

Investigation of Vehicle Owner Age and Its Relationship to Adhering to Manufacturer
Recommended Service Schedules

Vernon Lee Roberts, Matthew Kuofie

Grand Canyon University, USA

vroberts10@my.gcu.edu, vleeroberts@outlook.com, matthew.kuofie@my.gcu.edu,
mhkuofie@msn.com

Abstract

Vehicle manufacturers provide warranties to protect their customers from harm and unexpected repair costs from a new vehicle. These warranties function as contracts between the manufacturer and the vehicle owner and establish expected service intervals to keep the vehicle in good working order. A question exists of whether the age of a vehicle's owner impacts adherence to the manufacturer's recommendation. This paper objective was to discover if the owner's age and adherence to the recommendations are related. To determine if a relationship exists, the authors of this study used a 10-question survey via SurveyMonkey.com. Participants were informed that their participation was voluntary, and that the project, if accepted, could be published in a peer reviewed journal. The responses were tested using the chi-square test of independence on a contingency table analysis. The results indicate that the vehicle owner's age is not related to adherence to the manufacturer's recommended service intervals.

Keywords: vehicle service intervals, oil changes, manufacturer recommendations, Hyundai, Toyota

Introduction

Car, truck, and motorcycle manufacturers provide warranties designed to promote sales based on the premise that the purchased vehicle meets certain quality expectations (Sabbagh, Ab Rahman, Ismail, & Wan Hussain, 2017). These warranties provided with the purchase of a vehicle vary across manufacturers. For example, the 2016 Toyota Camry comes with a warranty requiring the owner to change the oil every 5,000 miles or 6-months, whichever comes first (Toyota, 2016a). The 2016 Sonata SE Hybrid comes with a warranty requiring the owner to change oil every 7,500 miles or 6-months, whichever comes first (Hyundai, n.d.).

Vehicle warranties provide product protection for purchasers. Yet, at the same time provide protection to the manufacturers. According to Jeon and Sohn (2015), as cited by Sabbagh et al. (2017), warranties represent contracts between the purchaser and the manufacturer. These contracts provide guidance for care and use by the vehicle owner which protects the manufacturer from inappropriate care and abuse. When the vehicle fails under proper care and use, the manufacturer holds responsibility for repair (Sabbagh et al., 2017; Tesla, 2019; Toyota, 2016a).

Olsen (2017) noted that advancements in vehicle engines makes the recommendation of changing oil every 3,000 miles or 3-months outmoded. Engine advancements make it reasonable, in some cases, to change oil every 10,000 miles or 12-months. Warranties prescribe the regularly scheduled intervals at which oil changes should occur, but also identify the approved oil types (AAA Club Alliance, Inc., n.d.). Warranties identify recommendations for more than oil changes. Hyundai (n.d.) and Toyota (2016b) recommends inspections of air cleaner filters, air conditioning refrigerant, brake fluid, brake hoses, driveshafts, and several other items at various intervals.

This paper seeks to determine if owner's age affect following of prescribed maintenance requirements. The remainder of this paper identifies the purpose of the study, method of data collection, data analysis and results, and concluding remarks.

Purpose of the Study

This study seeks to discover whether the variable "age of the owner" and the variable "within how many months since last maintenance" are related. As previously noted, manufacturers provide recommended maintenance intervals to help owners extend the serviceability of their vehicles and to protect manufacturers from improper care and abuse. According to the U.S. Department of Transportation (2018), the average driver drives 13,476 per year. Manufacturer recommended service schedules suggest that vehicle servicing should occur one to four times every 12-months regardless of the number of miles driven. Unfortunately, as described by Stork (2006), younger drivers pay less attention to mechanical maintenance requirements than more seasoned drivers.

Does the owner's age affect the timing of the recommended service schedule?

H₀: The months since last maintenance and owner's age are not related.

H₁: The months since last maintenance and owner's age are related.

Data Collection

LinkedIn, founded in 2002 by Reid Hoffman, provides a platform for professionals to connect, become more productive, and achieve success. LinkedIn's network includes over 645 million members from over 200 countries and territories (LinkedIn, n.d.). In 2016, Microsoft acquired LinkedIn "bringing together the world's leading professional cloud and the world's leading professional network (LinkedIn, n.d., para. 5).

This research project collected data by questionnaire (see Appendix A) using SurveyMonkey.com. The project required a minimum of 30 respondents to be a valid sample population. Invitations to complete the survey were sent to 256 people.. After excluding one submission from a retired individual, a total of 38 responses or 14.84% were collected. The questionnaire included 10 questions, Appendix A, designed to increase an understanding if vehicle owner's age is related to adherence to manufacturer's recommended service schedule (within how many months since last maintenance). All participants were informed that the purpose of this research was for academic purposes and not related to any form of marketing. This study focused solely on a household's primary vehicle. Table 1 represents an aggregation of the data collected from the sample population.

Table 1: Survey Response Aggregation

| Age | | Type | | |
|--|----|---|------------------------|----|
| 18-24 | 1 | SUV | 15 | |
| 25-34 | 11 | Truck | 2 | |
| 35-44 | 6 | Van | 1 | |
| 45-54 | 9 | Sedan | 18 | |
| 55-64 | 11 | Compact | 2 | |
| | | Motorcycle | 0 | |
| Total Household Income | | | | |
| Less than \$20,000 | 0 | Year of Manufacture of Primary Vehicle | | |
| \$20,000 to \$34,999 | 0 | 1997 | 1 | |
| \$35,000 to \$49,999 | 2 | 2003 | 1 | |
| \$50,000 to \$64,999 | 3 | 2005 | 2 | |
| \$65,000 to \$74,999 | 1 | 2006 | 2 | |
| \$75,000 to \$99,999 | 7 | 2007 | 1 | |
| \$100,000 to \$149,999 | 11 | 2008 | 2 | |
| \$150,000 or More | 14 | 2009 | 1 | |
| | | 2011 | 1 | |
| Current Job Level | | 2012 | 4 | |
| Management | 17 | 2013 | 4 | |
| Non-management | 21 | 2014 | 4 | |
| | | 2015 | 1 | |
| Highest Level of Education | | 2016 | 6 | |
| Primary school | 0 | 2017 | 3 | |
| Some high school, but no diploma | 0 | 2018 | 4 | |
| High school diploma (or GED) | 0 | 2019 | 1 | |
| Some college, but no degree | 2 | | | |
| 2-year college degree | 2 | Current Mileage of Primary Vehicle | | |
| 4-year college degree | 20 | Class 1 | 21 to 59850.83 | 16 |
| Master's | 12 | Class 2 | 59850.83 to 119680.67 | 11 |
| Doctorate | 2 | Class 3 | 119680.67 to 179510.5 | 7 |
| None of the above | 0 | Class 4 | 179510.5 to 239340.33 | 1 |
| | | Class 5 | 239340.33 to 299170.17 | 2 |
| Manufacturer of Primary Vehicle | | Class 6 | 299170.17 to 359000 | 1 |
| BMW | 1 | | | |
| Chevrolet | 3 | Average Yearly Maintenance Cost of Primary Vehicle | | |
| Chrysler | 1 | Class 1 | 0 to 416.67 | 15 |
| Ford | 4 | Class 2 | 416.67 to 833.33 | 11 |
| GMC | 3 | Class 3 | 833.33 to 1250 | 4 |
| Honda | 4 | Class 4 | 1250 to 1666.67 | 5 |

| | | | | | |
|---------------|----|--|--|--------------------|---|
| Hyundai | 2 | | Class 5 | 1666.67 to 2083.33 | 3 |
| Infinity | 1 | | Class 6 | 2083.33 to 2500 | 1 |
| Jeep | 1 | | | | |
| KIA | 1 | | Within How Many Months Since Last Maintenance | | |
| Mazda | 1 | | 1 | 5 | |
| Mercedes-Benz | 1 | | 2 | 15 | |
| Nissan | 3 | | 3 | 8 | |
| Toyota | 10 | | 4 | 5 | |
| Volkswagen | 1 | | 5 | 3 | |
| Volvo | 1 | | 6 | 2 | |

Data Analysis and Results

As previously noted, this study approaches compliance with manufacturer service interval recommendations from the lens of the vehicle owner's age. Age classes are based on adult working ages of (1) 18 – 24, (2) 25 – 34, (3) 35 – 44, (4) 45 – 54, (5) 55 – 64. The service interval question, "Within how many months since last maintenance," has responses ranging from one. to six-months.

Since manufacturers recommend oil changes every three months or prescribed miles (e.g., 5,000 and 7,500), the author elected to focus on months. As manufacturers recommend oil changes at intervals of every three months, Table 2 identifies the frequency less than or equal to the three-month interval and greater than the three-month interval. Based on responses, most respondents follow the three-month recommendation.

Table 2: Within how many months since last maintenance

| Within How Many Months Since Last Maintenance | |
|--|----|
| Less than or equal to 3 Months | 28 |
| Greater than 3 months | 10 |

The question becomes, does owner age change the result? The next sections, seek to discover if the null hypothesis is correct using chi-square's test for independence using a contingency table.

Owner's Age

Applying chi-squared analysis first requires identifying the mean owner's age. The mean owner's age is calculated to be 44.24 (see Table 4) using the following formula sets:

Age Class Midpoint

Calculating the age class midpoint requires using the formula of:

$$(\text{Minimum age} + \text{Maximum age}) / 2$$

Table 3, below, provides the midpoint for each age class.

Table 3

Results of calculating age class midpoint

| Age | Formula | Midpoint |
|-------|-------------|----------|
| 15-24 | $(15+24)/2$ | 19.5 |
| 25-34 | $(25+34)/2$ | 29.5 |
| 35-44 | $(35+44)/2$ | 39.5 |
| 45-54 | $(45+54)/2$ | 49.5 |
| 55-64 | $(55+64)/2$ | 59.5 |

Age Class Mean

Calculating the age class mean requires two equations. First, one must calculate the extended age class or the total age of the class based on the frequency. The formula for calculating the extended age class midpoint is:

$$\text{Frequency} * \text{Midpoint} = \text{Extended Age Class Midpoint}$$

The second equation for calculating the is:

$$\bar{x} = \Sigma(\text{Extended Midpoint}) / 38$$

Table 4

Age Class Mean

| Age | Frequency | Midpoint | Extended Midpoint |
|-------|-----------|----------|-------------------|
| 15-24 | 1 | 19.5 | 19.5 |
| 25-34 | 11 | 29.5 | 324.5 |
| 35-44 | 6 | 39.5 | 237 |
| 45-54 | 9 | 49.5 | 445.5 |
| 55-64 | 11 | 59.5 | 654.5 |
| Mean | | | 44.23684 |

Chi-squared Analysis

According to Lind, Marchal, and Walthen (2018), chi-square's test for independence allows for testing whether a variable is independent of another variable. As previously noted, in this case, is the observed maintenance schedule (within how many months since last maintenance) independent of the vehicle owner's age. To perform this analysis, the authors established the following contingency table with expected frequencies (see Table 5).

Table 5: Maintenance versus Owner's Age

| | ≤ 44.24 | > 44.24 |
|-----------------|--------------|-----------|
| ≤ 3 Months | 12 | 16 |
| f_e | 13.26316 | 14.73684 |
| > 3 Months | 6 | 4 |
| f_e | 4.736842 | 5.263158 |

The following process follows the six-steps provided by Lind, Marchal, and Walthen (2018), for conducting a contingency table analysis.

Step 1: State the hypotheses

H_0 : The months since last maintenance and owner's age are not related.

H₁: The months since last maintenance and owner's age are related.

Step 2: Select the level of significance

The desired significance level is 0.05.

Step 3: Select the test statistic

Calculate the chi-square critical value using:

$$\text{Degrees of freedom (df)} = (\text{number of rows} - 1) * (\text{number of columns} - 1)$$

$$\text{df} = (2 - 1) * (2 - 1)$$

$$\text{df} = 1 * 1$$

$$\text{df} - 1$$

Using the chi-square critical values table, the critical value is 3.841.

Calculate the chi-square (χ^2) value using:

$$\chi^2 = \sum(f_o - f_e)/f_e$$

$$\chi^2 = (12 - 13.26)^2/13.26 + (16 - 14.74)^2/14.74 + (6 - 4.38)^2/4.38 + (4 - 5.26)^2/5.26$$

$$\chi^2 = 1.13$$

Step 4: Formulate the decision rule

Reject the null hypothesis if χ^2 is greater than 3.841.

Step 5: Make a decision

Since χ^2 (1.13) is less than 3.841, one fails to reject the null hypothesis.

Step 6: Interpret the result

One does not have enough evidence to conclude that the months since last maintenance and owner's age are related at the 0.05 level of significance. Therefore, one fails to reject the null hypothesis.

Conclusion

Vehicle manufacturers design their warranties based on normal usage and proper care. The recommendations attached to the warranty exist to help owners get the most from their investment in their vehicles. As manufacturers enhance their technologies, vehicle service intervals differ across manufacturers and years (Sabbagh, 2017).

Early model vehicles may still have recommended oil change intervals of 3,000 miles or three-months, whichever comes first. Yet, newer model vehicles may have greater mileage ranges, but still have the three-month interval. For example, Toyota (2016) has a 5,000-mile interval, but still holds to the three-month interval. Hyundai (2016), has a 7,500-mile interval, but still holds to the three-month interval.

The literature search failed to discover research related to behaviors of vehicle owners related to how often they have their vehicle serviced. This project seeks to fill a portion of the gap in research covering vehicle owner behavior in relation to obedience of manufacturer recommended service intervals.

Based on the chi-square test for independence using a contingency table analysis, the null hypothesis of “the months since last maintenance and owner's age are not related” lacks enough evidence for rejection. Further in-depth research could be conducted to determine if a more accurate failure to reject the null hypothesis. Additional research could include examining relationships between recommended service intervals and owner income or owner job level.

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Appendix A

Survey Questions

1. What is your age?
2. What is your total household income?
3. Which of the following best describes your current job level?
4. What is the highest level of school that you have completed?
5. What company manufactured your primary vehicle?
6. What type of vehicle is your primary vehicle?
7. In what year was your primary vehicle manufactured?
8. What is the current mileage on your primary vehicle?
9. How much on average per year do you spend on maintenance for your primary vehicle?
10. Within how many months did you have your primary vehicle serviced?