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Practice Summaries: American Airlines Uses Should-Cost Modeling to Assess the Uncertainty of Bids for Its Full-Truckload Shipment Routes

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We used decision analysis to develop a probabilistic model to help American Airlines assess the uncertainty of bid quotes for its full-truckload (FTL) point-to-point freight shipments of maintenance equipment and in-flight service items in the United States. The model reduced the airline's risk of overpaying an FTL supplier.

Key words: decision analysis: applications; cost analysis; industries: transportation/shipping.

American Airlines, Inc. (AA) is the world's largest airline in passenger miles transported; its annual revenue is over $21 billion. Although its goal is passenger transportation, AA must minimize the costs of ancillary functions that are not related to its core business. One of these functions includes the full-truckload (FTL) freight shipment of maintenance equipment and in-flight service items for passengers. At any given time, the system inventory for these goods can be over $1 billion, creating a web of complexity as goods move point-to-point worldwide.

The purchasing department in AA's transportation and logistics group presented the Supply Chain Resource Cooperative at North Carolina State University with an opportunity to explore the costs associated with its FTL shipments in the United States. Specifically, AA desired a *should-cost* model to assess bid quotes for its FTL point-to-point freight shipment routes to ensure that AA does not overpay or underpay its FTL suppliers. We developed a probabilistic model using a decision tree that estimates reasonable costs for FTL freight shipments.

AA begins the bid process for an FTL point-to-point shipment route by sending out a request for quote (RFQ) to prospective suppliers. Suppliers respond to the RFQ, and AA does a side-by-side comparison of the bids. In any given year, AA's purchasing department has approximately 500 RFQs in its bid process. Bid quotes in the long-haul trucking industry can differ significantly. AA is no exception; its single-contract bids can deviate by as much as 200 percent. To account for this variability and to identify potential overbids and (or) underbids, we (1) collected base-case and range data from primary and secondary sources on the cost variables that can affect an FTL bid, (2) ensured that the cost variables were mutually exclusive and collectively exhaustive, and (3) modeled the uncertainty using the DPL decision analysis software. Primary research involved interviewing a number of trucking firms and truck manufacturers. Secondary research involved collecting data from various trucking websites, government websites, and trucking forums, and reviewing the literature.

AA piloted our should-cost FTL model against an RFQ consisting of bid quotes from six FTL carriers. We used DPL to conduct one-way sensitivity analyses of the cost variables (see Figure 1). The base-case deterministic value (shown by the vertical line

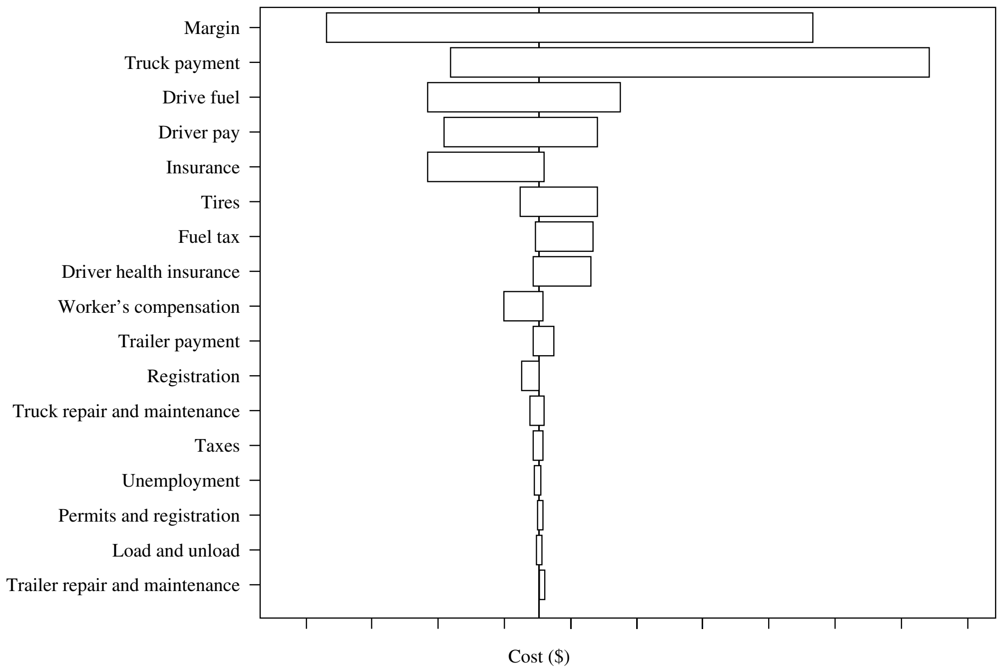

Figure 1: We varied each cost variable from its base-case value over its range of estimated values while leaving the other variables set at their base-case values. The most sensitive cost variables were margin and truck payment. We removed cost values for confidentiality purposes.

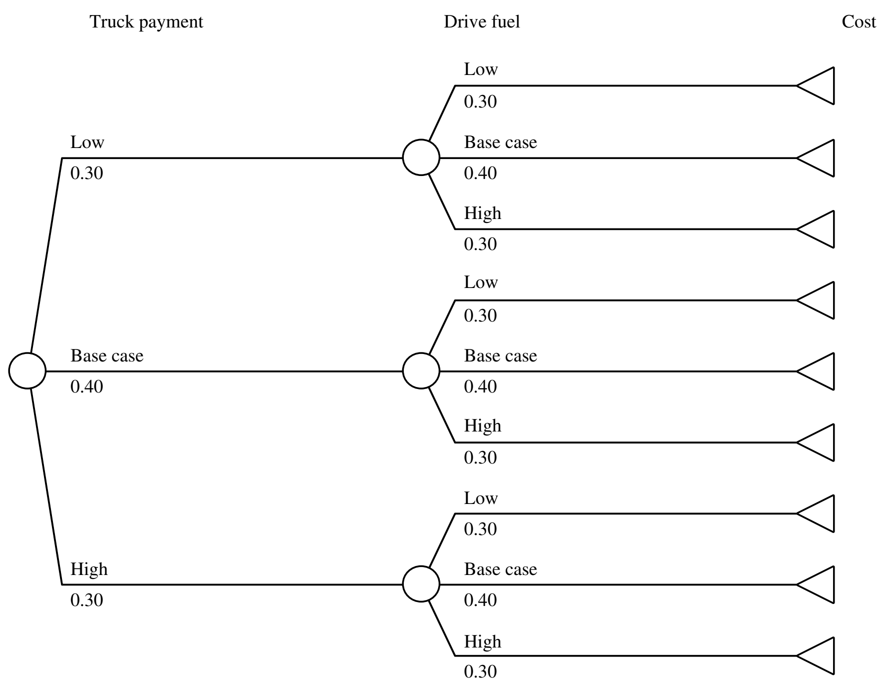

Figure 2: The simplified decision (probability) tree illustrates three-point discrete probability distributions for two of the 10 most sensitive variables—truck payment and drive fuel—using the extended Swanson-Megill (ESM) approximation.

in Figure 1) was lower for four bids and higher for two bids. To account for variability in the bids, we used the extended Swanson-Megill (ESM) approximation to model the probability distribution of the 10 most sensitive cost variables shown in Figure 1. Figure 2 is a simplified decision (probability) tree for the fully expanded tree that has 3^{10} (59,049) end points. The ESM approximation is a three-point discrete probability distribution for each continuous random variable and requires base-case and range estimates (10th, 50th, and 90th percentiles) for each variable. The ESM approximation assigns a probability of 0.3 to the 10th percentile, a probability of 0.4 to the 50th percentile, and a probability of 0.3 to the 90th percentile. We used DPL to analyze the cost data probabilistically. Five of the six bids for this RFQ were within three standard deviations from the mean, whereas one bid was an outlier and likely an overbid.

Since the pilot test, AA has used our should-cost FTL model on more than 20 RFQs. The model has assisted AA in prioritizing its contractual opportunities and has provided an accurate assessment of what the FTL costs should be; this allowed AA to minimize the risk of overpaying and underpaying its FTL suppliers. AA anticipates being able to (1) develop a cost structure for each FTL shipping route and (2) negotiate prices during its bid process for each route based on the results from the should-cost model.

Note to Future Authors: The goal of *Practice Summaries* is to present short descriptions of successful applications of operations research methodology, with measurable impact in practice, to a wide range of industrial applications. For information on submitting your manuscript, please see http://www.informs.org/Pubs/Interfaces/NEWS/Call-for-Practice-Summaries.