This topic is "practice ready." ☒ **Yes** ☐ **No**

Predicting high frequency failure components, costs, and their first occurrence for a class of vehicles at the Iowa Department of Transportation.

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Abstract

Big Data and Data Analytics has become a necessity for organizations to remain competitive or reduce operational costs. Analytics methods can be used to conduct descriptive, diagnostic, predictive, or prescriptive explorations of data. Many departments of transportation have large collection of data on a plethora of equipment and many are attempting to apply these analytics solutions.

In this paper, we present a study of a class of vehicles, namely, snow plows, that the Iowa Department of Transportation uses. Iowa DoT collects substantial amount of data on repair events and costs for several classes of vehicles. Applying analytic methods, specifically, descriptive and diagnostics analyses, help answer two questions. First, which parts fail more often and cause heavy repair costs? Second, can an estimate of the time of first failure be determined? A third question explored differences between manual and automatic transmission vehicles.

Any machine requires periodic maintenance and often requires replacement or repair of worn parts to sustain good serviceable life. Such maintenance will either restore the machine to its original level of performance or extend its usability until such time that it is replaced. As these maintenance activities are repeated over the life of the machine, data are available to explore and identify discernable patterns of diminishing utility. It is known that after a few years of continuous usage, Iowa DOT starts to incur increasing repair and maintenance costs for all classes of vehicles. Often, an optimal time to stop maintaining and sell off these vehicles is determined mostly on gut instincts or just a rule of thumb.

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Selling poorly performing vehicles at the right time will not only avoid unnecessary repair costs but also help Iowa DOT recover higher resale value.

Repair data, including cost of repairs, type of repair, days of service, etc. are collected and analyzed for 721 A07 class of vehicles. These vehicles have accumulated 219,973 repair events over the ten-year period from 2004-2013. In order to analyze the data on repair costs and events, we treated the data to follow the Non-Homogenous Poisson Process (NHPP) distribution. A *non-homogeneous Poisson process* is similar to an ordinary Poisson process, except that the average rate of arrivals (repair events) is allowed to vary with time (more repairs as vehicle ages). The analyses showed that repairs and associated costs increase between 3,000 and 5,000 days of service. Analyzing the repair data revealed that the top repair events contributing to the rising costs, excluding repairs for brakes and tires, are repairs for engine, transmission, radiator and clutch, respectively. Engine repairs typically occur around 3.2 years (1,180 days) of life. Among transmission failures, manual transmission based vehicles had a higher propensity of failure than automatic transmission vehicles.

Our results provide decision guidance to Iowa DoT in that they can anticipate significant engine repairs to occur around 3.2 years or 1,180 days of operation. Furthermore, peak costs of repairs will come between 3,000 and 5,000 days of operation. Additionally, comparison of manual versus automatic transmission vehicles suggests the need to explore additional factors that may influence failures.

Keywords: Analytics —descriptive and diagnostic analyses -- maintenance—non-homogenous Poisson process