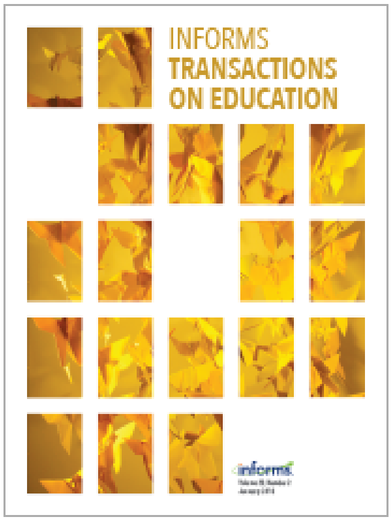

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Case

Swirltubs After-Market Product Inventory and Service

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Swirltubs manufactures appliances, such as washers, dryers, dishwashers, refrigerators, and stoves, among other products. Swirltubs offers after-market warranty service and repairs to its customers when their appliance has a problem. Jim Jenkins, the director of after-market logistics for Swirltubs, oversees a network of approximately 1,000 service technicians who conduct these warranty repairs. They carry service parts inventory on their vans for warranty calls that require a replacement part. Jim manages the technicians and the inventory that is required to support the warranty program. He is responsible for both the costs of this program and the customer service provided by the technicians.

Swirltubs is concerned about inventory levels throughout the organization. Parts can be expensive. The cost of holding for Swirltubs is 25% of the part cost per year, including interest, insurance, damage, loss, and other inventory holding costs.

Jim is concerned about carrying the inventory on the 1,000 service vans. Carrying any part in 1,000 different vans instead of only at the distribution center requires significantly more units of that part in total for Swirltubs. Holding them only in a central location and sending them as needed would reduce inventory significantly for Swirltubs.

On the other hand, technicians need parts to conduct repairs. An important metric of service is the percent of time technicians fix the appliance on the first visit. If the part is on the truck, the technician uses it, completes the repair, and orders a replacement for his or her inventory. Of course, trucks have limited useful space for parts (about 500 cubic feet), so technicians might not always have the required part.

If the part is not on the truck, the technician orders a part from the central warehouse and revisits the customer when it arrives. Of course, customers are not happy about waiting to get their appliances fixed, which reduces Jim's customer service level. Also, without the required part, technicians waste time driving back to remote customers. Driving time reduces the amount of time available for actual repairs, reducing the number of repairs per week they can conduct, another important metric. Technician time is expensive at $50 per hour. The time to drive to a customer averages about 30 minutes per customer for most technicians.

Though Jim is in charge of inventory, technicians are highly protective of their vans. Technicians like to devise their own strategy on what to stock because they have a sense for their individual territories. Generally, they do not want Jim to interfere with what they consider their space. Some look at minimal inventory as desirable as it is easier to track and organize. Other technicians pack parts on their trucks, even going so far as to stock parts in sheds so that they are more likely to have what they need for any call. As a result, each truck has somewhat unique inventory holdings.

Jim is struggling with this problem. Appliance breakdowns are essentially random; there is almost no way to predict what is going to break or where. He can't stock every part out there—there is no room and it would cost too much. Still, his biggest headache is customer complaints about waiting for a part to complete a repair.

Jim has tried to take control of the technicians' on-van stock, both because they do not feel the cost of holding more parts and because he senses he could do a better job with determining the best stock centrally with a more analytical approach.

So far, he has tested various rules, such as

1. Only stock parts with annual usage greater than some number.
2. Do not stock parts with a cost greater than some dollar amount.
3. Do not stock parts greater than some cubic size.

He is not sure those rules are working. Technicians are still out of important parts sometimes, and technicians often disagree with many of his suggestions on what to carry.

He has collected data for a typical technician's parts needs for the past year. The data include part number, the average number of uses in the year, part size (in cubic feet), and part cost. He has excluded the rarely used and more outdated parts and has included only the 400 or so parts that are used in about 80% of the technician's typical annual repairs.

Typically, a single part is needed for each repair. Jim assigns a single part number to any group of parts that are used together, and they are stocked as a single part in the system.

Technicians work five days per week, 50 weeks per year. Delivery time is five business days.

Case Part 1: Introductory Meeting with Jim Jenkins

Jim wants to discuss the problem with an outside expert.

- What questions are important to ask Jim in order to understand the problem?
- How would you characterize and quantify the problem?
- What are the assumptions required to address this problem?

Case Part 2: Test Problem Optimization

Preliminary investigation into the problem reveals that the full problem is too big to solve in Excel using the built-in solver software. However, Jim did not want to purchase higher-end optimization software.

Jim set up a test case with 30 parts. He chose the 10 smallest, lowest-cost, and most-used parts out of the 400 because he feels they are the best parts to carry. Jim wants to know which parts are best in this small test case.

Develop an optimization model. Carefully and precisely define the decision variables, objective function, and constraints. Evaluate the optimal solution, characterizing the parts that are stocked and not stocked.

Case Part 3: Heuristic Comparison

In order to understand how well various rules of thumb perform, Jim asks you to compare the heuristics that he has tried to the optimal solution for the test data set (e.g., stock the smallest parts, stock the lowest cost parts, stock the highest demanded parts).

Based on the comparison of the optimization analysis to the heuristics, experiment with developing other simple heuristics of your own that might allow him to get a better stocking strategy. Compare the heuristic performance to the optimum and the other heuristics using the test data set.

Finally, apply your rule to the full data set in the original problem and make a truck stock recommendation.

Case Part 4: Uncertainty of Part Usage

Jim observes that in any given year the actual part needs for technicians will vary, so actual service and cost levels may vary because of the randomness of part demand. Jim asks you to test the recommended truck stock against uncertainty of part demand, evaluating how well it performs in the face of random part breakdowns.

Jim would like to see a risk assessment of the recommended truck stock. What are the fix-it-first percentages and total cost distributions? Describe the cost and service risk associated with the recommended truck stock.

Case Part 5: Reoptimization Under Uncertainty

As observed, part breakdowns are random and different for each technician. Jim notes that the recommended solution may be misleading because it may not be best for all technicians or for future repair patterns if there are differences in part usage.

Though we have estimated the cost and service risk of the recommended stock, we have not evaluated how the recommended stock might change as demand changes. The decision to stock a part depends on demand; if our estimate of demand is incorrect, it could mean our recommended stock is incorrect. Jim wants to figure out to what extent the optimal parts chosen would change if the input data changed.

Jim would like to see recommended truck stocks for different levels of random demand and understand whether the recommended stock is significantly different if the part breakdowns change.