

Comparison of Small, Medium and Large Cars across Traditional and Alternative Energy Sources

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Abstract: This study highlights the insignificance of the type of cars across traditional and alternative energy sources. A particular type of car (small, medium or large) can be purchased by the customer irrespective of the category of energy sources. This paper tries to answer a very important question for the car manufacturing organizations:

Whether there is any relationship between the type of car and the type of fuel/energy used by the car?

Keywords: CNG, Diesel Cars, Petrol Cars, Hybrid Cars, Electric Cars, Chi Square Test, Small/Medium/Large Cars

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I. Introduction:

Different types of cars are available in the market using traditional or alternative energy sources. The Government is also trying to shift the consumers from traditional energy sources to alternative energy sources. What is interesting to note is that consumers are willing to buy any type of car across these varied energy sources. This is also going to fulfill the Government's initiative to pursue people into buying cars with low carbon emission. People can buy small/medium/large cars depending on their purchasing power.

II. Research Methodology:

a. Data Collection: A questionnaire was prepared and the data was collected by administering the questionnaire on the selected sample by posting a link on the whatsapp or through e mails.

b. Sample Size:

The sample size of the survey is around 213 respondents. Out of these 213 respondents, 101 respondents were females and 112 respondents were males. The sample unit consists of respondents ranging from housewives, entrepreneurs (male and female), salaried working males and females, female and male students (from the Universities as they are the future prospects), practicing professional males and females, retired people (male and female). Demographic (age, sex, income and occupation) basis of segmentation is used for this survey.

Tools/Techniques used for Data Analysis:

For testing the hypothesis, Chi Square Test will be performed. Chi Square Test is used as a statistical tool to analyze and interpret the data so collected. This test is used to study the relationship between two categorical variables. The two categorical variables included in this study are type of car (small car, medium car and large car) and type of fuel/energy used by the car (CNG, diesel, petrol, hybrid and electric). Through the Chi Square Test, the researcher tries to determine whether the difference between the observed values and the expected values is statistically significant.

To undertake this test, firstly framing of hypothesis is done. Null hypothesis and alternate hypothesis is accordingly framed.

Hypothesis:

Null Hypothesis (H_0): There is no relationship between the type of car and the type of fuel/energy used by the car

Comparison of Small, Medium and Large Cars across Traditional and Alternative Energy Sources

Alternate Hypothesis (H₁): There is a relationship between the type of car and the type of fuel/energy used by the car

The significance level will be taken as 0.05 i.e. $\alpha = 0.05$

This indicates that there is a 5% risk of concluding that there exists an association between the variables taken when there is actually no association.

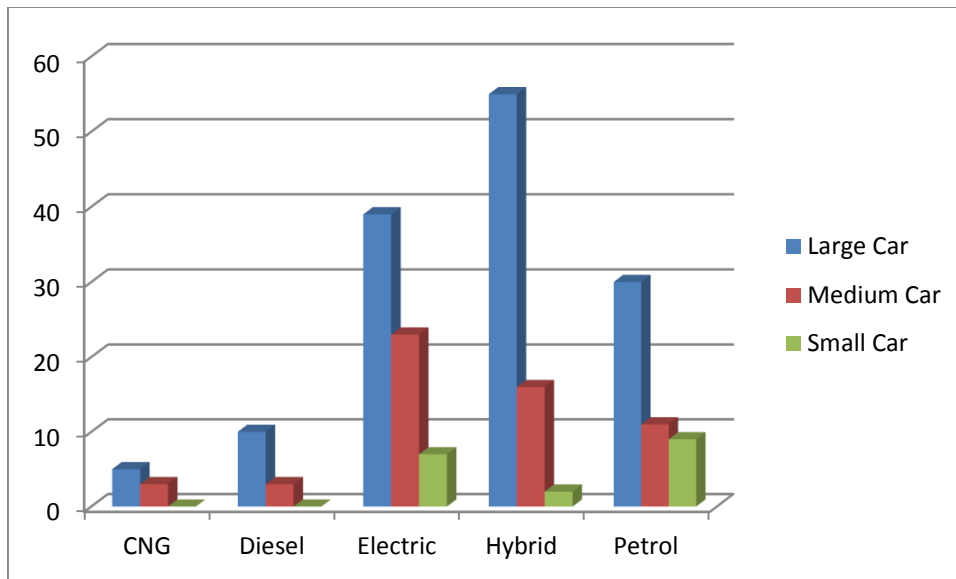
Once the hypothesis is framed, tabulation of the data will be done.

Table of Observed Values:

Observed value is the actual number of observations in a sample that belongs to a category.

Type of Car	Nature of Car on the basis of Type of Fuel/Energy					Grand Total
	CNG	Diesel	Electric	Hybrid	Petrol	
Large Car	5	10	39	55	30	139
Medium Car	3	3	23	16	11	56
Small Car	0	0	7	2	9	18
Grand Total	8	13	69	73	50	213

Table 1



Graph 1

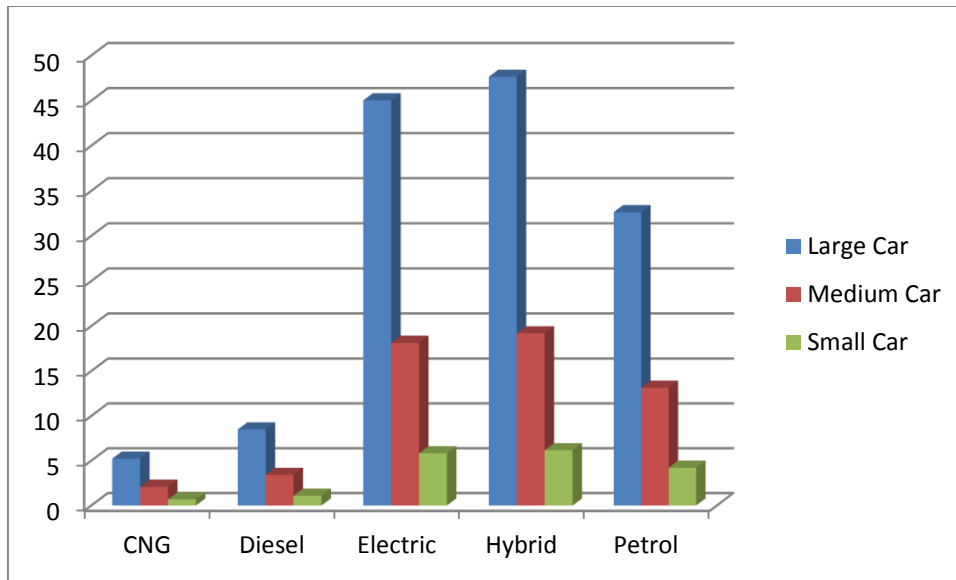
Table of Expected Values:

The expected value is the frequency that would be expected in a cell if the variables are independent.

Expected Value: Row Total * Coloumn Total / Grand Total

Type of Car	Nature of Car on the basis of Type of Fuel/Energy				
	CNG	Diesel	Electric	Hybrid	Petrol
Large Car	5.22	8.48	45.03	47.64	32.63
Medium Car	2.1	3.42	18.14	19.19	13.14
Small Car	0.68	1.1	5.83	6.17	4.22

Table 2



Graph 2

Calculation of χ^2 Value:

Observed Value (O)	Expected Value (E)	(O-E)	(O-E) ²	(O-E) ² /E
5	5.22	-0.22	0.0484	0.0093
10	8.48	1.52	2.3104	0.2724
39	45.03	-6.03	36.3609	0.8075
55	47.64	7.36	54.1696	1.1371
30	32.63	-2.63	6.9169	0.212
3	2.1	0.9	0.81	0.3857
3	3.42	-0.42	0.1764	0.0516
23	18.14	4.86	23.6196	1.3021
16	19.19	-3.19	10.1761	0.5303
11	13.14	-2.14	4.5796	0.3485
0	0.68	-0.68	0.4624	0.68
0	1.1	-1.1	1.21	1.1
7	5.83	1.17	1.3689	0.2348
2	6.17	-4.17	17.3889	2.8183
9	4.22	4.78	22.8484	5.4143
			Summation (O-E) ² /E	$\chi^2 = 15.3039$

Table 3

The Chi Square Calculated Value is **15.3039**

Comparison of the Calculated Value of the χ^2 with the Tabulated Value is done.

χ^2 Tabulated Value:

For this, the degrees of freedom have to be calculated. The formula for degrees of freedom is:

Degree of Freedom = (Column - 1) (Row-1)

f = (5-1) (3-1)

f = 8

Then using the chi square table for degrees of freedom 4 and significance value of 0.05, the χ^2 Tabulated Value is calculated.

So χ^2 tabulated value will be 15.507

If the Chi Square Calculated Value is less than the Chi Square Tabulated Value or the critical value, then the Null Hypothesis (H_0) is accepted and the Alternate Hypothesis (H_1) is rejected. Accordingly, the Null Hypothesis (H_0) 'There is no relationship between the type of car and the type of fuel/energy used by the car' is accepted and the Alternate Hypothesis (H_1) 'There is a relationship between the type of car and the type of fuel/energy used by the car' is rejected.

Comparison of Small, Medium and Large Cars across Traditional and Alternative Energy Sources

As the calculated value is less than the critical value, we have sufficient evidence to say that there is no association between the type of car and the nature of car preferred on the basis of type of fuel/energy. Hence the Null Hypothesis (H_0) ‘There is no relationship between the type of car and the type of fuel/energy used by the car’ is accepted and the Alternate Hypothesis (H_1) ‘There is a relationship between the type of car and the type of fuel/energy used by the car’ is rejected.

This further shows that the as the critical value is lesser than the expected value, any observed differences are the result of a random chance and there is no significant difference between the observed and the expected (predicted) value.

This can further be ascertained by calculating the p value.

Calculation of p value:

The two tailed p value with a Chi Square Calculated Value of 15.3039 and degrees of freedom 8 equals 0.0535.

If the p value is more than 0.05, then the variables do not have a statistically significant association and the Alternate Hypothesis (H_1) can be rejected.

ie. $p > \alpha$
 or $p > 0.05$
 $0.0535 > 0.05$

If the p value is more than the significance level, the Null Hypothesis (H_0) is accepted and concluded that there is no statistically significant association between the variables. And by conventional criteria, the difference is considered to be not quite statistically significant. Therefore, the Null Hypothesis (H_0) ‘There is no relationship between the type of car and the type of fuel/energy used by the car’ can be accepted and the Alternate Hypothesis (H_1) ‘There is a relationship between the type of car and the type of fuel/energy used by the car’ can be rejected.

Also, from the graph, it can be seen that depending upon the probability of purchase of fuel/ energy based cars, small/medium/large cars are purchased across all the categories. Therefore, we can say that there is no relationship between the type of car and the type of fuel/energy used by the car. In today’s scenario, there are very few cases of purchase of CNG and diesel cars across the small car category, hence not depicted in the table and the graph.

Type of Car	Values	Nature of Car on the basis of Type of Fuel/Energy					Total	%
		CNG	Diesel	Electric	Hybrid	Petrol		
Large Car	Observed Value	5	10	39	55	30	139	65.26
	Expected Value	5.22	8.48	45.03	47.64	32.63		
Medium Car	Observed Value	3	3	23	16	11	56	26.29
	Expected Value	2.1	3.42	18.14	19.19	13.14		
Small Car	Observed Value	0	0	7	2	9	18	8.45
	Expected Value	0.68	1.1	5.83	6.17	4.22		
Total		8	13	69	73	50	213	
%		3.76	6.10	32.4	34.27	23.47		

Table 4

Furthermore, the graph also depicts that

- a. Maximum purchase of large cars (65.26%) will take place across all categories of traditional and alternative energy sources. Maximum purchase of large cars will take place in the hybrid category (39.57%), followed by electric (28.06%) and petrol car category (21.58%).
- b. It will then be followed by purchase of medium sized cars (26.29%) across the petrol/electric/hybrid cars category. The interesting thing to note here is that the medium sized cars will be more purchased in the electric cars category (41.07%), followed by hybrid (28.57%) and petrol car category (19.64%).
- c. The graph showcases that the third category of car ie the small size cars are purchased maximum in the petrol car category (50%), followed by the electric car (38.89%) and the hybrid car category (11.11%).

III. Conclusion:

From the survey conducted regarding the comparison of small, medium and large cars across traditional and alternative energy sources, it can be seen that maximum sales of large sized cars take place in the hybrid car category. The maximum sales of medium sized cars take place in the electric car category. And, maximum sales of small sized cars take place in the petrol car category. Therefore it can be concluded that people have moved towards the alternative energy sources (electric/hybrid) in case of large and medium sized cars but they still prefer traditional sources (petrol) in the case of small car category. In order to move towards alternative energy sources, the car manufacturing industry should focus more on the small car segment category and devise marketing strategies to help people purchase cars in this category too.

References:

- [1]. Alangzi Fayez, 'Electric Vehicles: Benefits, Challenges, and Potential Solutions for Widespread Adaptation', Applied Sciences, Volume 13, Issue 10, 2023
- [2]. Halder Pobitra, Babaie Meisam, Salek Farhad, Shah Kalpit, Stevanovic Svetlana, Bodisco Timothy A and Zare Ali, 'Performance, emissions and economic analyses of hydrogen fuel cell vehicles', Renewable and Sustainable Energy Reviews, Volume 199, July, 2024.
- [3]. Liao Fanchao, Molin Eric and Vee Bert Van, "Consumer preferences for electric vehicles: a literature review" Transport Reviews, Volume 37, 2017, Issue 3
- [4]. Link Steffan, Stephan Annegret, Speth Daniel and Plotz Patrick, 'Rapidly declining costs of truck batteries and fuel cells enable large-scale road freight electrification', Nature Energy, May, 2024.
- [5]. Towoju Olumide A, 'Fuels for Automobiles: The Sustainable Future', Journal of Energy Research and Reviews, 7(3) April, 2021.
- [6]. Waseem Mohammed, Amir Mohammad, Lakshmi G Sree, Harivardhagini S and Ahmad Mumtaz, 'Fuel cell-based hybrid electric vehicles: An integrated review of current status, key challenges, recommended policies and future prospects', Green Energy and Intelligent Transportation, Volume 2, Issue 6., December 2023.
- [7]. Weiss Martin, Cloos Kira Christina and Helmers Fckard, 'Energy efficiency trade-offs in small to large electric vehicles', Environmental Sciences Europe, March 2020.