Math
Internal Assessment
Applications and Interpretations

Standard Level

Research Question:
"To what extent does the behaviour of Indian car consumers have changed post and pre lockdown?"

Contents

Introduction

In 2019 India was the fourth largest automobile market and it was expected that it would become the third biggest automobile market by the end of 2021[1]. However, in the start of 2020, i.e., in March 2020, the covid pandemic stuck and the country's economic growth was severely affected. Recently it was mentioned in the news that for the first time in the history of India, a recession has happened[2] and this was going to affect the economy of the country in an even more adverse manner[3]. Due to contraction of the economy, all sectors in the economy have been affected and the worse hit sector has been the automobile industry. In April 2020, there was not a sale of a single vehicle anywhere in India[4] which means that the covid pandemic induced lockdown had caused a major destabilizing effect on the Indian automobile sector.

I have also observed that the automobile industry in India has declined significantly after lockdown due to mass unemployment in many sectors and also due to fall in the income of individuals due to the extended lockdown announced by the government of India to control the covid 19 outbreak. As the buying behaviour of the Indian car consumer had changed after the lockdown, I wanted to compare the relation with that of pre- covid era (when there wasn't any lockdown). Therefore I decided to do a research to find about the relationship and the following research question has been framed for the same: To what extent ***does the behaviour of Indian car consumers have changed post and pre lockdown?***

[1] https://www.ibef.org/industry/india-automobiles.aspx
[2] https://www.business-standard.com/article/economy-policy/india-in-historic-technical-recession-rbi-signals-in-first-ever-nowcast-120111200122_1.html
[3] https://timesofindia.indiatimes.com/business/india-business/india-in-historic-technical-recession-rbi-nowcast-shows/articleshow/79185526.cms
[4] https://www.thequint.com/tech-and-auto/car-and-bike/car-makers-record-zero-sales-in-india-due-to-lockdown

Aim

The aim of this research paper is to conduct a detailed investigation on the car buying behaviour of 100 Indian consumers - which is actually a comparison between pre and post lockdown. The participants of the survey will be given closed ended questions and the questions will be related to buying of cars during a fixed period of time. It will help me in comparing the car buying behaviour of the Indian consumers before and after the lockdown.

Rationale

My topic of interest is about cars because my family is into the business of automobiles since the last 12 years. I have seen the car industry close than all the other students of my class and I feel that I have a natural inclination towards cars. India is among the top five car markets in the world5 and this has been due to the ever increasing economic capacity of the Indian consumers. The above research question will help me to analyse the behaviour of Indian car consumer post and pre lockdown which will help me to manage my inventory stocks appropriately as per the demand in the market. Due to lower sales in the automobile industry, many companies have reduced their production because of higher inventory in the factory.

[5] https://www.ibef.org/industry/india-automobiles.aspx

Hypothesis

The research hypothesis is that the behaviour of the Indian consumers would have changed after the lockdown in a significant way when it came to buying a car.

The null hypothesis is that the consumer behaviour would have remained the same – before and after the lockdown was imposed.

Method used

I will be conducting a survey upon 100 Indian consumers as part of the primary research. This would be done to check to what extent the sales of cars have changed post lockdown in comparison with pre lockdown conditions. The sampling would be done in a random manner so that bias could be eliminated from the sampling. To evaluate my report I will use various math like statistical methods like mean. I will also use the chi-square test to give an appropriate hypothesis.

Planning

For accurate results, planning is necessary for any research work. Following is the step by step process which will be used for the investigation.

I will collect data in the form of a survey from 100 people whom I am acquainted with. These participants reflect the car buying consumers

I will segregate data in a different category of a table (budget, gender, effect on type of car and post and pre lockdown).

The collected data is shown in the form of histograms and pie charts.

The mean budget pre and post lockdown is calculated and the difference is shown.

Chi-square test will be used to show the hypothesis between different data.

Then data will be evaluated to give an appropriate conclusion

Data Collection

The data would be collected from 100 residents who are known to me and who live in and around the Delhi NCR area as I also live in this area. The survey would be in the form of a questionnaire which will try to seek the buying behaviour of the Indian consumers towards buying something as luxury as a car. The survey questions were sent through email in which the participants received a Google Document link for the survey. Upon opening the link, they were able to see the questions and after answering the responses they were able to submit it online using the submit button provided at the end of the form. The data collection method was done using online method as it was safest option to collect data in times of the covid pandemic. The questionnaires were as following:

Questionnaire is in the appendix[6]

[6] Detailed Questionnaire with responses in Appendix

Data Processing

Once the people had filled out the forms that I have emailed them, I collected the complete information from the filled forms and analyzed the data. I had structured the form in such a way that the people cannot skip any of the formed questions and they will have to answer all of them one after the other. They can submit their responses to the forms only if they have completely filled the form. All the 100 people who filled out the form had answered all the 5 questions that I have framed for them. I have kept the questions precise and to the point for the convenience of the people answering the form. Once all the data needed was obtained from the people, I have entered this data into the excel worksheet and the following analysis has been formulated by me:

Data Analysis

Q 1. What is your gender?

MALE	65
FEMALE	35

Table 1: Gender of customer

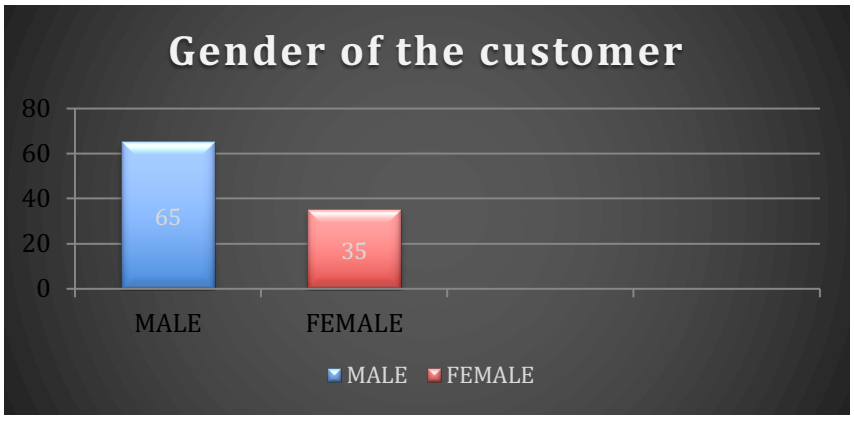

Figure 1: Gender of the customer Interpretation: The percentage of male customers is 65% and that of females is 35% and hence it was seen that majority of the respondents were male.

Q 2. Did you wanted to buy a car before the lockdown?

YES	70
NO	20
CANNOT SAY	10

Table 2: Desire of buying a car before lockdown

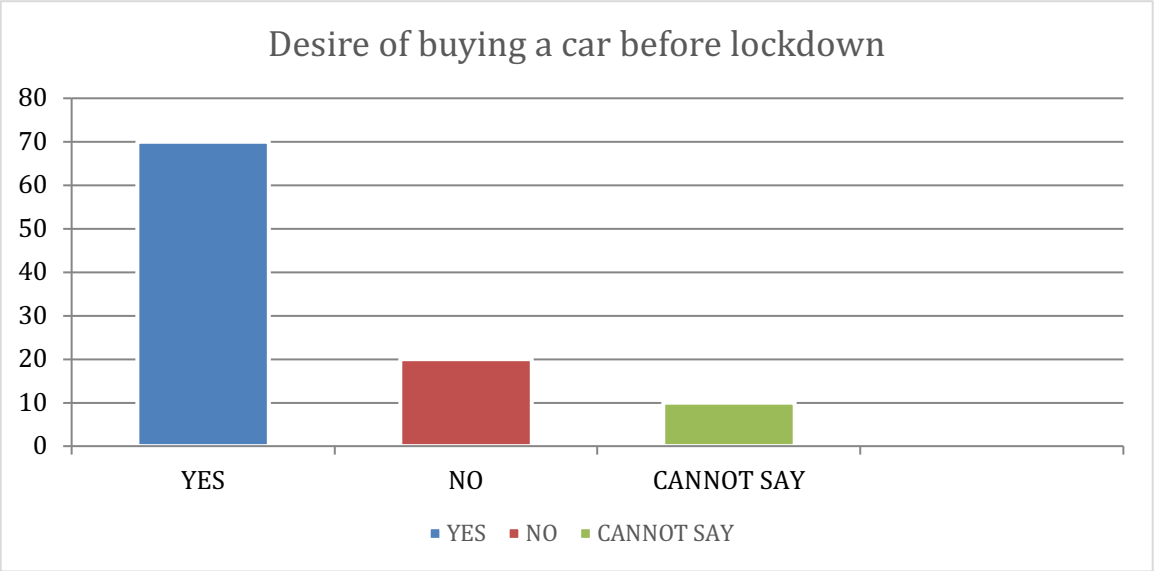

Figure 2: Desire of buying a car before lockdown

Interpretation: It was found that 70% of the respondents wanted to buy a car before the lockdown

Q 3. If yes, what was the chance of buying the car?

LOW CHANCE	20
MEDIUM CHANCE	30
HIGH CHANCE	50

Table 3: Chance of buying a car before lockdown

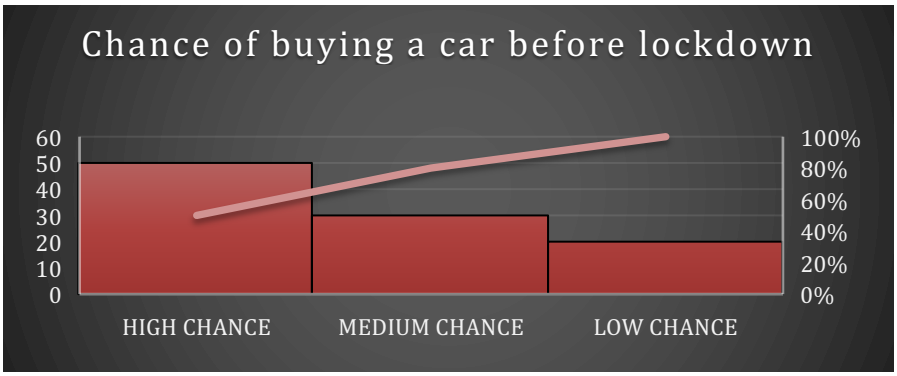

Figure 3: Chance of buying a car before lockdown

Interpretation: It was found that the probability of buying a car before the lockdown was high

Q 4. What was the budget of the car before lockdown?

0-10 Lakhs	30
10-20 Lakhs	40
20-30 Lakhs	20
30- 40 Lakhs	10

Table 4: Budget of car before lockdown

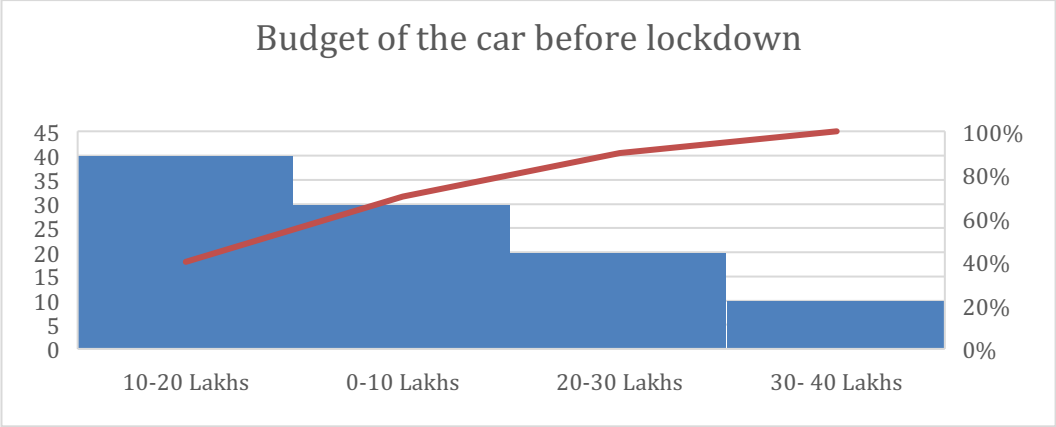

Figure 4: Budget of the car before lockdown

Interpretation: It was found that the respondents were ready to spend over 10-20 lakhs for buying a new car before the lockdown.

Q 5. Do you want to buy a car now(after lockdown)?

YES	30
NO	50
CANNOT SAY	20

Table 5: Desire of buying a car after lockdown

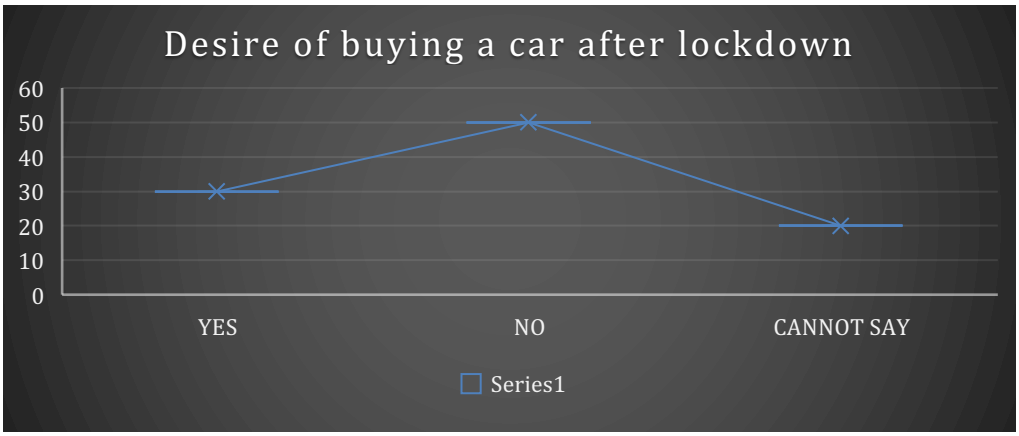

Figure 5: Desire of buying a car after lockdown

Interpretation: It was found that majority of the people didn't wanted to buy a car after the lockdown was imposed.

Q 6. If yes, what was the chance of buying the car?

LOW CHANCE	50
MEDIUM CHANCE	35
HIGH CHANCE	15

Table 6: Chance of buying the car after lockdown

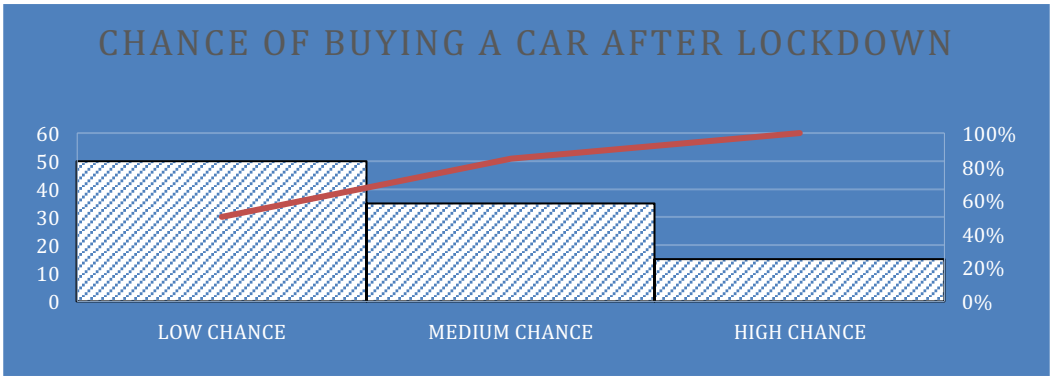

Figure 6: Chance of buying the car after lockdown

Interpretation: Even if they wanted to buy a car then the chance was low for buying the car.

Q 7. What is the budget of the car after lockdown?

0-10 Lakhs	51
10-20 Lakhs	35
20-30 Lakhs	12
30- 40 Lakhs	2

Table 7: Budget of the car after lockdown

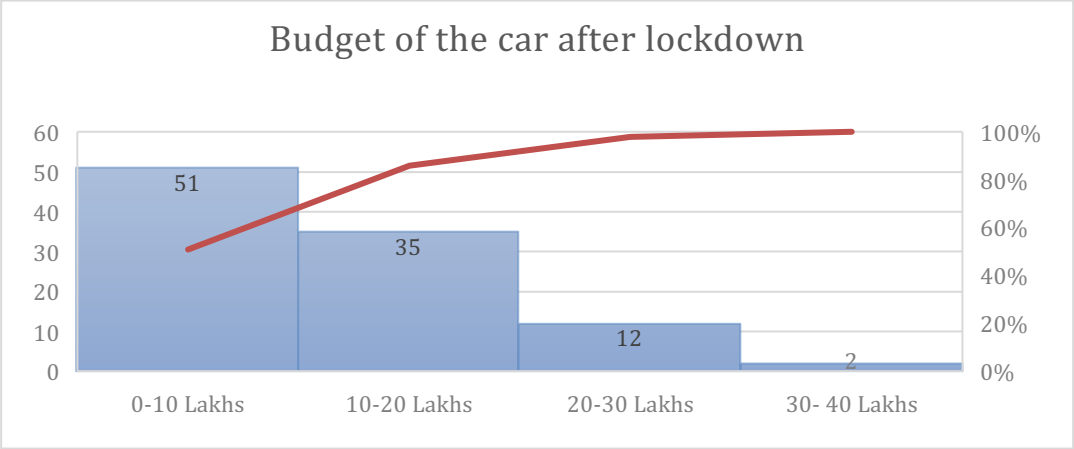

Figure 7: Budget of the car after lockdown

Interpretation: It was found that after the lockdown was imposed, the people were ready to spend only 0-10 Lakhs for buying a new car.

Q 8. Has the pandemic induced lockdown affected your car buying decision?

YES	95
NO	4
CANNOT SAY	1

Table 8: Decision affected by pandemic lockdown

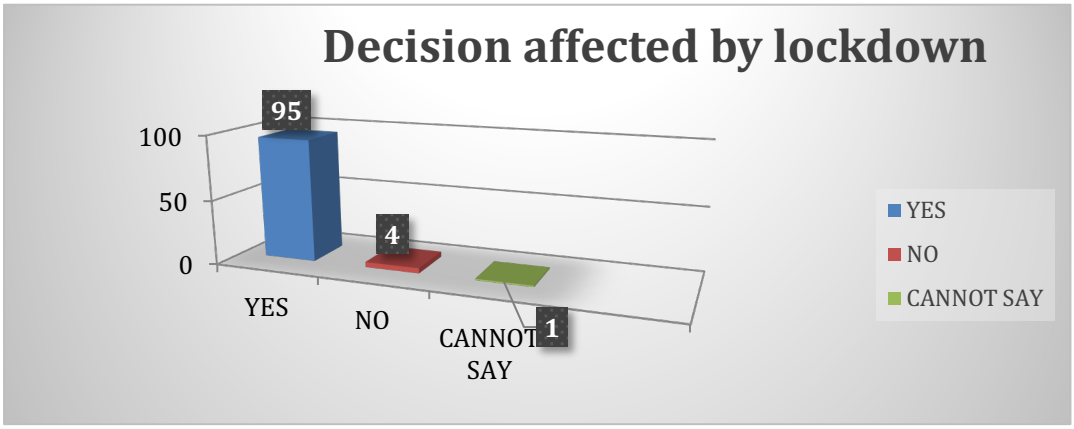

Figure 8: Decision affected by pandemic lockdown

From the above chart: 95% of the people say that pandemic induced lockdown affected their car buying decision while 4% say that their decision is independent of pandemic and 1% of the people are unable to establish the relation. It was found that the pandemic induced lockdown affected the car buying decision significantly as most of the respondents said that they have changed their mind of buying a new car after the pandemic.

Q 9. Have you reduced the budget of the car?

YES	70
NO	20
CANNOT SAY	10

Table 9: Reduction in budget of the car

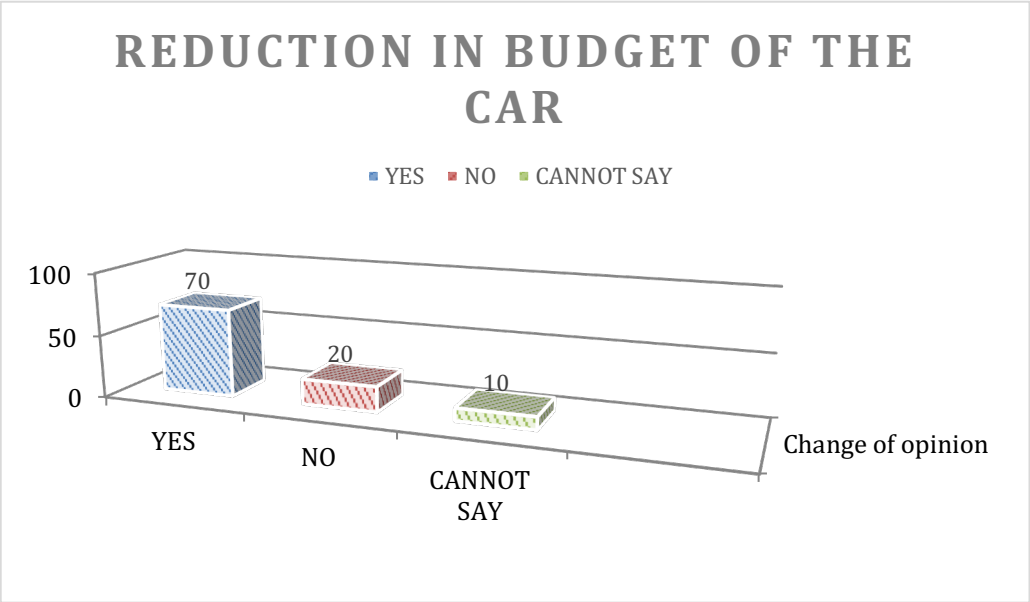

Figure 9: Reduction in budget of the car

From the above chart, 70% of the people reduced the budget of the car, 20% of the people say that their budget is independent of the lockdown and 10% of the people cannot establish a relationship between them. It was found that the pandemic induced lockdown also affected the budget of the car in a significant way.

Q 10. What is your age?

Between 18-28 years	20
Between 28-38 years	25
Between 38-48 years	35
Between 48-58 years	15
Above 58 years	5

Table 10: Age of potential buyers

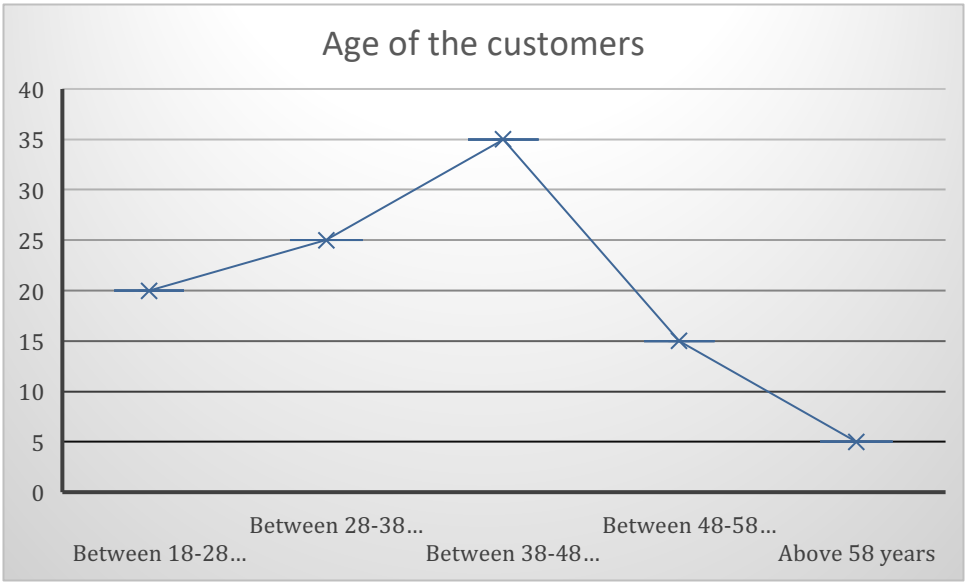

Figure 10: Age of potential buyers

It was found that most of the car buyers were between 38-48 years of age.

Q 11. How much is your monthly earning?

Less than 100000 per month	20
Between 100000-150000	40
Between 150000-200000	20
Between 200000-250000	10
Between 250000-300000	5
Above 300000 lacs	5

Table 11: Monthly earnings

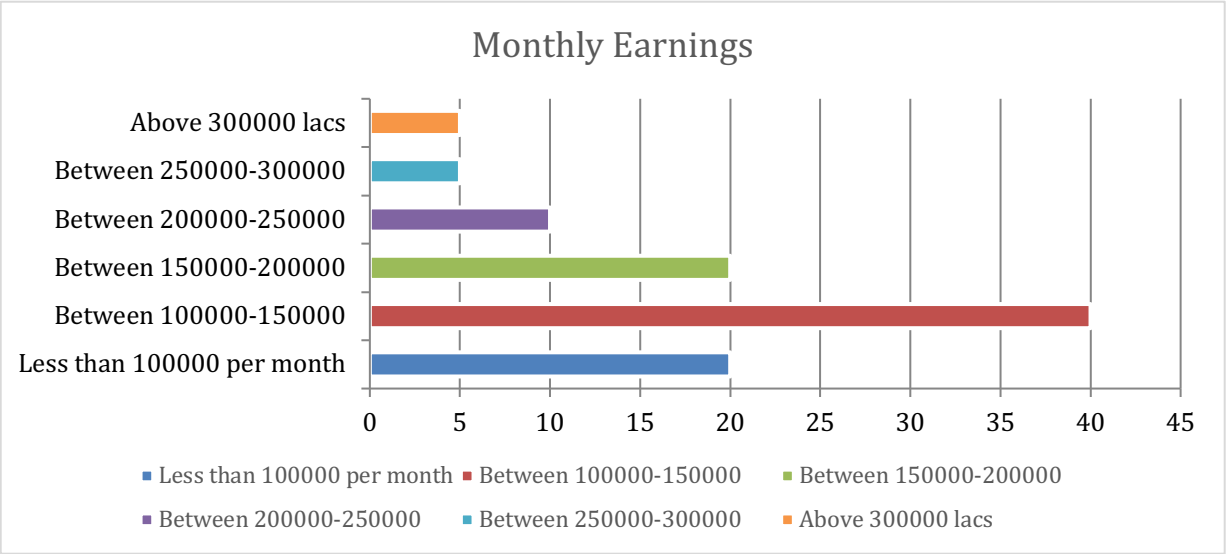

Figure 11: Monthly earnings

Out of all the respondents, the highest number of respondents said that their earnings were between 100000-150000 per month. The number of respondents having income above 300000 lacs were the lowest at just 5 individuals out of 100.

The histograms for the budgets in the above tables have been analysed and processed to showcase the data numerically as follows:

Budget of the car	Before Lockdown	After Lockdown
0-10	30	51
10-20	40	35
20-30	20	12
30-40	10	2

Table 12: Histogram data

Based on the above, the X value, the mid-point of the interval is considered and the mean has been calculated as follows:

Budget of the car	Mid value (x)	Before Lockdown (y1)	Mid value X y1	After Lockdown (y2)	Mid Value X y2
0-10	5	30	150	51	255
10-20	15	40	600	35	525
20-30	25	20	500	12	300
30-40	35	10	350	2	70

Table 13: Mean calculation table

Mean = $\frac{\sum xy}{\sum x}$

Mean budget before lockdown = (150 + 600 + 500 + 350)/ (5 +15 + 25+ 35)

Mean budget before lockdown= 20 Lakhs

Mean budget after lockdown = (255 + 525 + 300 + 70)/ (5 +15 + 25+ 35)

Mean Budget after lockdown= 14.375 Lakhs

Therefore, it can be seen that the mean budget has fallen after the lockdown.

The fall in the budget pre and post lockdown is = 20 – 14.375 = 5.625 Lakhs

Spearman's correlation

Budget of the car	Before Lockdown	After Lockdown	Rank Before lockdown	Rank After lockdown
0-10	30	51	2	1
10-20	40	35	1	2
20-30	20	12	3	3
30-40	10	2	4	4
	100	100		

Table 14: Spearman correlation data

Rank Before lockdown	Rank After lockdown	D	D^2
2	1	1	1
1	2	-1	1
3	3	0	0
4	4	0	0

Table 15: Spearman correlation analysed

$$\sum D^2 = 2$$

$$\rho = 1 - \frac{6\sum D^2}{n\,(n^2 - 1)}$$

$$\rho = 1 - \frac{12}{4(15)}$$

$$\rho = 0.8$$

This indicates a positive relationship between the sales of cars before and after lockdown.

Chi Square Independence test

Chi square independence test is used to see that the relationship between any two variables that this test is being performed on. Here, the two variables on which the test is being performed is the number of people willing to buy the car and the budget of the car.

We now consider two types of hypothesis which are as follows:

The null hypothesis (Ho): There is no relationship between the two variables on which the test is being performed is the number of people willing to buy the car and the budget of the car. Their behaviour of car sales is independent of the covid induced lockdown.

The research hypothesis (H_1): There is a relationship between the two variables on which the test is being performed is the number of people willing to buy the car and the budget of the car. Their behaviour of car sales is dependent on the covid induced lockdown.

For chi square test, the following contingency table is used for consideration:

Budget of the car	Before Lockdown	After Lockdown	Total
0-10	30	51	81
10-20	40	35	75
20-30	20	12	32
30-40	10	2	12
	100	100	200

Table 16: Observed values of the Chi square test

Budget of the car	Before Lockdown	After Lockdown	Total
0-10	(81 x 100)/200	(81 x 100)/200	81
10-20	(75 x 100)/200	(75 x 100)/200	75
20-30	(32 x 100)/200	(32 x 100)/200	32
30-40	(12 x 100)/200	(12 x 100)/200	12
			200

Table 17: Expected values of the Chi square test

Budget of the car	Before Lockdown	After Lockdown	Total
0-10	40.5	40.5	81
10-20	37.5	37.5	75
20-30	16	16	32
30-40	6	6	12
	100	100	200

Table 18: Calculated expected values of the Chi square test

After the entire calculations have been performed, the final values are:

Observed Frequency (f_o)	Expected Frequency (f_e)	$(f_o - f_e)$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
30	40.5	-10.5	110.25	2.72
40	37.5	2.5	6.25	0.16
20	16	4	16	1
10	6	4	16	2.66
51	40.5	10.5	110.25	2.72
35	37.5	-2.5	6.25	0.16
12	16	-4	16	1
2	6	-4	16	2.66
				13.08

Table 19: Final of the Chi square test

The formula used is

$$\chi^2 = \sum \frac{(\text{Observed} - \text{Expected})^2}{\text{Expected}}$$

The value of Chi square from the above calculation is 106.54.

The degree of freedom (df) of the chi square test is calculated using the formula:

Df= (r – 1) (c – 1)

Df= (4 – 1) (2 – 1)

Df=3

Taking the value of $\propto = 0.05$ *and considering the table for chi square distribution*:

The critical value corresponding to Df=3 and $\propto = 0.05$

	P										
DF	0.995	0.975	0.2	0.1	0.05	0.025	0.02	0.01	0.005	0.002	0.001
1	.0004	.00016	1.642	2.706	3.841	5.024	5.412	6.635	7.879	9.55	10.828
2	0.01	0.0506	3.219	4.605	5.991	7.378	7.824	9.21	10.597	12.429	13.816
3	0.0717	0.216	4.642	6.251	7.815	9.348	9.837	11.345	12.838	14.796	16.266
4	0.207	0.484	5.989	7.779	9.488	11.143	11.668	13.277	14.86	16.924	18.467
5	0.412	0.831	7.289	9.236	11.07	12.833	13.388	15.086	16.75	18.907	20.515
6	0.676	1.237	8.558	10.645	12.592	14.449	15.033	16.812	18.548	20.791	22.458
7	0.989	1.69	9.803	12.017	14.067	16.013	16.622	18.475	20.278	22.601	24.322
8	1.344	2.18	11.03	13.362	15.507	17.535	18.168	20.09	21.955	24.352	26.124
9	1.735	2.7	12.242	14.684	16.919	19.023	19.679	21.666	23.589	26.056	27.877
10	2.156	3.247	13.442	15.987	18.307	20.483	21.161	23.209	25.188	27.722	29.588
11	2.603	3.816	14.631	17.275	19.675	21.92	22.618	24.725	26.757	29.354	31.264
12	3.074	4.404	15.812	18.549	21.026	23.337	24.054	26.217	28.3	30.957	32.909
13	3.565	5.009	16.985	19.812	22.362	24.736	25.472	27.688	29.819	32.535	34.528
14	4.075	5.629	18.151	21.064	23.685	26.119	26.873	29.141	31.319	34.091	36.123
15	4.601	6.262	19.311	22.307	24.996	27.488	28.259	30.578	32.801	35.628	37.697
16	5.142	6.908	20.465	23.542	26.296	28.845	29.633	32	34.267	37.146	39.252
17	5.697	7.564	21.615	24.769	27.587	30.191	30.995	33.409	35.718	38.648	40.79
18	6.265	8.231	22.76	25.989	28.869	31.526	32.346	34.805	37.156	40.136	42.312
19	6.844	8.907	23.9	27.204	30.144	32.852	33.687	36.191	38.582	41.61	43.82
20	7.434	9.591	25.038	28.412	31.41	34.17	35.02	37.566	39.997	43.072	45.315

Table 20: Critical value table

The critical value corresponding to the value of 3 and $\propto = 0.05$ is 7.815 which is lesser than the chi square value.

7.815 < 13.08

Hence the null hypothesis can be rejected and the research hypothesis is accepted.

Conclusion

The conclusion of this research paper states that there is a relationship between the two variables on which the test is being performed is the number of people willing to buy the car and the budget of the car.

The covid induced pandemic has definitely affected the sales of the cars and this has a huge impact on the economy of the country. The people have considered to reduce the amount of money that they have decided to spend on buying new car. Some of them have even decided to

opt out of the decision to buy a car. Because of this, the sales of the cars have also decreased considerably.

Limitations

Though the best assumptions have been made and the effort has been made to maintain the accuracy, the survey has been done on 100 people and there could be a case where they would not have answered the questions honestly. There might be a case where the decision of the people could have changed after the survey too. A larger sample of people would have given better and more accurate results.

Validation

The techniques used for finding of the relations between the data are quite accurate and are known to yield good results.

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Appendices

Questionnaire[7]:

Q 1. What is your Gender?
Male
Female
Q 2. Did you want to buy a car before the lockdown?
Yes
No
Cannot say
Q 3. If yes, what was the chance of buying the car?
Low chance
Medium chance
High chance
Q.4 What was the budget of the car before lockdown?
0-10 Lakhs
10-20 Lakhs
20-30 Lakhs
30-40 Lakhs
Q 5. Do you want to buy a car now(after lockdown)?
Yes
No
Cannot say
Q 6. If yes, what is the chance of buying the car in this situation?
Low chance
Medium chance
High chance
Q. 7 What is the budget of the car after lockdown?
0-10 Lakhs
10-20 Lakhs
20-30 Lakhs
30-40 Lakhs

[7] https://forms.gle/GYL2XcrA89wW9nZ6A

Q 8. Has the pandemic induced lockdown affected your car buying decision negatively?
Yes
No
Cannot say
Q 9. Have you reduced the budget of the car after lockdown?
Yes
No
Cannot say
Q 10. What is your age?
Between 18-28 years
Between 28-38 years
Between 38-48 years
Between 48-58 years
Above 58 years
Q 11. How much is your monthly earning?
Less than 100000 per month
Between 100000-150000
Between 150000-200000
Between 200000-250000
Between 250000-300000
Above 300000 lacs