

The Impact of Metro Rail on ownership of private vehicles in Delhi

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Abstract

In India, the ownership of a vehicle is always considered to be a thing of pride and social respect. But as the number of private vehicles has increased, so has the congestion on the roads. The government, in a bid to reduce congestion, tries to improve the public transport in cities. Delhi Metro has become the heartbeat of the city with its massive network spanning 348 Kilometers. Through this study, we aim to find the impact of Delhi metro on the ownership pattern of private vehicles in Delhi. This study is restricted only to the people from Delhi, and data is taken from the inception of the metro in 2002 up to 2018. The concluding observation is that there is a weak positive correlation between the ridership of metro passengers and the purchase of private two wheelers and a strong negative correlation between metro ridership and purchase of private four-wheelers.

Keywords: *Delhi Metro, Private Vehicles, Correlation, Ownership, Congestion.*

1 Introduction:

In India, the ownership of a car or a bike is a thing of immense pride. It is not just a vehicle for travel, but a status symbol in the society. Before 1991, the automobile sector in India was restricted to only Fiat and Ambassador as four-wheeler options. But after liberalization, there was suddenly a huge amount of choice and options for the Indian public. Maruti Suzuki captured the market in a large way and gave rise to an Aspirational India, which was a middle-class man aspiring to own a car and enhancing his reputation in the society. The falling prices of vehicles coupled with an increased spending power of the public led to an explosive growth in the Auto industry in India. India became one of the top markets for all companies globally to invest in, in the auto sector.

But due to this large increase in number of private vehicles, many problems also arose. The infrastructure in terms of roads and highways did not expand in the same proportion as the number of vehicles. This led to a disproportionate growth which meant increased congestion and increased the time to travel for individuals. It also created problems like lack of parking spaces, greater consumption of fuel and increased level of frustration and stress for the vehicle owners and riders.

The Delhi government in a bid to ease this and also improve the connectivity within the city, launched the massive Delhi Metro project in 2002. It was completed under the leadership of Elattuvalapil Shreedharan, popularly known as “Metro Man”. Under his leadership, the Delhi Metro project was completed before time. The Government of India awarded the Padma Shree and Padma Vibhushan to him for his efforts.

Today it has expanded to cover 348 kilometers of distance and is the preferred mode of transport for most Delhiites. It provides a cheap, convenient and quick mode of transport. There have been a lot of studies to check whether the objectives of Delhi Metro have been achieved or not. This study aims to identify whether its aim of reducing the number of private vehicles owned by the public has been achieved or not.

The Metro also has had an impact on the lives of various people as newer and newer businesses have been developed along the metro stations. Due to these metro stations, the autos and taxis have had an increase in business and they help in ferrying people from one station to their destination. This has also reduced the number of cars owned privately.

In today's world of online cab booking through apps like Ola and Uber, it has become even more convenient and safe to not own a private vehicle and instead rely on these services. The concept of Rent more Own less has been popularized among the millennials. It will gain even more traction as the entire ecosystem around it develops.

Another important factor to consider is that due to a relatively weak local train network in Delhi as compared to metros like Mumbai, there is no obvious alternative to travelling through the metro, apart from travelling by road. As the space in metros like Delhi cannot be increased, vertical development is of critical importance, and by building underground and overhead tracks, the Delhi Metro successfully achieved in expanding the public infrastructure in the limited constraints of a congested urban city.

2 Review Of Literature:

M N Murty, Kishore Kumar Dhavala, Meenakshi Ghosh and Rashmi Singh [1] in their study titled “Social Cost-Benefit Analysis of Delhi Metro” (2006) have analyzed the various benefits of Delhi Metro to the public. They range from reduction in traffic congestion, air pollution, time taken by passengers to travel and to fuel savings as well. The study also analyzes the return on investment made by the government and predicts the future revenue to be generated by this mode of transport. The paper also predicts the daily ridership of the metro to go up from 12.63 Lakh trips in 2002 to 54.17 Lakhs in 2021. The study touches on prediction of reduction in number of vehicles on the road and the consequent fuel savings. These are based on the predictions of RITES (1995 a) (Rail India Technical and Economic Service) that only forty percent of two-wheelers sixty five percent of taxis and three wheelers and twenty eight percent of cars are on the roads.

Mukta Advani and Geetam Tiwari [2] in their paper titled “Evaluation of Public Transport Systems: Case Study of Delhi Metro” have compared the Delhi, Chennai and Kolkata Metro networks. They have considered the influence zone within 500 meters of the metro corridor, feeder service and integrated ticketing, luggage and parking as the four main criteria for evaluation. In addition to this, they have also analyzed who exactly will be using the metro and issues that affect two-wheeler users for shifting mode of transport from one to another. A comparison of services provided by metros and buses is also done in the same study.

Christopher N.H. Doll and Osman Balaban (2013) [3] wrote a paper titled “A methodology for evaluating environmental co-benefits in the transport sector: application to the Delhi metro”. They developed an evaluation tool and implemented the same for the Delhi Metro to measure the environmental benefits of various transport initiatives. Various factors like the number of vehicles, utilization factor, fuel share of vehicles, the average annual distance travelled, derived value, fuel efficiency and emission factor are taken into account to perform this quantitative analysis. This study eventually concludes that one of the main ways in which the Delhi metro can contribute to a cleaner environment is by reducing the number of private vehicles owned by the population of Delhi.

Kirti Bhandari, Yoshitsugu Hayashi and Hirokazu Kato (2011) [4] tabled a paper titled “Economic and Equity Evaluation of Delhi Metro” which has tried to measure the accessibility benefits of the Delhi

Metro. They have tried to link accessibility and mobility to equity. The study tries to estimate the generalized cost for each mode of transport post implementation of metro, based on the cost of time, user charges like tolls and fares and vehicle operating costs. It goes on to conclude that the generalized cost of each mode decreases after implementation of the project.

Berenice Bon [4] released a paper titled “A new megaproject model and a new funding model. Travelling concepts and local adaptations around the Delhi metro” which tries to analyze the governance patterns at different scales through the prism of the Delhi metro project. This paper mainly tries to understand the new financing mechanism for raising funds for urban megaprojects. The costs of capital are raised by capturing land value and has produced mixed spaces in the heart of the city. This has created an arrangement of commercial, transport and residential connectivity seamlessly.

3 Data And Methodology:

A. Objectives of the study:

- To understand whether there is a significant impact of the increase in ridership of Delhi metro on the ownership of all private vehicles
- To understand whether there is a significant impact of the increase in ridership of Delhi metro on the ownership of private vehicles for two-wheelers (bikes and scooters)
- To understand whether there is a significant impact of the increase in ridership of Delhi metro on the ownership of private vehicles for four-wheelers (cars and jeeps)

B. Data Collection

The data required to complete this study is of the number of riders of the Delhi metro annually. Since the Delhi metro was launched in 2002, the annual ridership data can be found from the Delhi Metro Rail Corporation Ltd. (DMRC) From: The Ministry of Housing & Urban Affairs. We have taken data from the inception of metro rail up to the year 2018. Quarterly ridership data was available which has been aggregated annual ridership data for the ease of calculation. The “Sustainability in Motion” document released by DMRC was used to get the ridership data for metro from 2002 up to 2013.

The other data set required for this is also the number of private vehicles owned in Delhi. This data has been extracted from various Economic Surveys of Delhi which are conducted by The Planning Department, Government of NCT of Delhi. We referred to the report of 2018-19 and 2014-15 for collecting this data. The data is collected for the number of private cars and jeeps owned in Delhi and also the number of private scooters and motorcycles owned in Delhi.

C. Methodology

The methodology used for this study is after assimilation of secondary data through various sources, a simple linear regression is done to check the goodness of fit for the number of private vehicles based on the number of riders of metro. Following that, after confirmation of whether we can represent the model correctly with these variables, we look for the correlation between ridership of metro and the growth in the number of two-wheelers and four-wheelers and identify how the trend is for that particular data. The dependent variables here are the total number of private vehicles, the total number of private two-

wheelers and the total number of private four-wheelers. The independent variable is the number of riders of metro.

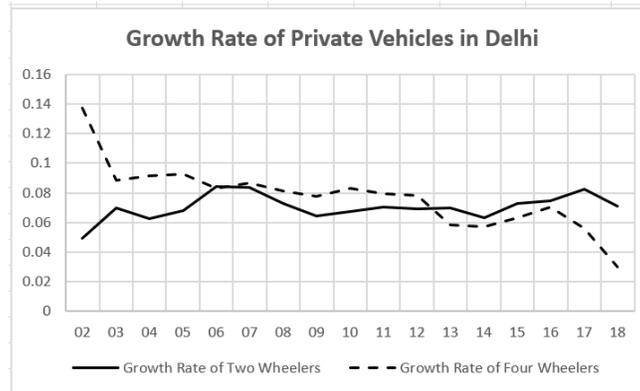


Figure 1. Growth Rate of Private vehicles in percentage from 2002 to 2018

Year	Ridership of Metro	Total Two-Wheelers (Scooters and Motorcycles)	Total Four-Wheelers (Cars and Jeeps)	Total Number of Private Two-Wheelers
1996	-	1741260	633802	2375062
1997	-	1876053	705923	2581976
1998	-	1991710	765470	2757180
1999	-	2101876	818962	2920838
2000	-	2184581	869820	3054401
2001	-	2230534	920723	3151257
2002	3868093	2339923	1047048	3386971
2003	19642583	2502484	1139753	3642237
2004	45436825	2659449	1243759	3903208
2005	98030614	2839838	1359273	4199111
2006	169322536	3078660	1471858	4550518
2007	218706636	3335763	1599463	4935226
2008	263733520	3578199	1729695	5307894
2009	307427745	3808503	1863574	5672077
2010	411961543	4065789	2017882	6083671
2011	577251875	4352963	2177525	6530488
2012	682203309	4654706	2347276	7001982
2013	779255282	4980227	2483886	7464113
2014	865599153	5296163	2625250	7921413
2015	931364952	5681265	2790566	8471831
2016	1007199428	6104070	2986579	9090649
2017	984707703	6607879	3152710	9760589
2018	919790709	7078428	3246637	10325065

Table 1. Complete Dataset

4 Hypothesis:

Hypothesis for the study

H1: The increase in ridership of Delhi metro has resulted in the reduced growth rate of private vehicles owned in Delhi

H2: The increase in ridership of Delhi metro has resulted in the reduced growth rate of private two-wheeler vehicles owned in Delhi

H3: The increase in ridership of Delhi metro has resulted in the reduced growth rate of private four-wheeler vehicles owned in Delhi

5 Results:

1) We test simple linear regression with Dependent variable as Number of Private Vehicles(Y) owned in Delhi (Cars, Jeeps plus Scooters and Motorcycles), Independent Variables as Ridership of Metro(X1).

$$Y = aX1 + b$$

Upon working with the data in excel, we find that R Squared value is 0.94 which means that we have a model which can be predicted accurately by our dependent variable. Such a high R2 value indicates the possibility of multicollinearity.

<i>Regression Statistics</i>	
Multiple R	0.97
R Square	0.94
Adjusted R Square	0.94
Standard Error	534639.81
Observations	16

Table 2. Simple Regression Statistics

2) Next, we need to test the effect of ridership of metro on the ownership of total private vehicles in Delhi. For this we will use CORREL function in excel. This results in the correlation coefficient coming to be -0.57. This means there is a negative correlation between the increase in ridership of metro passengers and growth rate of private vehicles.

<i>Year</i>	<i>Total Private Vehicles</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private vehicles</i>
2001	3151257	-	-
2002	3386971	3868093	0.074799993

<i>Year</i>	<i>Total Private Vehicles</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private vehicles</i>
2003	3642237	19642583	0.075367046
2004	3903208	45436825	0.071651296
2005	4199111	98030614	0.075810205
2006	4550518	169322536	0.083686047
2007	4935226	218706636	0.084541584
2008	5307894	263733520	0.075511841
2009	5672077	307427745	0.068611581
2010	6083671	411961543	0.072564953
2011	6530488	577251875	0.073445293
2012	7001982	682203309	0.072198892
2013	7464113	779255282	0.066000027
2014	7921413	865599153	0.061266489
2015	8471831	931364952	0.069484825
2016	9090649	1007199428	0.073044186
2017	9760589	984707703	0.073695508
2018	10325065	919790709	0.057832166
Correlation Coefficient			-0.57692513

Table 3. Correlation between metro ridership and growth of total private vehicles

3) Next, we need to test the effect of ridership of metro on the ownership of two-wheeler private vehicles in Delhi. For this too we will use CORREL function in excel. This results in the correlation coefficient coming to be 0.26. This means there is a weak positive correlation between the increase in ridership of metro passengers and growth rate of two-wheeler private vehicles.

<i>Year</i>	<i>Total Two-Wheelers (Scooters and Motorcycles)</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private two-wheelers</i>
2001	2230534	-	-
2002	2339923	3868093	0.04904162
2003	2502484	19642583	0.069472799
2004	2659449	45436825	0.062723678
2005	2839838	98030614	0.067829464
2006	3078660	169322536	0.084097051

<i>Year</i>	<i>Total Two-Wheelers (Scooters and Motorcycles)</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private two-wheelers</i>
2007	3335763	218706636	0.083511333
2008	3578199	263733520	0.072677825
2009	3808503	307427745	0.064363106
2010	4065789	411961543	0.067555677
2011	4352963	577251875	0.070631801
2012	4654706	682203309	0.06931899
2013	4980227	779255282	0.06993374
2014	5296163	865599153	0.063438072
2015	5681265	931364952	0.072713396
2016	6104070	1007199428	0.074420926
2017	6607879	984707703	0.08253657
2018	7078428	919790709	0.071210293
Correlation Coefficient			0.287942435

Table 4. Correlation between metro ridership and growth of total private two-wheelers

4) The final test we need to do is to check the correlation between the increase in the number of riders of metro year wise with the growth rate of four-wheelers in Delhi. This results in the correlation coefficient coming to be -0.79. This means there is a strong negative correlation between the increase in ridership of metro passengers and growth rate of four-wheeler private vehicles.

<i>Year</i>	<i>Total Four-Wheelers (Cars and Jeeps)</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private four-wheelers</i>
2001	920723	-	-
2002	1047048	3868093	0.13720196
2003	1139753	19642583	0.088539398
2004	1243759	45436825	0.091253105
2005	1359273	98030614	0.092874906
2006	1471858	169322536	0.082827364
2007	1599463	218706636	0.086696543
2008	1729695	263733520	0.081422327
2009	1863574	307427745	0.077400351
2010	2017882	411961543	0.082802185
2011	2177525	577251875	0.07911414
2012	2347276	682203309	0.077955936
2013	2483886	779255282	0.058199377
2014	2625250	865599153	0.056912435
2015	2790566	931364952	0.062971527
2016	2986579	1007199428	0.070241306

<i>Year</i>	<i>Total Four-Wheelers (Cars and Jeeps)</i>	<i>Ridership of Metro</i>	<i>Percentage growth of total private four-wheelers</i>
2017	3152710	984707703	0.055625852
2018	3246637	919790709	0.029792464
Correlation Coefficient			-0.791531976

Table 5. Correlation between metro ridership and growth of total private four-wheelers

6 Conclusion:

The conclusions from the study are that the growth in number of private vehicles can be explained by the independent variable that is the ridership of Delhi metro to a very good extent. This is based on a very high R squared value we found after conducting simple linear regression on the secondary data that we have collected. Based on this we have conducted further tests to analyze how the ridership of metro is correlated to the growth rate of private vehicles in the city of Delhi.

The results show us that the ridership of metro has a negative correlation with the growth rate of total private vehicles in Delhi. It means that as the Delhi metro network has expanded and the number of riders has increased over the years, the growth rate of ownership of private vehicles has reduced. This is a relatively strong negative correlation and means that the overall the Delhi government has been successful in making people use more of public transport and reduce reliance and dependence of private vehicles.

When it comes to two-wheelers, as the ridership of Delhi metro has increased, the growth rate of two-wheeler private vehicles shows a weak positive correlation. It means that people are still buying more two-wheelers even after increase in ridership of metro. It points to the fact that two-wheelers are more convenient and help in ferrying public from point to point in a congested city like Delhi. Another reason might be that two-wheelers are comparatively cheaper than four-wheelers and hence much more affordable to the common public as the disposable income increases.

The trend completely shifts when it comes to the growth rate of private four-wheelers owned in Delhi. We observe a strong negative correlation between the increase in ridership of metro and the number of private four-wheelers owned by the population of Delhi. This points to the fact that the Delhi metro has been successful in reducing the need for four-wheelers among the public by providing them an alternative in the form of transport. It also points to the fact that due to reduction in growth rate of four-wheelers, there will be reduced congestion, parking problems and delays in transit.

7 Future Scope:

Through our study we have successfully managed to find a correlation between the increase in ridership of Delhi metro and the number of private vehicles in Delhi. But there is a lot still to be explored in this domain. The impact of Delhi metro is not only restricted to the reduction in ownership of private vehicles. Its impact on the environment has also been immense. Work can be continued on this topic to identify how the air quality of Delhi has been impacted by the introduction of Delhi metro and consequent reduction in the growth rate of four-wheelers. Whether there is any significant impact of the metro in improving the air quality of Delhi.

Another point of study can be how the metro has helped decongest the roads in Delhi. Whether the reduction in number of cars has been backed up by improvements in physical infrastructure to provide a better driving experience for the travelers. Another thing that could be looked at is the impact of Delhi metro on the time spent of travelling by the commuters. We could identify whether the transit time has significantly reduced for the people.

One could also go further to find whether this has disciplined the people of Delhi and check the behavior of the people qualitatively whilst travelling in a metro and in the surrounding area compared to the other areas. This could also be mapped to the crime rate in the areas surrounding the metros and compare it with the entire city of Delhi.

The next area that could be ventured into is the impact of Delhi metro on the economy and how the ecosystem surrounding the metro has increased in a commercial sense. The metro has been successful in allowing a lot of businesses to start and grow and it is a secondary benefit which can also be attributed to it. This could be taken into consideration while checking the financial feasibility of projects of such scale in other areas of the country.

Finally, we can check whether the impact of the Delhi metro on all these factors could be applied for other cities as well. The Hyderabad metro project has recently been completed and the Mumbai and Pune metro projects are currently in progress. We can use the Delhi metro as a blueprint to identify the things which have worked and which have not worked and implement the same in future projects. This can also help us to predict how the ecosystem in a metro city will change by the introduction of this new form of transport.

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