PROJECT SUMMARY

Texas Department of Transportation

0-6693: Equipment Replacement/Retention Decision Making

Background

The Texas Department of Transportation (TxDOT) vehicle fleet is a fundamental part of the departmental infrastructure, enabling many activities essential to accomplishing daily departmental operations. Maintenance of a robust vehicle fleet is essential but costly. Reductions in fleet costs are potentially beneficial to the department as a whole and thereby beneficial to Texas taxpayers. Currently, TxDOT owns and maintains an active vehicle fleet of approximately 17,000 units and annually replaces approximately 10 percent of its fleet. In monetary terms, TxDOT has a fleet valued at approximately $500,000,000, with an annual turnover of about $50,000,000. Any methodology that can improve TxDOT's replacement procedures can potentially save millions of dollars.

Also critical is being able to respond adequately under disaster/emergency conditions, which requires maintaining a fleet robust enough to capably respond in a multi-event contingency. TxDOT is considered a first responder in times of disasters, with the mission of clearing roadways ahead of emergency aid and assisting the Division of Emergency Management (DEM) with specialty equipment and manpower. In this regard, the increment of equipment above and beyond the day-to-day "right size" quantities must also be clearly established.

What the Researchers Did

The research team undertook several tasks for this project. First, researchers conducted a comprehensive review of the state of the art and state of the practice in the use and development of advanced optimization techniques in the current TERM2 equipment replacement optimization (given the results of TxDOT Project 0-6412). Researchers also reviewed the use and development of advanced optimization techniques to solve the optimal fleet vehicle allocation and facility location problems, particularly under disaster/emergency event scenarios.

Researchers then identified several issues related to the original strategy implemented to estimate and forecast future equipment purchase costs for Project 0-6412. Of several strategies developed and tested, the best method was implemented in the new TERM2 software to investigate future uncertain purchase costs due to technology changes and to model the future uncertain purchase costs. The impact of future uncertain equipment purchase costs on equipment replacement decision making was also investigated through the conducted sensitivity analyses.

An optimization and evaluation framework was developed in the new TERM2 software to investigate how to estimate costs to the department of *not* replacing equipment when it should be replaced (i.e., determine the increase in cost when delaying replacing equipment). In addition, the downtime costs, operations and maintenance (O&M) costs, and mileage forecasting methods in the previous ERO software were also reviewed. Several issues were identified, and modification strategies were developed and implemented in the new TERM2 software to improve forecasts.

Texas' emergency management strategy and support concept and the levels of commitment to the DEM and Department of Public Safety, particularly from the fleet management perspective, were comprehensively reviewed. A comprehensive online survey was conducted of how other state departments of transportation and major metropolitan governments manage their fleets to handle multiple disasters. The survey results yielded insights into the state of the practice.

Finally, TxDOT's historical fleet usage data during several disaster/emergency events were collected and analyzed.

Research Performed by:
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Project Completed:
8-31-2013

Based on the analysis, the two most likely simultaneous events in Texas were identified.

What They Found

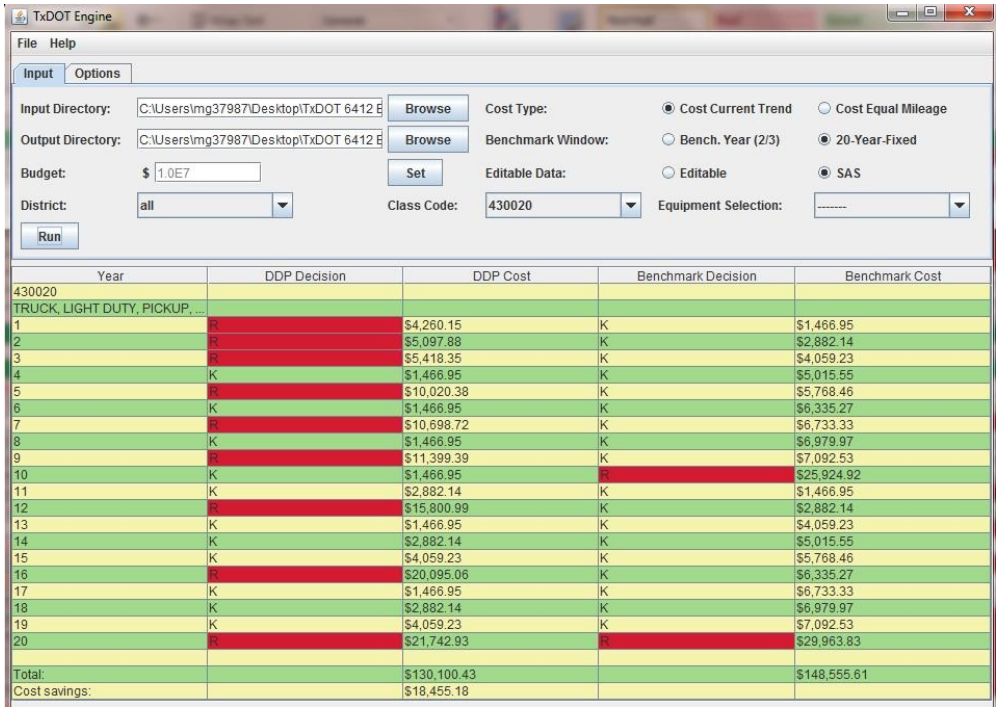
The best algorithm to forecast future purchase costs was identified. It first removes the remaining outliers for the purchase cost across all model years. Then, it checks the following three conditions: whether the sample size is greater than 6, whether the slope of the linear model is positive, and whether the R-squared value is greater than 0.6. If any of these three condition checks fail, then the software uses the one-half inflation rate model to conduct the future purchase cost forecast. If all three condition checks pass, the software uses the developed linear regression model.

The best algorithm to forecast O&M costs was also developed and implemented in the new TERM2 software such that all classcodes will generate appropriate forecasts and results, based on the best available use of the historical TERM data, regardless of sample size or other data characteristics. The comprehensive testing of all classcodes indicated satisfactory and quality down-time cost, O&M cost, and mileage forecasts.

What This Means

The newly developed TERM2 ERO software provides more reliable statistical and equipment replacement decision-making results based on the new development and implementation of various advanced forecasting strategies and the optimization framework. It can be used to make optimal keep/replace decisions for districts for both new and used vehicles; both with and without annual budget considerations; and based on the equipment classcode, age, mileage, salvage value, and replacement cost—either obtained externally or calculated internally by using the developed SAS macro codes.

The solutions produced by using the software are both efficient and effective. TxDOT can save significant funds using the TERM2 ERO software. However, the method developed may not be a fit for all fleet acquisition and funding scenarios.



Year	DDP Decision	DDP Cost	Benchmark Decision	Benchmark Cost
430020				
TRUCK, LIGHT DUTY, PICKUP, ...				
1	R	$4,260.15	K	$1,466.95
2	R	$5,097.88	K	$2,882.14
3	R	$5,418.35	K	$4,059.23
4	K	$1,466.95	K	$5,015.55
5	R	$10,020.38	K	$5,768.46
6	K	$1,466.95	K	$6,335.27
7	R	$10,698.72	K	$6,733.33
8	K	$1,466.95	K	$6,979.97
9	R	$11,399.39	K	$7,092.53
10	K	$1,466.95	R	$25,924.92
11	K	$2,882.14	K	$1,466.95
12	R	$15,800.99	K	$2,882.14
13	K	$1,466.95	K	$4,059.23
14	K	$2,882.14	K	$5,015.55
15	K	$4,059.23	K	$5,768.46
16	R	$20,095.06	K	$6,335.27
17	K	$1,466.95	K	$6,733.33
18	K	$2,882.14	K	$6,979.97
19	K	$4,059.23	K	$7,092.53
20	R	$21,742.93	R	$29,963.83
Total:		$130,100.43		$148,555.61
Cost savings:		$18,455.18		

Figure 1. Software Output Display with Early Replacement Recommendations for Classcode 430020.

For More Information

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