PHH Arval - Trucks

Maximizing Fleet Efficiencies with Predictive Analytics

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Maximizing Fleet Efficiencies with the use of Predictive Analytics

Equipment leasing companies provide billions of dollars yearly for capital ventures in just the US alone. In turn manufactures are able to produce goods, provide services, or invest in other ventures at reasonable cost levels resulting in increased growth rates. A major benefit to leasing equipment compared to ownership is the option that a lessor has to replace the equipment once the cost begins to outweigh the inherent benefits. What is cost? How should it be measured? Understanding costs can be as simple as looking at a financial statement line and determining if it is a direct cost or an indirect cost. Unfortunately, this approach does not provide customers with the level of detail that is needed to make good business decisions. Predictive analytics is a method of compiling massive amounts of data, which can be used to build sophisticated statistical models; will provide us with information and allow us to make financial predictions with extremely high levels of confidence. The following is a basic overview and approach to predictive analytics and how it can benefit our customers.

1. Issue

Our customers have requested that we provide them with a repair and maintenance cost analysis on their fleet. This analysis will allow them to monitor and predict their fleet's costs and assist them in determining when the optimal vehicle replacement points should be.

2. Purpose of Analysis

It is generally accepted in the industry that repair and maintenance costs increase as the vehicle's utilization and age increases. Therefore, the purpose of this analysis will be to develop a Predictive Vehicle Component Failure Model (PVCFM) that will forecast significant component failures throughout the life cycle of the vehicle(s), and provide recommendations to our customer on their current fleet. This in turn will allow our customer with the opportunity to:

- Maximize their current fleet's efficiency by replacing vehicles at the determined optimal replacement point
- Realize cash savings by avoiding unnecessary repair and maintenance costs

3. Data Extraction and Validation of Population

Historical repair and maintenance data was extracted from our in-house repair and maintenance tracking database that includes several key categories as follows:

Vehicles Current Age	Mileage
Model	Repair Dates
Make	Work Orders
Repair Category	Region
Cost	Driving Habits
Mileage	Etc.

Note: there are several different approaches to the information gathering process. Our customer may benefit from providing us with information that is stored in their own system. In many cases, a conclusion can be drawn from any amount of data.

The population of vehicles used for this analysis covered the following ranges:

- Repair and maintenance dates (01-01-2008 to 05-31-2012) – (4 Years).
- Ages of vehicles (1 – 16 years old)
- Total vehicle population was 3,054

The following table shows the range and allocation of the vehicle population used:

Table 1

% Allocation of Vehicle Count by Age

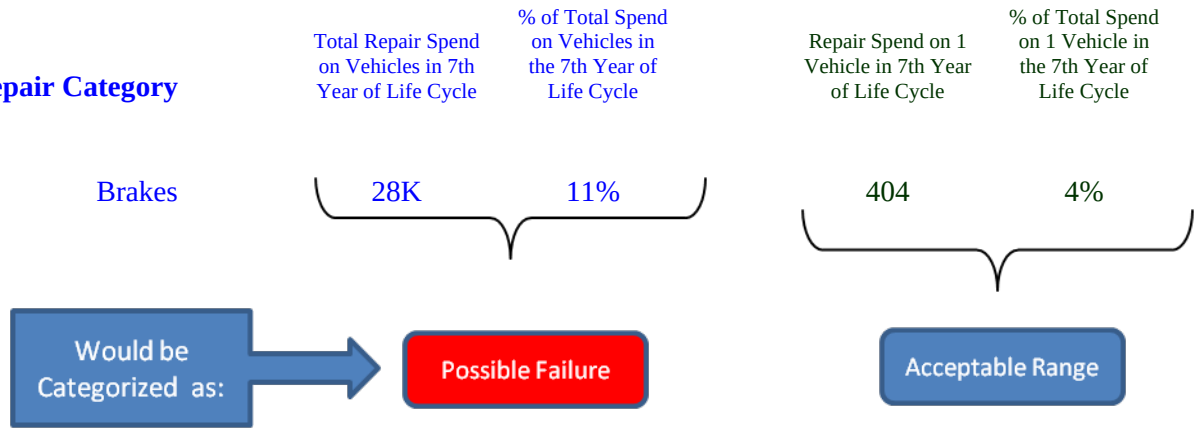
Vehicle Age	% of Population	Vehicle Count
1	2%	75
2	3%	80
3	4%	108
4	4%	113
5	5%	162
6	8%	248
7	13%	407
8	7%	216
9	5%	157
10	9%	268
11	8%	256
12	10%	301
13	10%	296
14	7%	223
15	2%	67
16	3%	77
Total Population:		**3,054**

Based on our experience, we have determined that the sample size and allocation by vehicle age will result in a statistically accurate conclusion.

4. Total vs. Per Vehicle Cost

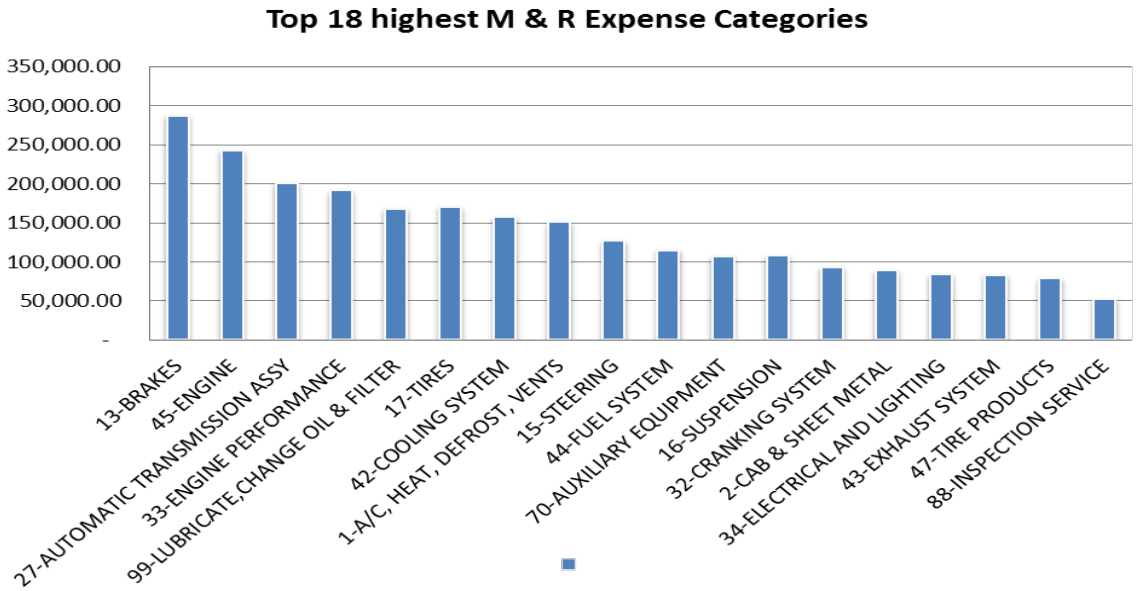
Though it is important to understand which repair categories are yielding the highest expenses, analyzing aggregate numbers alone may possibly provide results that are skewed either positively or negatively. There are several factors that contribute to this; however, the primary reason is due to inconsistencies in data input from period to period. To eliminate or minimize this issue the data pool was normalized to produce reports and statistics on a per vehicle cost basis. This will also allow us to categorize expenses by age group, determine and ultimately forecast vehicle failures throughout the life cycle.

Total Fleet Cost vs. Per Vehicle Cost:

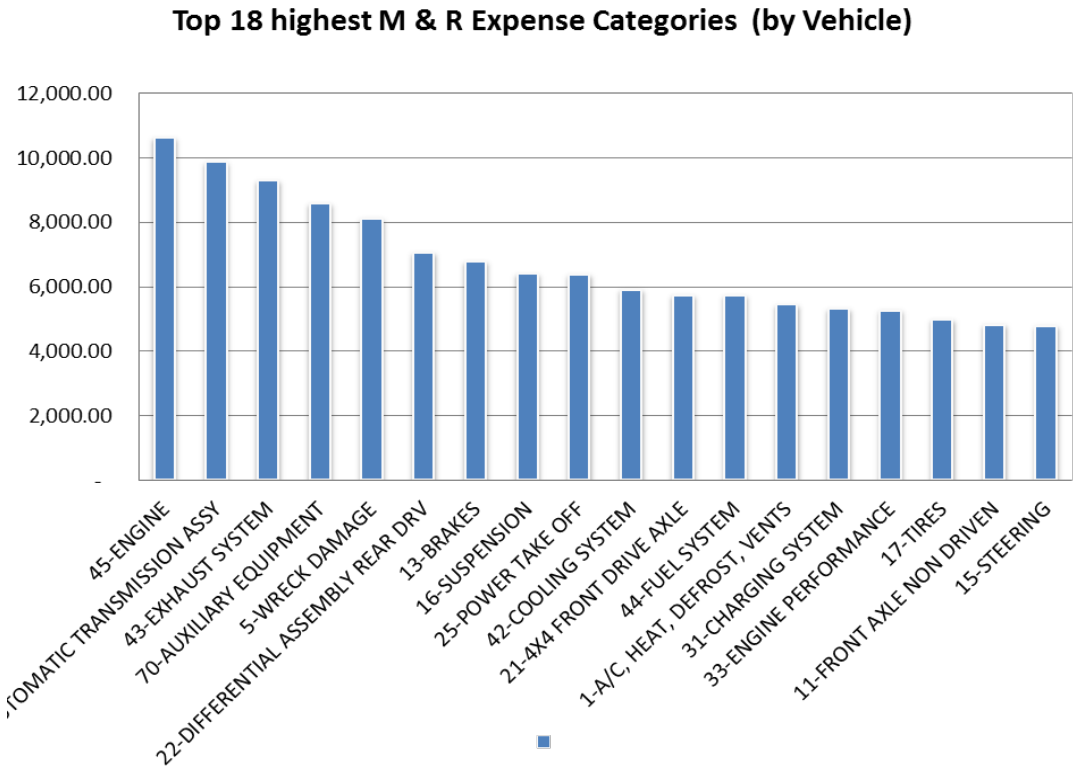


The graph below shows the top 18 highest repair spend categories based on the sample of vehicles used. Note: Graph "A" **(aggregate)** brake repairs ranks highest, however in Graph "B" **(per vehicle)** engine repairs rank the highest.

Graph A



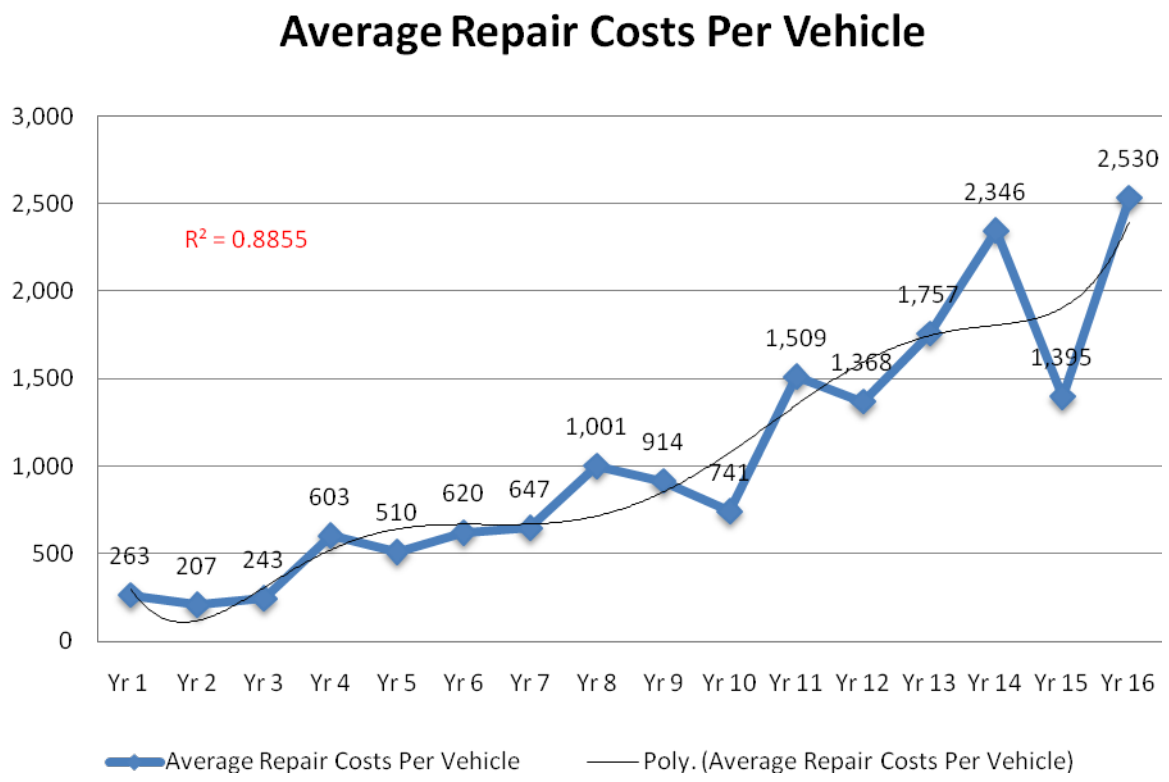
Graph B



Compiling, Graphing, and Explaining Data points

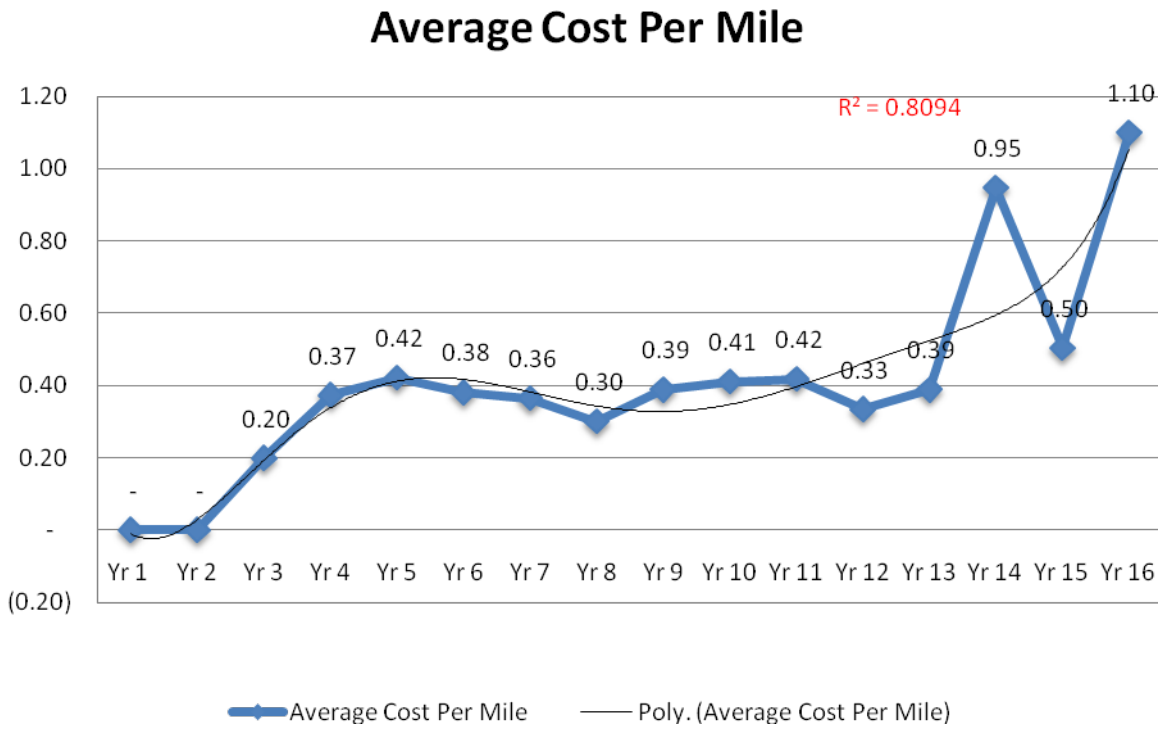
The graph illustrated below plots the average repair cost by vehicle (Y-axis Left side) and by the vehicles respective age (X-axis along bottom). By categorizing vehicles in this format we will be able to determine where failure points may occur and whether these failure points are standard occurrences in the vehicle's life cycle.

Graph C



Based on the data extracted and graphs compiled, repair and maintenance costs are increasing at an average rate of **19.7%** per year on vehicles ranging from 1 – 16 years of age. The average repair cost over the same period is **$988** per vehicle per year. Utilizing a vehicle for 16 years will cost approximately **$15,804** in repair and maintenance costs alone. The graph illustrates that repair expenses are trending upward through year 13 and is followed by a decline through the remainder of the range. Theoretically we have determined that at year 13 the average vehicle will be completely overhauled. Therefore, we would expect to see a subsequent decline in expenses.

Graph D



The graph above represents the average cost per mile by age of the vehicle. In an attempt to maintain the integrity of our results, certain categories were excluded from the calculation of average cost per mile. Excluded categories are as follows:

- Minimum mileage data not meeting predetermined thresholds **(greater than 500 miles)**
- Mileage between repair points were not reasonable based on the majority

Based on the data highlighted in the graph, the overall cost per mile trend upwards as the vehicle's age increases. The average cost per mile based on the sample is **$.47.**

The previous graphs provide us with information that will assist us in determining key areas or points of concern. In all three graphs vehicle age is a strong determinant for increased cost due to increased maintenance, and the probability of component failures.

Factors that may impact maintenance and repair cost variances:

- Component failure due to vehicle specification issues
- Component failure due to poor product quality
- Changes in the vehicle utilization
- Geographical location of vehicles
- Model, Make of Vehicle

5. Results

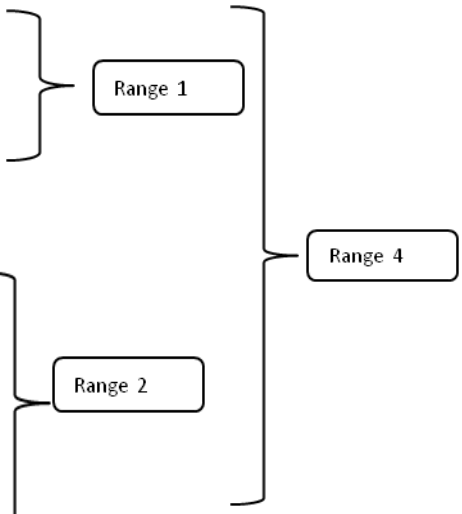
Cost Variances from Year to Year

Referring back to Graph C, we have determined that there are three ranges that produced the greatest cost variances from one period to another and therefore should be analyzed for vehicle component issues or normal maintenance with slight price fluctuations.

Table 2

Cost Variance (Year-to-Year):

Vehicle Age	Cost Change (%) from Previous Year
1	0%
2	-21%
3	17%
4	148%
5	-15%
6	21%
7	4%
8	55%
9	-9%
10	-19%
11	85%
12	28%
13	34%
14	-41%
15	81%
16	-74%



Range 1 from the table above highlights that repair costs had an increase of 148% in year 4 compared to the prior year. There were two factors used to categorize the significance of the maintenance and repair cost type. (1) Variance percentage & (2) Population percentage. Certain categories with high variances were excluded that had a minimal population size in order to maintain statistical integrity.

Range (Age 4 - 1)

% of Population Count	Repair Category	Repair Cost Variance (Per Vehicle)	Total Cost Variance
Normal Maintenance - Pricing Difference			
37%	47-TIRE PRODUCTS	(18.18)	(763.71)
21%	41-AIR INTAKE SYSTEM	(57.07)	(1,369.75)
18%	53-EXPENDABLE ITEMS	(31.35)	(627.07)
13%	34-ELECTRICAL AND LIGHTING	(11.78)	(176.64)
12%	13-BRAKES	(415.22)	(5,397.92)
Possible Component Issue			
10%	15-STEERING	(247.99)	(2,727.92)
10%	33-ENGINE PERFORMANCE	(201.48)	(2,216.24)

Possible component issues:

The following table highlights component repairs and maintenance services that occurred during the fourth year of the vehicle's life cycle and are categorized as a possible component issue due to significant cost variances.

Range (Age 8 - 4)

% of Population Count	Repair Category	Repair Cost Variance (Per Vehicle)	Total Cost Variance
Normal Maintenance - Pricing Difference			
19%	13-BRAKES	(55.25)	(2,320.39)
Possible Component Issue			
18%	2-CAB & SHEET METAL	(42.97)	(1,675.87)
16%	33-ENGINE PERFORMANCE	(130.29)	(4,560.27)
15%	15-STEERING	(177.13)	(5,668.07)
13%	32-CRANKING SYSTEM	(45.23)	(1,221.14)
9%	1-A/C, HEAT, DEFROST, VENTS	(277.93)	(5,558.50)
8%	45-ENGINE	(451.67)	(8,130.04)
6%	27-AUTOMATIC TRANSMISSION ASSY	(458.12)	(6,413.74)

Possible Component issue:

The following table highlights component repairs and maintenance services that occurred during the fourth year of the vehicle's life cycle and are categorized as a possible component issue due to significant cost variances.

Range (Age 13 - 1)

The following table highlights component repairs and maintenance services that occurred during the thirteenth year of the vehicles life cycle and are categorized as a possible component issue due to significant cost variances.

% of Population Count	Repair Category	Repair Cost Variance (Per Vehicle)	Total Cost Variance
Normal Maintenance - Pricing Difference			
55%	99-LUBRICATE,CHANGE OIL & FILTER	(73.32)	(11,877.75)
28%	47-TIRE PRODUCTS	(111.31)	(9,238.63)
27%	53-EXPENDABLE ITEMS	(60.56)	(4,905.11)
24%	13-BRAKES	(495.74)	(34,701.76)
22%	34-ELECTRICAL AND LIGHTING	(118.37)	(7,693.83)
20%	88-INSPECTION SERVICE	(5.48)	(318.01)
19%	41-AIR INTAKE SYSTEM	(48.25)	(2,702.00)
Possible Component Issue			
25%	2-CAB & SHEET METAL	(41.02)	(3,035.64)
21%	33-ENGINE PERFORMANCE	(484.86)	(29,576.63)
21%	1-A/C, HEAT, DEFROST, VENTS	(387.24)	(23,621.51)
20%	42-COOLING SYSTEM	(410.03)	(23,781.95)
19%	32-CRANKING SYSTEM	(217.92)	(11,985.35)
18%	15-STEERING	(349.24)	(18,509.64)
17%	18-WHEELS, RIMS, HUBS, & BEARINGS	(217.40)	(11,087.55)
15%	45-ENGINE	(847.34)	(38,130.32)
14%	44-FUEL SYSTEM	(750.46)	(30,018.46)
13%	27-AUTOMATIC TRANSMISSION ASSY	(1,164.92)	(44,267.06)
10%	16-SUSPENSION	(580.87)	(18,007.00)

Summary:

Based on the data extracted and the analysis performed we have determined the following:

Graph C – Average repair cost per vehicle:

Three vehicle-age ranges were selected to be analyzed based on the increased cost variances when compared to others.

Range 1 – Vehicle Age Group (1-4):

Within this range we have determined that **steering** and **engine performance** repairs are possible component issues through year 4 and will result in a variance of $3K compared to prior years and will contribute a total of $5K to total repair spend.

Range 2 – Vehicle Age group (8-4):

Within this range we have determined that **steering** and **engine performance** repairs continue to fall into the category of possible component issues through year 8. Five additional categories are included as follows: **Cranking System, A/C, Engine, Transmission, Cab**. These repair types have resulted in a total cost variance compared to vehicles aged 4 of $33K and will contribute a total of $92K to repair spend.

Range 3 – Vehicle Age group (13-1):

Within this range we have determined that all repair categories that are considered possible component issues in range 1 and 2 show up in range 3. (Refer to range 13-1 for newly added categories). These repair types have resulted in a total cost variance compared to vehicles aged 8 of $252K and will contribute a total of $364K to repair spend.

(Note: the car & truck mix that were subject to possible component issue repairs are similar for all three ranges analyzed)

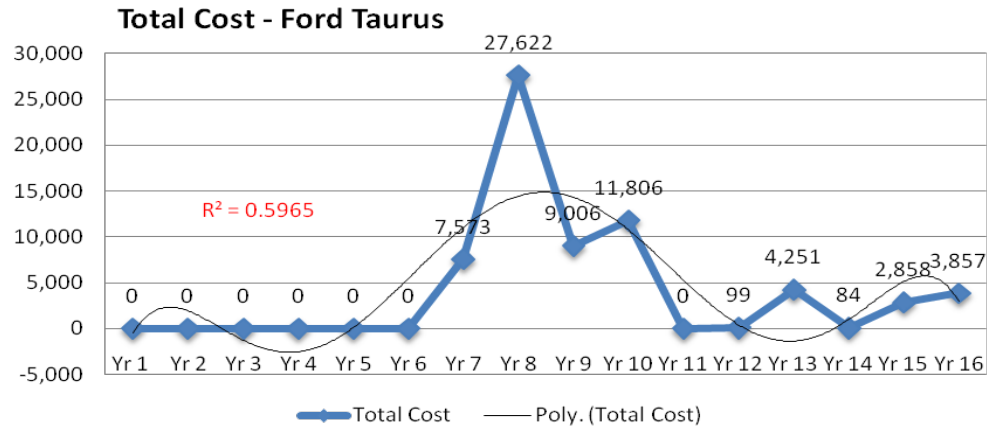
Recommendations:

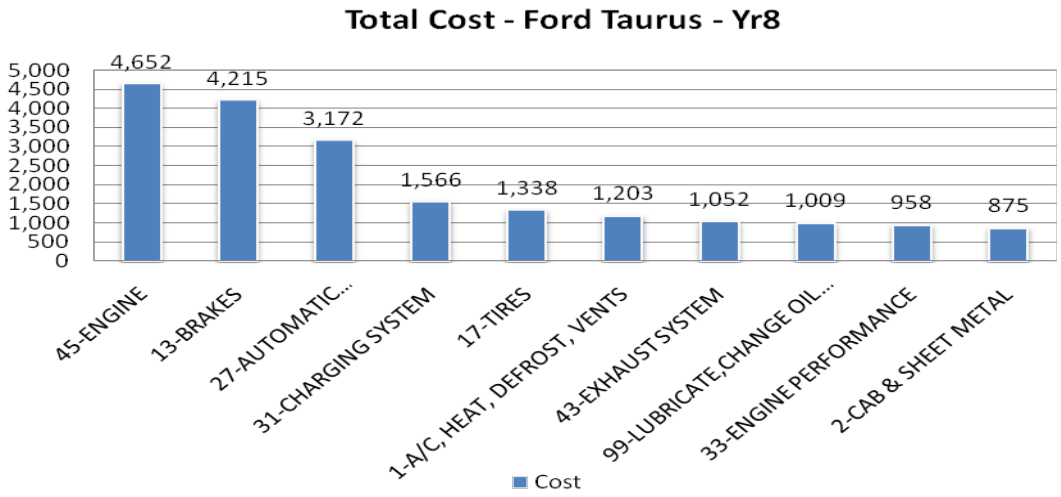
Based on the results and data sampled we have determined that the majority of possible component failures will occur close to the eighth year of the vehicle's life cycle; therefore, we recommend replacing vehicles prior to year eight to avoid increased repair and maintenance costs. Predictive analytics is extremely powerful and easily adaptable to any industry. The primary objective is how to predict an occurrence that subsequently will result in some kind of cost. Predictive analytics can be simple; however, taking an abstract approach to the analysis will separate a good analysis with a great analysis. The addition of more advanced statistical models includes understanding standard deviation intervals and regression analysis (dependent and independent variables). These types and models increase the flexibility and accuracy of our predictions.

Supplemental Analysis (by Model Type)

Analysis of Repair and Maintenance Costs
Ford - Taurus
Year 8

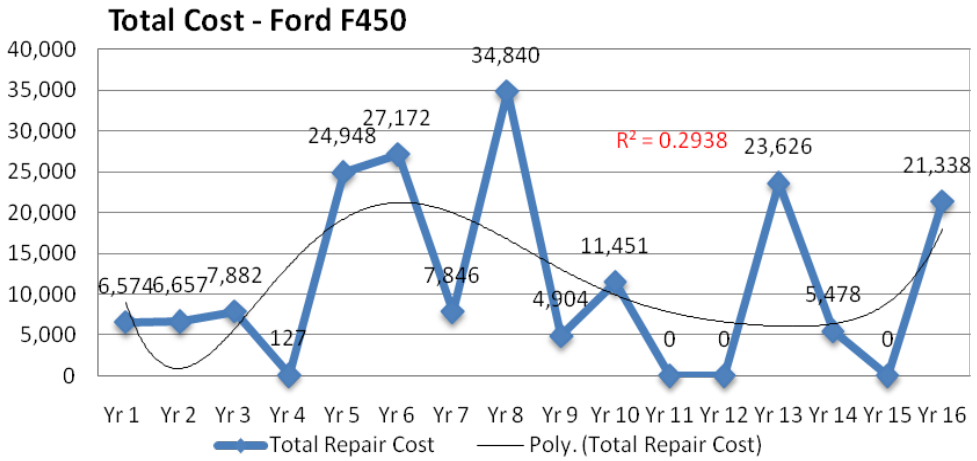
Vehicle Age	**8.00**
Total Category Cost	**263,169.00**
Make	**Ford**
Total Cost	**119,569.97**
Model	**Taurus**
Total Cost	**27,621.85**

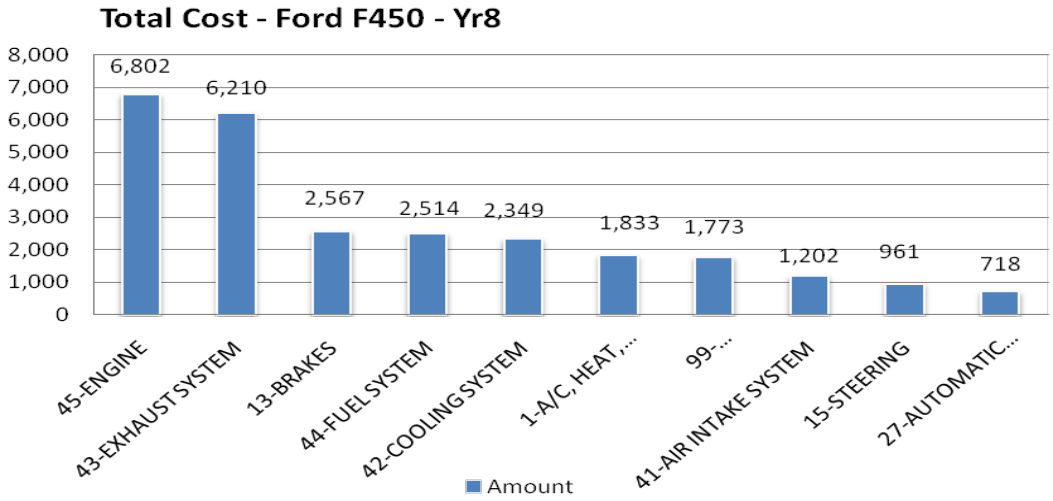




Analysis of Repair and Maintenance Costs
Ford - F450
Year 8

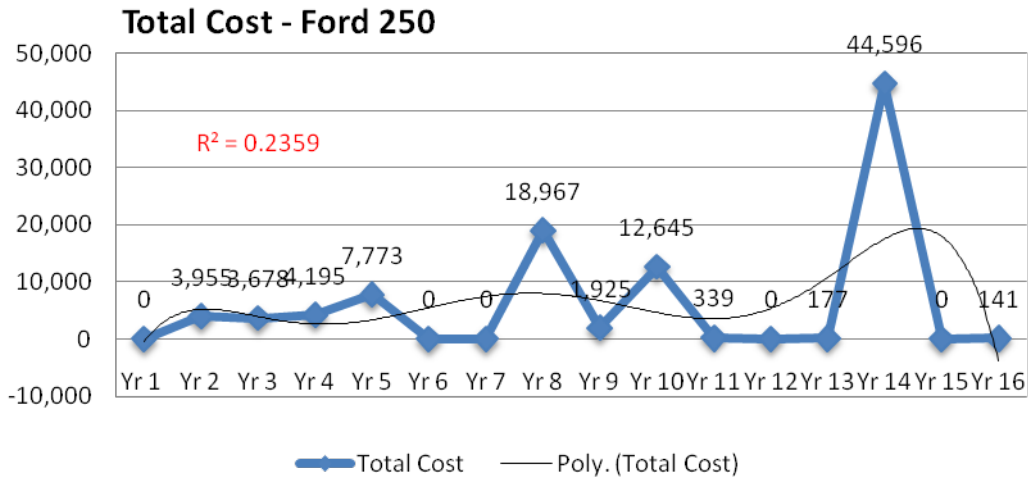
Vehicle Age	**8.00**
Total Category Cost	**263,169.00**
Make	**Ford**
Total Cost	**119,569.97**
Model	**F450**
Total Cost	**34,839.80**

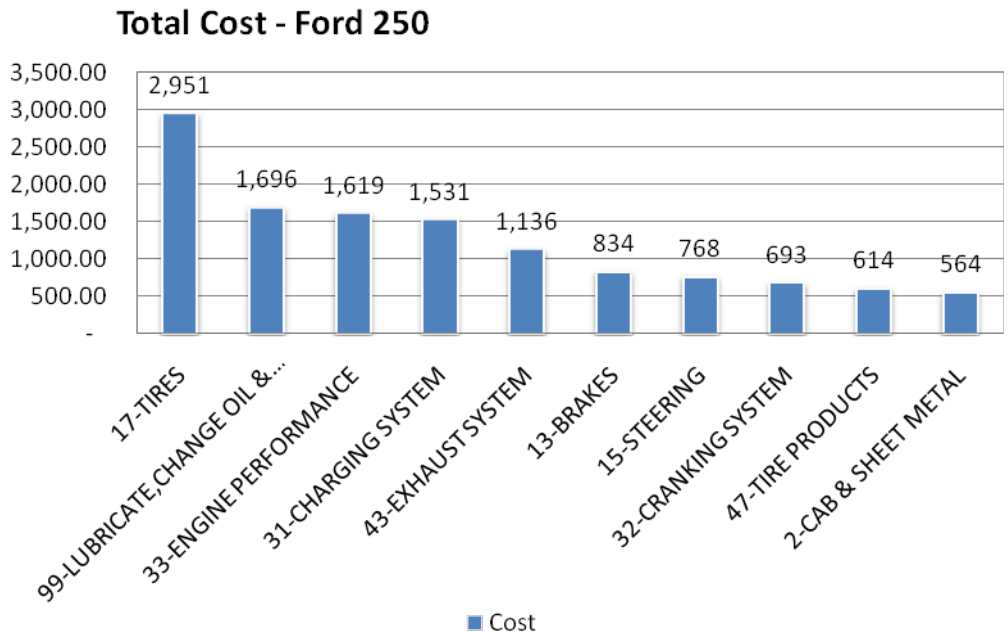




Analysis of Repair and Maintenance Costs
Ford - F250
Year 8

Vehicle Age	**8.00**
Total Category Cost	**263,169.00**
Make	**Ford**
Total Cost	**119,569.97**
Model	**F250**
Total Cost	**18,966.87**





Analysis of Repair and Maintenance Costs
Bucket Trucks
Year 8

Vehicle Age	**8.00**
Total Category Cost	**263,169.00**
Make	**Multi**
Total Cost	**230,648.14**
Model	**Multi**
Total Cost	**37,267.12**