds on cumulative regret with respect to the omniscient agent minimizing expected fulfillment cost with full information of the pick failure probabilities. We also hope to extend some of the analysis to the much harder multi-item order problem by comparing with simpler benchmarks.

In the third chapter, we address the problem of detecting merchandising errors using sales data. Retailers are very careful about the shelf placement of their products as it significantly affects product sales. The actual execution of the merchandising strategy is done by store-level employees, and is subject to frequent errors. Merchandising errors should hypothetically manifest in available data such as store receipts. In this context, the question we seek to address is whether such merchandising errors be detected from data and corrected effectively.

In the fourth chapter, we solve the baseline demand prediction problem in light of disruptions using real sales data that we have access to from a large retail data firm. A key requirement to assess the impact of promotions is to predict the baseline sales that would have occurred in the absence of promotions. Retailers typically maintain a forecast of such baseline sales of all SKUs for operational efficiency. The demand disruption due to COVID-19 threw off the retailers' baseline predictions. We created a new matrix-based baseline demand prediction model and incorporated COVID-specific features in the model to make it amenable to accurate predictions after demand disruption.

In the fifth chapter, we propose to work with our retail sales data for better assortment planning before and after disruptions like COVID-19. After the onset of COVID, when their preferred products are missing, customers exhibit significantly different substitution behavior than from before the pandemic. The stock-out frequency of products is also higher and different during COVID due to stockpiling by customers. We plan to use and modify customer choice models from the literature to capture this effect and make better assortment decisions after disruptions like COVID.