Title: Optimizing the Aquisition of Heavy Equiptment for Small Businesses

Summary: Project Proposal for University of Virginia SYS 6014 Decision Analysis Spring 2020

Author: David Hill, Jr.

Introduction

In the real estate industry, there is a huge opportunity for digital transformation. Moreover, there is a strong need for data driven analysis tools to empower small to medium-sized real estate companies to realize their fullest potential. With this project I would like to introduce a decision analysis tool to help real estate development companies evaluate key business decisions namely relating to the acquisition of real-estate development equiptment. The target decision maker for this tool is the owner or executive of a small-medium sized real-estate development company. For companies of this nature, financial resources are often limited so it is imperitive for them to make a wise decision regarding the acquisition of heavy equiptment. Often times this equiptment is very expensive to buy and a decision of whether to lease or buy is critical to the longevity of the business.

A poor acquisition decision can lead to project failure, injury to personnel and significant loss of capital which can be crippling to a small business. Thus, the approach of this tool will be to provide a classic rent versus buy analysis based on the decision maker's access to capital, financial posture, and goals. The innovation of this tool is in the inclusion of equiptment condition based on age and use in the decision model. This will provide a propability of catastrophic failure to various categoriztions of equiptment so the decision maker not only knows whether to rent or buy but also what condition of equiptment they should seek.

Decision Problem

We define the decision maker's action set A as the set of actions the user can make within our decision tool.

Let α_1, α_2 ,..., $\alpha_n \in A$

where:

α_1 = Buy a new bulldozer with service contract in cash

α_2 = Buy a new bulldozer without a service contract in cash

α_3 = Buy a new bulldozer with service contract with loan

α_4 = Buy a new bulldozer without a service contract with nloan

α_5 = Rent a bulldozer

α_6 = Buy a used bulldozer with a service contract in cash

α_7 = Buy a used bulldozer without a service contract in cash

α_6 = Buy a used bulldozer with a service contract with loan

α_7 = Buy a used bulldozer without a service contract with loan

We define the state space X as the set of possible outcomes.

Let χ_1

where:

χ_1 = The bulldozer suffers a catastrophic failure

χ_2 = The bulldozer will not suffer a catastrophic failure.

We define the parameter space Θ as the set of unobserved parameters that will represent the period of time until a catastrophic failure is expected. We will use a Poisson distribution on our data to achieve this.

Let θ_1, θ_2 ,..., $\theta_n \in \Theta$

where:

θ_1 = The probability of a catastrophic mechanical failure in the next 2 years

θ_2 = The probability of a catastrophic mechanical failure in the next 4 years

θ_3 = The probability of a catastrophic mechanical failure in the next 6 years

θ_4 = The probability of a catastrophic mechanical failure in the next 8 years

θ_5 = The probability of a catastrophic mechanical failure in the next 10 years

Predictive Model

The novel predictive value this tool will provide is it's ability to predict catastrophic equiptment failure given it's wear. This will reduce uncertainty for a decision maker who is assessing used equiptment options. This uncertainty is directly related to the payoff of our decision model as there is a monetary benefit to purchasing a used piece of equiptment over new equiptment. However, used equiptment poses a higher risk of catastrophic mechanical failure.

This tool will be created using python and be deployed in the form of a command line application. The data used will come from heavy equiptment manufacturers such as CAT, Caterpillar and John Deere, as well as, equiptment rental companies. Data and formulae will also come from the US Army Corps of Engineers Construction Equipment Ownership and Operating Expense Schedule.

The tool will make predictions based on Bulldozer failure data. By using a Poisson Distrubution we will determine the probability of failure for a bulldozer with a certain amount of use.

Value

The value of this tool is in minimizing the cost of ownership for the decision maker. The tool helps decion makers weigh the pros and cons of renting, buying new, and buying used and helps balance risk v.s monetary benefit to accomplish the organization's goals.

References

Some of the sources that will be used in the development of the tool:

U.S. Army Corps Operating Expense Schedule Region 2

Poisson Distribution Process

Used Bulldozers

John Deere

CAT

Foley Equiptment

Bulldozer Rental

Bulldozer Rental