Rise in Sales of Multi Axle Trucks in India : Governmental Initiatives, Industrial Development, and Operator Preferences

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Abstract

The research paper expressed two aspects that affect truck operators, on the one hand, it demonstrated the relationship between the sale of heavy trucks and road, infrastructural, and industrial development while, on the other hand, it also showed how the business performance of truck owners gets affected by government policies and personal perceptions. The paper, in quest of these two objectives, also established a time series model (ARIMA model) and three regression equations that clearly explained the relationship between the relevant dependent and independent variables.

Keywords : **multi axle trucks, heavy trucks, HCV, MHCV sales, index of industrial productivity, time series analysis, ARIMA model, regression analysis**

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Road freight transportation is a significant contributor to the GDP of a country, in fact, as pointed out by Raghuram (2015), as of 2012-13, the GDP share of road freight transportation was 4.9% in our country (in comparison, the contribution of Indian Railways was 0.9%). Rambaskar and Kumar (2015) in their research paper mentioned the importance of the logistics sector and its contributions to the economic growth of India. The Indian transport industry consists of government policies, legal structure, economic situation, technology, etc. (Dubey & Gunasekaran, 2015).

The study of various economic indicators on a target dependent issue of focus has been carried out in literature. Bagheri and Rodrigues (2017) found the relationship between degree of broadband access and economic outputs (at the macro-economic level) to get insights, and empirical evidences from broadband studies revealed that broadband services did contribute to GDP. Similarly, the transport industry has also made such a substantial contribution over the economies of developed and developing markets, and the transport industry has also been found to be benefited by improvement in economic activity. A study conducted by Rashidi and Samimi (2012) found a positive relationship between growth in transportation productivity and economic indicators in selected metropolitan statistical areas of USA. It is also noteworthy, as found by Bloemhof, Van der Laan, and Beijer (2011), from an economic performance perspective, when compared to inland waterways and rail networks, heavy

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trucks in long haulage applications have been found to be a better transportation mode choice, in terms of flexibility and speed. Lumsden (2004), in his research for European markets, observed why there was a need for increasing the load capacity of trucks by making trucks longer and heavier. Lumsden compared development of GDP and heavy truck sale along with the impact of increase in truck sizes. It was argued that in European conditions, bigger and longer trucks would imply lesser number of trucks and safer roads.

Knight, Burgess, Maurer, Jacob, Irzik, Aarts, and Vierth (2010), in their study for the European Commission, explored the socioeconomic effects and technical details on adapting to the rules[1] regarding weights and dimensions of heavy trucks in the European markets. Under the economic aspect, it was found that exhaustive research studies need to be carried out to capture the shift to larger vehicles[2] that is taking place in the European road transport (freight) sector.

Londoño - Kent (2009) compared issues and emerging trends in road - freight transport industries by describing market structures, effect of regulations, and competitive nature of road freight transport. The paper also examined the good/bad practices of the transport industry; it was found that as industrialization increases, trip lengths increase, and medium rigid trucks (typical two axle trucks) lose out to larger trucks that could be the typical multi - axle trucks that carry freight in between large warehouses/hubs. As a result, the small delivery vans have also become very popular, which redistribute from hubs to the smaller last mile nodes. This phenomenon is a common trend in numerous developing countries, including India ; the study also found that less than 20% of the average trips went empty.

The usage of productivity indices have been taken up earlier in literature for gauging the improvement in the factory/manufacturing sector. Ganesan and Anbumani (2007) compared the Solow's index for pre and post liberalization era for the state of Tamil Nadu and found improvement in economic development due to consistent policy decisions taken by the State and Central governments.

The report by McKinsey & Company (2010) pointed out that it is imperative for India to develop its logistics network efficiencies; it was shown that on considering the purchasing power parity (PPP), the road costs in India are 30% higher – which essentially hampers the economic growth of India. The report also suggested that poor logistics infrastructure costs the Indian economy almost 4.3 % of its GDP every year, alarmingly two - third of this figure is hidden (generally not regarded as logistics cost), this includes theft and damage, higher inventory holding costs, facilitation and transaction costs, etc. The report recommended ensuring setting up of common standards that help intermodal transferability and inter-operability, adopting a national-level electronic tolling mechanism, setting dedicated coastal & rail freight corridors, and improving the existing national expressways and add new expressways in high – traffic routes.

Chavan and Bhola (2013) established that infrastructural development can prove to be a problem if not properly developed, the researchers of this paper also focused on the study of infrastructural development (as well as the industrial activity required to sustain the infrastructural development). Sales volume and sales growth of medium and heavy commercial vehicles (MHCVs) for goods carriage applications should throw some light on its impact on the growth of multi axle heavy trucks in the Indian context.

The Indian heavy truck industry has been experiencing some interesting developments, the very nature of the ubiquitous Indian heavy truck and the transporter is changing; the Indian heavy truck market is actually following the global pattern of changing its characteristics through various stages. It is an interesting industry with its unique set of characteristics, consumer perceptions, and market dynamics. The majority of the demand side of the market (i.e. the national route transporters) is highly fragmented and unorganized; of course, there are large organized transportation service providers (OSL, VRL, Transafe, Coastal, etc.) who provide complete logistical solutions, but they do not represent an average transporter. Also, there is an increasing trend of multi-axle trucks turning out to be a popular choice among transporters in national routes or long haulage applications.

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[1] Directive 96/53/EC for EU member states (national as well as international transportation).

[2] Euro Modular System.

Global giants like Volvo, MAN, Mercedes Benz, Scania, etc. are making a beeline for the Indian market to grab a share in the growing Indian commercial vehicle market. The Indian commercial vehicle manufacturers have also taken up the initiative to pitch in competitive platforms with the help of strategic tie ups and knowledge partnerships : TATA - Cummins - Daewoo , Ashok Leyland - Iveco - Hino, and Mahindra - Navistar. There are also some comparatively new players who have introduced innovative manufacturing approach, e.g. AMW.

The Hypotheses to be Tested in this Background

In the above context, it is of interest to understand the key determinants that are driving the growth of multi - axle trucks in the Indian market. What drives a transporter to have substantial trust in purchasing bigger and heavier trucks ? What makes them suitable for the Indian transport market space ? The probable aspects that drive the demand to buy bigger trucks with greater load capacity would be availability of freight to be transported across long distances over a road network suitable for such applications.

Availability of freight depends upon demand for various categories of goods across the Indian market ; a measure to understand the need to transport various category of goods lies in the level of production activity of such goods year on year. The index of industrial production provides a good insight to understand the vigor of industrial activity (which obviously would be there only if there is enough demand for such goods) in the market. There would naturally be a requirement of such goods to be transported to diverse and distant locations for downstream utilization and distribution. Also, a healthy growth of national highways (with upto four, six, and even eight lanes) would ensure availability of suitable mode for these heavy and large multi – axle trucks to run without hindrance.

That brings us to the primary question of this paper : the role of road and infrastructural development in growth of multi - axle trucks engaged in long distance freight haulage applications. Thus, the relevant hypotheses put forward are:

- **H_{01A} :** Growth of MHCV trucks is not related to road, infrastructural, and industrial development.
- **H_{01B} :** Business performance of MHCV truck owners is not driven by government policies and personal perceptions.

Data and Methodology

The study presented here focuses upon the MHCV truck segment in general and particularly on multi axle heavy trucks of 25 tonnes GVW and above; which is seeing new product introductions ; influx of established global OEMs ; and rising product refinement, productivity, and complexity.

Secondary data in the form of : Central Statistics Office (CSO) data from Reserve Bank of India (2015) on index of industrial productivity for basic goods, capital goods, intermediate goods, consumer goods, consumer durables, and consumer non-durables from 1990-91 to 2014-15; OICDA (2016) data on production of MHCV trucks from 1996 - 97 to 2014 - 15 ; and MORTH (2015) data on available kilometres of national highways from 2001- 02 - 2014-15 has been used. The CSO data on IIP was used with a common base year of 1980-81 for IIP data on basic goods, capital goods, intermediate goods, consumer goods, consumer durables, and consumer non-durables from 1990-91 to 2014-15. A weighted average of these various categories of goods were calculated and data was recalculated with a single base year of 1980-81 to ensure a single uniform base value.

Besides these, primary data were collected from 171 respondents (unorganized transporters) from 11 cities across India during the period of 2014 - 15. The cities covered in North Zone were New Delhi and Ghaziabad ; in the East Zone, the cities covered were Bhubaneswar, Cuttack, Guwahati, and Kolkata ; and in the South Zone, the cities covered were: Bengaluru, Chennai, and Hyderabad.

(1) Sample : Stratified random sampling was used to collect primary data from transporters (unorganized), drivers, manufacturers, and financiers from each of the aforementioned cities. Only certain relevant responses for transporters are discussed. It felt interesting to us to understand the relationship between MHCV production, availability of national highways, and index of industrial production. The trends present in between these parameters were also probed to accept/reject the null hypotheses, and if possible, to establish a time series model based on historic data available for production of MHCVs, length of national highways, and IIP from 1996 - 97 to 2014 -15.

Furthermore, from the primary data collection (from transporters) done to understand various operational aspects of running multi-axle heavy trucks and infrastructural development, bivariate correlation was performed in an attempt to understand whether the business performance of heavy trucks [Y_1] is being driven by governmental policies (and effect of various governmental agencies) [X_1] and personal preferences (of product usage) [Z_1]. Also, regression equations were formed to show the effect of governmental policies [X_1] and [Z_1] personal preferences of transporters on business performance of heavy trucks [Y_1].

(2) Model Specification and Regression Equations : Times series model fit formula (derived from SPSS output ARIMA model parameters) :

$$\Delta Y_t = 6.204E4 + (-1.282^3) . X_t + e_t ;$$

where,
e_t follows normal distribution,
with, mean = 0 and variance = σ^2 (sigma sq.)
e_t is white noise.

Three regression equations were formed for the three relevant dependent variables :

(R Squared = .586 (adjusted R squared = .471)) .... (1)

(Predicted) *agltr* = 3.893E3 + (-839.142) * *gst_inf* + (-596.860) * *rdql* + (-339.003) * *etrn* + (378.072) * *cmfpow* + (224.689) * *axep_rt*

(R squared = .382 (adjusted R squared = .211)) .... (2)

(Predicted) *mx_no* = 108.691+ (-55.364) * *gst_inf* + (-8.558) * *rdql* + (-3.587) * *etrn* + (13.872) * *cmfpow* + (-1.960) * *axep_rt*

(R squared = .629 (adjusted R squared = .526)) .... (3)

(Predicted) *mpf_dmy* = 2.878+ (-0.316) * *gst_inf* + (-0.281) * *rdql* + (-0.186) * *etrn* + (-0.213) * *cmfpow* + (0.391) * *axep_rt*

where,

agltr = Avg. length of a trip (in km) [dependent variable],
mx_no = No. of trucks with 3 or more than 3 axles [dependent variable],
mpf_dmy = Most profitable route preference (Intra =1/Inter =2) [dependent variable],
gst_inf = GST information (Y = 1, N = 2) [independent variable],

rdql = Average quality of roads (1 to 7) [independent variable],
etrn = Extortion (*Y* =1, *N* =2) [independent variable],
cmfpow = Comfortable cabin & powerful engine (1 to 7) [independent variable],
axep_rt = Number of axles and engine power (rating: 1 to 7) [independent variable].

Analysis and Results

(1) Linking Industrial Productivity, National Highway Construction, and Medium & Heavy Truck Production : On using the OICA, CSO, and MORTH data, we can easily observe the strong and significant correlation between production of MHCV, index of industrial production (IIP), and national highways constructed

Figure 1. Frieght Hauled by MHCV and LCV Trucks and Length of Highways

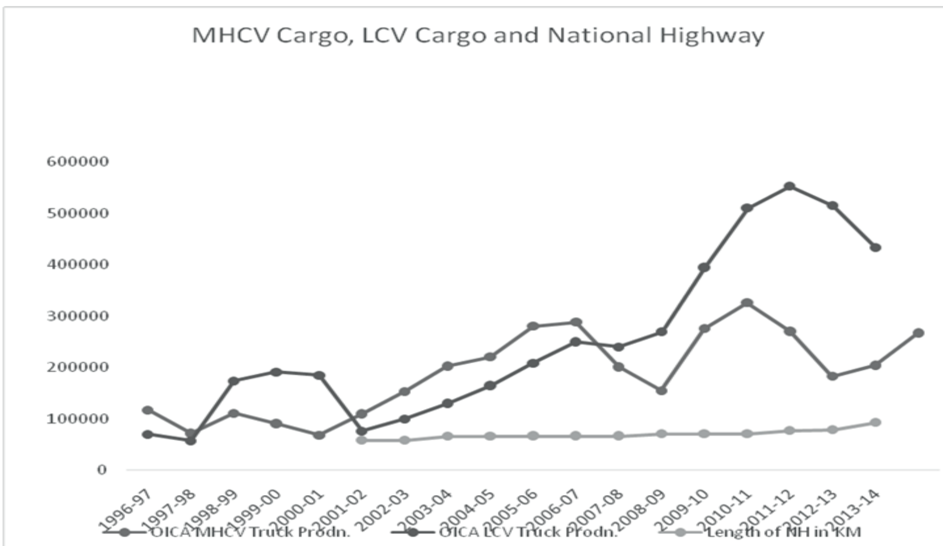

Table 1. Correlations Between Production of MHCVs, Length of National Highways, and Index of Industrial Production

Correlations				
		IIP Base Year 80-81	**National Highways**	**MHCV Prodn.**
IIP Base Year 80-81	Pearson Correlation	1	.843**	.796**
	Sig. (2-tailed)		.000	.000
	N	16	16	16
National Highways	Pearson Correlation	.843**	1	.756**
	Sig. (2-tailed)	.000		.001
	N	16	16	16
MHCV Prodn.	Pearson Correlation	.796**	.756**	1
	Sig. (2-tailed)	.000	.001	
	N	16	16	16

Note : **. Correlation is significant at the 0.01 level (2-tailed).

(Figure 1). The growth of MHCV sales in India and growth in index of industrial production closely followed each other during the period of June 2006 to August 2010, the trend for growth of sale of MHCVs also moved through in a very similar pattern of growth trend of IIPs.

Before initiating a time series analysis on production of MHCV trucks (mhcvprodn), total length of national highways in a given year in kilometers (nh), and index of industrial production (IIP), these three variables were tested for any correlation among them. It was found (Table 1) that all three variables had significant (0.01 level of significance) positive correlation with each other. The variables for yearly production of MHCV trucks (mhcvprodn) and total length of national highways in a given year in kilometres (nh) had a positive correlation (+ 0.756) ; mhcvprodn and index of industrial production (IIP) also had a positive correlation (+ 0.796). Both of these figures were significant (0.01 level of significance). It is also interesting to note that the variables : nh and IIP were also significantly (0.01 level of significance) and positively correlated (+ 0.843) with each other.

(2) The Time Series Model : Once it was ascertained that production of MHCV trucks had a positive correlation with length of national highways (nh) and index of industrial production (IIP), a time-series analysis was conducted to find out the trends, and if possible, fit a model that would be suitable to the situation. As Gebre and Singh (2016) successfully demonstrated the utilization of time - series based forecasting for a manufacturing company and Karjagi, Chakrabarty, and Mohite (2010) developed a model for forecasting of prices, we used a time series tool to forecast production of MHCV trucks. The variable : (mhcvprodn) was taken as dependent variable and total length of national highways in a given year in kilometres (nh), and index of industrial production (IIP) were taken as independent variable for this analysis. After running the time series analysis, an ARIMA (0,1, 0) model was derived. This model was named 'Truck Production Forecast Model' and was used in the time period between: 1996-97 to 2014-15. This model was found to fit into the upper and lower-class limits at 95% level of confidence ; the observed and fit values are located within the upper - class limit and the lower - class limit. Also, the fit values correctly follow the observed values throughout the forecasting time line of 2012-13 to 2014-15. The forecast values have stayed within the upper-class limit and the lower-class limit at 95% level of confidence.

In the model fit table (Table 2 and Figure 2), the stationary *R* - squared value (+ 0.363) implies that the ARIMA model explains 36.3% of the variation in the series; but since there is no seasonality, we are free to take up the ordinary *R* - squared value (+ 0.722) which implies that the ARIMA model explains 72.2% of the variation in the series as explained by the model. Also, RMSE[3] (root mean square error), which is a measure of how much a dependent series varies from its model-predicted level, expressed in the same units as the dependent series, has a value of 4.573E4, which implies that the predictions of the 'Truck Production Forecast Model' may vary by an approximate margin of ± 45,730 MHCV trucks from its predicted level. The MAPE (mean absolute percentage error) value of (20.895) implies that on an average, the model may vary up to 20.90% from the predicted level. The MAE (mean absolute error) value of 3.233E4 implies that the series varies by 32,330 trucks from its model predicted level.

The ARIMA model parameters (Table 3) demonstrates the ARIMA model equation as :

$$\Delta Y_t = 6.204E4 + (-1.282^3) . X_t + e_t ;$$

Table 2. Time Series - ARIMA Model Statistics

Model	Number of Predictors	Model Fit statistics				
		R-squared	Stationary *R*-squared	Root Mean Sq. Error (RMSE)	Mean Absolute % Error (MAPE)	Mean Absolute Error (MAE)
Truck Production Forecast Model	1	.722	.363	4.573E4	20.895	3.233E4

[3]A measure of how much a dependent series varies from its model-predicted level, expressed in the same units as the dependent series.

Figure 2. Time Series – Model Fit & Forecasting Chart

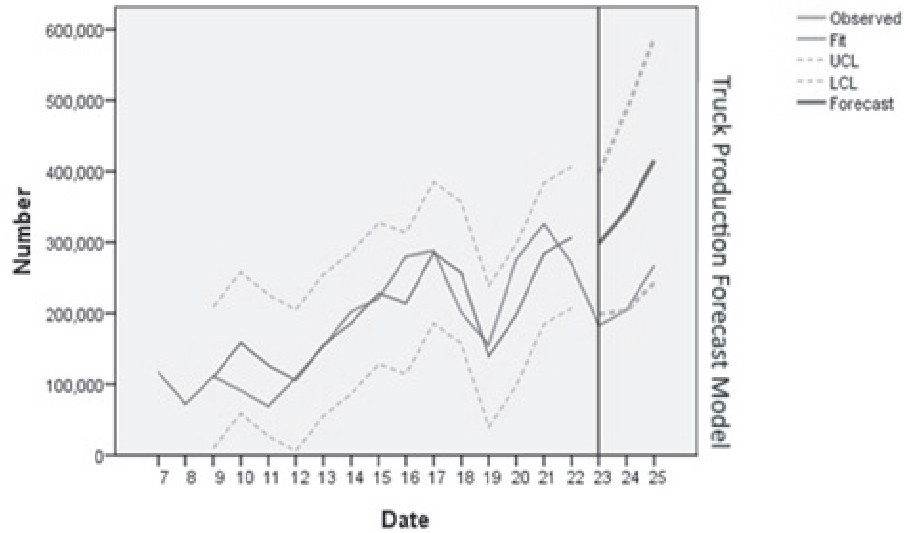

Table 3. ARIMA Model Parameters

				Estimate	*SE*	*t*	Sig.
Mhcvprodn.-Model_1	Mhcvprodn.	No Transformation	Constant	6.204E4	2.200E4	2.820	.015
			Difference	1			
	IIP base year 80-81	No Transformation	Delay	1			
			Numerator Lag 0	-1.282E3	489.819	-2.617	.023
			Difference	1			

where, e_t follows normal distribution with mean = 0 and variance = σ^2 (sigma sq.) and e_t is white noise.

The equation implies that to predict any subsequent year's production of MHCV trucks, we would have to put IIP (at 80-81 base year value) and determine e_t . Through the establishment of this model, it is also proven that production of MHCV trucks is related to road, infrastructural, and industrial development.

So, from the aspects discussed above, it is proved that production and the growth of MHCV trucks are indeed related to infrastructural and industrial development, an ARIMA model (0,1,0) has been established from the output of ARIMA model parameters (Table 3). This model 'Truck Production Forecast Model' is also within the significance levels of 0.05 (p - value = 0.015). Thus, the null hypothesis H_{01A} stands rejected.

(3) Correlations : From the primary data collection (from transporters) done to understand various operational aspects of running multi-axle heavy trucks and infrastructural development, an attempt was made to evaluate the interaction of governmental initiatives (and effect of various governmental agencies) [X_1], personal preferences (of product usage) [Z_1], and business performance of heavy trucks (growth) [Y_1].

Governmental initiatives (and effect of various governmental agencies) clubbed under group of X_1 consisted of aspects like: information about GST, effect of golden quadrilateral, North – South & East – West corridor on turnaround time, average quality of roads, and incidences of extortion. Personal preferences were grouped in Z_1 which included preference of the transporter to have trucks with comfortable cabin and powerful engine, greater number of axles, and higher engine power. The attributes for business performance (growth) were : years of operating a truck fleet, number of trucks being operated, proportion of heavy trucks in the fleet, average length of a trip, and preference for intra-zonal and inter-zonal routes, these were clubbed under Y_1.

The analysis was made to understand the effect of governmental initiatives [X_1] and personal preferences [Z_1] on business performance (growth) [Y_1] of heavy trucks. A correlation analysis established significant (at 0.05 and 0.01 level of significance) correlation of business performance (growth) [Y_1] of heavy trucks with governmental

Table 4. Correlations Between Y_1 with X_1 and Z_1 variables

			X_1				Z_1
			GST Information (*y* = 1 /*n* =2)	Avg. Quality of Roads (Rating: 1 to 7)	Extortion Frequency	Comfortable Cabin & Powerful Engine	Number of Axles and Engine Power (Rating : 1 to 7)
Y_1	Since how many years are you operating trucks (figure in years) ?	Pearson Corr.	-0.093	0.027	0.124	-.172*	-0.147
		Sig. (2-tailed)	0.515	0.732	0.147	0.026	0.061
		N	51	168	138	167	162
	No. of trucks you operate (nu_trk) <range>	Pearson Corr.	-.299*	0.073	-0.072	0.13	0.026
		Sig. (2-tailed)	0.033	0.349	0.4	0.094	0.739
		N	51	167	137	167	162
	Avg. of length of a trip (in km)	Pearson Corr.	-0.078	0.149	.305**	.228**	.247**
		Sig. (2-tailed)	0.695	0.091	0.001	0.009	0.005
		N	28	129	113	129	127
	No. of trucks with 3 or more than 3 axles <number>	Pearson Corr.	-.341*	0.063	0.049	.208**	0.126
		Sig. (2-tailed)	0.014	0.416	0.57	0.007	0.111
		N	51	168	138	167	162
	Total no. of trucks	Pearson Corr.	-.352*	0.044	-0.094	0.112	0.031
		Sig. (2-tailed)	0.011	0.568	0.275	0.149	0.691
		N	51	168	138	167	162
	Most profitable route reason (Intra Zonal =1/Inter zonal = 2)	Pearson Corr.	-0.01	0	0.14	.178*	.163*
		Sig. (2-tailed)	0.947	0.997	0.108	0.027	0.045
		N	44	157	133	156	152

Note : **. Correlation is significant at the 0.01 level (2-tailed).
Note : *. Correlation is significant at the 0.05 level (2-tailed).

Table 5. Correlations Within Y_1 Variables

Correlations within Y_1			
		Total No. of Trucks	Avg of Length of a Trip (in km)
Most profitable route reason	Pearson Correlation	.387**	.480**
(Intra Zonal = 1 / Inter zonal = 2)	Sig. (2-tailed)	0	0
	N	160	128

Note: **. Correlation is significant at the 0.01 level (2-tailed).

Table 6. Correlations Between Total No. of Trucks and Avg. of Length of a Trip (in km)

		Avg. of length of a trip (in km)
Total no. of Trucks	Pearson Correlation	**0.15**
	Sig. (2-tailed)	0.086
	N	132

Table 7. Correlations Within X_1 and Z_1 Variables

Correlations within X_1 and within Z_1			
		Extortion Frequency	**Comfortable Cabin & Powerful Engine**
Number of Axles and Engine Power (Rating: 1 to 7)	Pearson Correlation	.203*	.718**
	Sig. (2-tailed)	0.02	0
	N	131	159
Comfortable Cabin & Powerful Engine	Pearson Correlation	.263**	1
	Sig. (2-tailed)	0.002	
	N	135	167

Note : *. Correlation is significant at the 0.05 level (2-tailed).

Note : **. Correlation is significant at the 0.01 level (2-tailed).

initiatives [X_1] and personal preferences [Z_1]. The Tables 4, 5, 6, and 7 consist of the relevant correlation tables for the aforementioned aspects.

(4) Regression Equations : The next phase of analysis uses the regression equations with the three Y_1 variables or dependent variables (Table 8). The set of independent variables are the combination of [X_1] variables (governmental initiatives) and [Z_1] variables (personal preferences) which have been established to be reliably predicting the previously mentioned [Y_1] variables.

The set of dependent variables are: avg. length of a trip (in km), no. of trucks with 3 or more than 3 axles, and most profitable route preference (Intra Zonal /Inter Zonal). The independent variables are : GST information, average quality of roads, extortion, comfortable cabin & powerful engine, number of axles and engine power (Table 9).

These dependent and independent variables are elaborated as provided below :

agltr = Avg. length of a trip (in km) [dependent variable],
mx_no = No. of trucks with 3 or more than 3 axles [dependent variable],
mpf_dmy = Most profitable route preference (Intra = 1/Inter = 2) [dependent variable],
gst_inf = GST information (Y = 1, N = 2) [independent variable],
rdql = Average quality of roads (1 to 7) [independent variable],
etrn = Extortion (Y = 1, N=2) [independent variable],

Table 8. Tests of Between - Subjects Effects (GLM) - Partial Output

Source	Dependent Variable	Type III Sum of Squares	*Df*	Mean Square	*F*	Sig.
Corrected Model	Number of trucks you operate	8.798	5	1.760	1.028	.431
	Avg of length of a trip (in km)	1.703E7[a]	5	3405582.096	5.089	**.004**
	No. of trucks with 3 or more than 3 axles	8202.040[b]	5	1640.408	2.228	**.096**
	Total no. of trucks	6803.566	5	1360.713	1.695	.187
	Most profitable route reason (Intra/Inter Zonal)	3.748[c]	5	.750	6.105	**.002**

a. R Squared = .586 (Adjusted R Squared = .471).
b. R Squared = .382 (Adjusted R Squared = .211).
c. R Squared = .629 (Adjusted R Squared = .526).

Table 9. Parameter Estimates (GLM) - Selected Variables

Parameter Estimates							
Dependent Variable	**Parameter**	***B***	**Std. Error**	***t***	**Sig.**	**95% Confidence Interval**	
						Lower Bound	**Upper Bound**
Avg of length of a trip (in km)	Intercept	3.839E3	1613.209	2.380	.029	449.679	7228.132
	gst_inf	-839.142	611.942	-1.371	.187	-2124.785	446.501
	Rdql	-596.860	217.220	-2.748	.013	-1053.222	-140.498
	Etrn	-339.003	364.359	-.930	.364	-1104.494	426.488
	Cmfpow	378.072	364.859	1.036	.314	-388.468	1144.613
	axep_rt	224.689	330.726	.679	.506	-470.140	919.518
No.of trucks with 3 or more than 3 axles	Intercept	108.691	53.511	2.031	.057	-3.731	221.113
	gst_inf	-55.364	20.298	-2.728	.014	-98.010	-12.719
	Rdql	-8.558	7.205	-1.188	.250	-23.695	6.580
	Etrn	-3.587	12.086	-.297	.770	-28.979	21.804
	Cmfpow	13.872	12.102	1.146	.267	-11.555	39.298
	axep_rt	-1.960	10.970	-.179	.860	-25.007	21.088
Most profitable route reason (Intra/Inter Zonal)	Intercept	2.878	.691	4.165	.001	1.426	4.330
	gst_inf	-.316	.262	-1.205	.244	-.867	.235
	Rdql	-.281	.093	-3.018	.007	-.476	-.085
	Etrn	-.186	.156	-1.189	.250	-.514	.142
	Cmfpow	-.213	.156	-1.364	.189	-.542	.115
	axep_rt	.391	.142	2.763	.013	.094	.689

cmfpow = Comfortable cabin & powerful engine (1 to 7) [independent variable],
axep_rt= Number of axles and engine power (rating : 1 to 7) [independent variable].

The three regression equations formed in the Model Specification and Regression Equations section of Methodology for the three dependent variables named as Equation 1, Equation 2, and Equation 3 are discussed in detail here. The equations are again expressed as below :

(R Squared = .586 (adjusted R squared = .471)) .... (1)

(Predicted) $agltr$ = 3.893E3 + (-839.142) * gst_inf + (-596.860) * $rdql$ + (-339.003) * $etrn$ + (378.072) * $cmfpow$ + (224.689) * $axep\_rt$

Equation 1, which predicts the average length of a trip (in km) has an R^2 value of 0.586. This values implies that 58.6% of the variance in average length of a trip (in km) can be predicted through the set of independent variables, which are a combination of [X_1] variables (governmental initiatives) and [Z_1] variables (personal preferences), and these independent variables are as provided above.

A coefficient value of -839.142 for GST information implies that for every unit increase in GST information, there is a 839.142 km improvement in average length of a trip (in km) (since non-information of GST has higher value (N = 2)). It implies that longer the routes run by transporters, the more likely they are to be aware of the benefits of GST ; more precisely, for every unit of increase in GST information, an increase of 839.142 km is predicted in the average length of the trip.

A coefficient value of -596.86 for average quality of roads implies that for an increase of 596.86 average length of a trip (in km), the average quality of roads deteriorates by one point. So, effectively, the longer the routes are for a truck, the higher are the chances of worsening of road conditions that it needs to travel through. As operating routes get longer and pass through distant road networks, the average road quality worsens.

A coefficient value of -339.003 for extortion implies that for every unit increase in extortion, there is a predicted reduction of 339.003 km in the average length of the trip. This is usually caused by unnecessary delay and holding up of trucks at authorized and unauthorized checkpoints to collect money from the affected trucks' crew members, which invariably reduces the distance covered. On an average, this delay can take up to 4 hours of a truck driver's time in a day (Transparency International India, 2006). Such delays also reduce the number of kilometres that a truck can cover each day and unnecessarily increase the turnaround time for trucks in longer routes.

A coefficient value of +378.072 for comfortable cabin & powerful engine implies that for every unit increase in comfortable cabin & powerful engine, the average length of the trip increases by 378.072 km. Where a truck driver has a cabin which is really comfortable and ergonomically suitable along with a powerful engine (which can help maintain higher average speeds and better turnaround time), the average length of a trip can increase. With the truck owner's attitudinal improvement on comfortable cabin & powerful engine by one unit, the average trip length can increase by 378.072 km.

A coefficient value of + 224.689 for number of axles and engine power implies that for every unit increase in number of axles and engine power, the average length of the trip increases by 224.689 km. With powerful engines and greater number of axles, the trucks have the capability to maintain higher average speeds with a greater payload to reach out to delivery points that are situated at a greater distance and earn better freight rates while returning better fuel efficiency per tonne of freight carried. So, a driver of a multi axle truck with powerful engines can drive 224.689 km more for one unit increase in the attitude of the transporter for number of axles and engine power.

(R squared = .382 (adjusted R squared = .211)) ....(2)

(Predicted) mx_no = 108.691+ (-55.364) * gst_inf + (-8.558) * $rdql$ + (-3.587) * $etrn$ + (13.872) * $cmfpow$ + (-1.960) * $axep\_rt$

Equation 2, which predicts the no. of trucks with 3 or more than 3 axles has an R^2 value of 0.382. This value implies 38.2% of the variance in no. of trucks with 3 or more than 3 axles can be predicted through the set of independent variables, which are a combination of [X_1] variables (governmental initiatives) and [Z_1] variables (personal preferences).

A coefficient value of -55.364 for GST information implies that for every unit increase in GST information, there is a 55.364 point improvement in no. of trucks with 3 or more than 3 axles (since non-information of GST had higher value (N = 2)). It implies that higher the number of 3 axles or more than 3 axles trucks, the transporters are more likely to be aware of the benefits of GST ; more precisely, for every unit of increase in GST information, an increase of 55.364 number of trucks with 3 or more than 3 axles is predicted. So, effectively, larger fleet owners are more aware and concerned about GST.

A coefficient value of - 8.558 for average quality of roads implies that for an increase of 8.558 number of trucks with 3 or more than 3 axles, the average quality of roads deteriorates by one point. So, effectively, the more the number of trucks transporters have, the higher the cumulative mileage of their trucks would be and their overall experience of quality of roads would fall. This implies that overall quality of roads has a lot to improve, especially in longer routes connecting various industrial and trading zones. The improvement in road quality would positively impact the operations of transporters who engage their multi axled trucks in long haul routes.

A coefficient value of -3.587 for extortion implies that for an increase of 3.587 number of trucks with 3 or more than 3 axles, impact of extortion increases by one point. So, if transporters try to increase the number of 3 or more than 3 axle trucks, they have to face a higher risk of extortion, and this has a very negative impact on fleet expansion and overall business growth of the transporters.

A coefficient value of +13.872 for comfortable cabin & powerful engine implies that for an increase of 13.872 number of trucks with 3 or more than 3 axles, the tendency to provide comfortable cabin & powerful engine increases by one point. So, transporters who are investing in bigger and heavier trucks are also providing more comfortable cabins and powerful engines in their trucks, which naturally help to cover greater distance, cover longer routes, and maintain better turnaround time for their trucks.

A coefficient value of -1.96 for number of axles and engine power implies that for every unit increase in number of axles and engine power, there is a reduction of 1.96 trucks with 3 or more than 3 axles. In a growing economy like India, the implications are far reaching. With continuous growth in industrial activity, more freight would need to be carried around for further downstream processing, which would naturally dictate an increase in production of trucks (as shown in the ARIMA model). However, since the multi axle trucks can carry more freight, relatively lesser number of trucks would be required to cater to this growing haulage requirement. The multi axle trucks could thus reduce the carbon footprint of the trucking industry and ensure a lesser number of trucks on the road (reducing the growth in traffic volume of trucks).

Thus, an every unit increase of the operator's personal preference for providing more number of axles and more powerful engines (number of axles and engine power) could potentially reduce the fleet size of an operator/transporter by 1.96 trucks.

(R squared = .629 (adjusted R squared = .526)) ....(3)

(Predicted) *mpf_dmy* = 2.878 + (-0.316) * *gst_inf* + (-0.281) * *rdql* + (-0.186) * *etrn* + (-0.213) * *cmfpow* + (0.391) * *axep_rt*

Equation 3, which predicts the most profitable route preference (Intra =1/Inter =2) has an adjusted R^2 value of 0.629. This value implies 62.90% of the variance in the most profitable route preference can be predicted through the set of independent variables, which are a combination of [X_1] variables (governmental initiatives) and [Z_1] variables (personal preferences).

A coefficient value of -0.316 for GST information implies that for inter zonal [4] routes, there would be an improvement of 0.316 points over intra zonal routes. So, transporters running their transportation operations across the zones covering multiple state boundaries would naturally be more aware and interested in the possible benefits of GST.

A coefficient value of -0.281 for average quality of roads implies that for inter zonal routes, there is a deterioration of 0.281 points over intra zonal routes, as transporters who travel through more remote or isolated regions, which are far away from population hubs or within state boundaries, experience roads that are inferior by 0.281 points.

A coefficient value of -0.186 for extortion implies that for inter zonal routes, there is a deterioration of 0.186 points over intra zonal routes, so transporters operating trucks on inter zonal routes experience greater degree of extortion, specifically 0.186 points more than their counterparts operating only in intra zonal routes.

A coefficient value of -0.213 for comfortable cabin and powerful engine implies that for inter zonal routes, there is a deterioration of 0.213 points over intra zonal routes. In other words, the attitude of inter zonal operators to provide comfortable cabins and powerful engines in their trucks reduces by 0.213 points in comparison to intra zonal operators.

[4] Geographical zones are North Zone, East Zone, South Zone, West Zone, and Central Zone.

A coefficient value of + 0.391 for number of axles and engine power implies that for inter zonal routes, there is an improvement of 0.391 points over intra zonal routes, so transporters operating trucks on inter zonal routes have a higher tendency (by 0.391 points) to invest upon trucks with a greater number of axles and higher output of the engine, so that they could legally carry more freight while adhering to load restrictions per axle [5].

It is quite evident, from the above discussion, that business performance of fleet owners (Y_1 variables) of MHCV trucks is affected and is driven by the government policies and initiatives (X_1 variables) and the personal perceptions (Z_1 variables) of the fleet owners. In fact, the [Y_1] variables like avg. of length of a trip (in km), no. of trucks with 3 or more than 3 axles, and most profitable route reason (Intra/Inter Zonal) are reliably explained by the combination of [X_1] variables (governmental initiatives) and [Z_1] variables (personal preferences) as the significance values (p - values) are 0.004, 0.096, and 0.002, respectively. So, H_{01B} stands rejected.

Discussion and Conclusion

From the aspects discussed above, it is proved that production and the growth of MHCV trucks are indeed related to infrastructural and industrial development. An ARIMA model (0, 1, 0) has been established from the output of ARIMA model parameters (Table 3). This model 'Truck Production Forecast Model' is also within the significance levels of 0.05 (p - value = 0.015), which justifies the rejection of the null hypothesis H_{01A}. As heavy trucks effectively carry the raw materials, intermediate goods, and finished goods across the geographical areas of an economy, it is natural there would be a linkage between the industrial activity in an economy and production of heavy trucks. The 'Truck Production Forecast Model' proves the linkage between industrial productivity and volume of heavy truck production in India.

Also, through the discussions put forward in the backdrop of (regression) equations 1, 2, and 3, it is also justified to reject the null hypothesis H_{01B}. Equation 1 demonstrates that chances/potential for longer routes (inter zonal routes for Equation 3) which justifies and encourages the usage of multi axle heavy trucks supported by government initiatives like GST (positive expectation among transporters, which facilitates free interstate movement), quality of roads, and level of extortion by government officials. On the other hand, transporter attitude in the form of ratings for comfortable cabin and powerful engine also determines the average length of a trip. Furthermore, Equation 2 shows that the aspect of owning multi axle trucks is also explained by governmental initiatives and personal attitude of the transporters or operator preferences.

Managerial/Policy Implications of the Research

The rejection of the null hypotheses H_{01A} and H_{01B} implies that industrial productivity and the overall performance of the core and basic production sectors of a growing/developing economy like India, aided with due improvement in road infrastructure boosts the demand for transportation of various finished products, semi-finished products, and raw materials, which in turn boosts the demand for trucks that would haul these freights. This pushes up the production of trucks. If seen from the perspective of the truck manufacturers, various government initiatives like GST, development of golden quadrilateral, North - South & East - West Corridor, average quality of national/state highways, and minimization of extortion [X_1] and industrial developments help to boost the market size for MHCV trucks. However, on the other hand, transport operator preferences [Z_1], basic average operator profile, and their business performance [Y_1] determine the product value that needs to be provided (to the transport operators),which, if appropriately catered to, would make the truck (to the truck operator) more relevant to its intended customer.

Also, the discussions show that for transporters to feel encouraged to ply on longer routes or inter - zonal routes

[5] As per load allowed per axle as defined by Ministry of Road Transport and Highways (Notification S.O. 728, dated 18/10/1996).

(across North - South - East - West zones), the governmental initiatives towards bringing in the GST system (to reduce delay and corruption), investing heavily on infrastructural development of road networks (Golden Quadrilateral, North - South - East - West corridors, etc.) have been significant. It is also established that the transport operators' preferences for powerful engine, more number of axles, and a comfortable cabin are also positively linked to and explain the tendency to carry loads across longer routes or interzonal routes. These attitudinal aspects also explain the tendency of operators to own more of multi - axle trucks and run them on more profitable interzonal routes.

Limitations of the Study

The study conducted has the following limitations :

- Only 171 transport operators could be covered across 11 cities across India. All respondents had to be reached out through face to face interviews as most of them were not active Internet users and could not be reached through various online and social media platforms.
- Sales breakup of heavy trucks across tonnage segments (like 25 tonnes, 28 tonnes, 31 tonnes etc.) were not available freely.
- Literature availability for academic research work on marketing/sales of multi-axle trucks in India is very limited.

Scope for Further Research

Although the present study covers the macro aspects of showing that the growth in sales of medium and heavy trucks is related to infrastructural development and industrial productivity, it also shows the attitudinal aspects of the transport operators. Further studies on the following aspects can be carried out on the following broad areas:

- Find various factors (including brand image) that determine purchase decisions of multi-axle trucks by transport operators.
- Determine the financial viability of multi-axle trucks.
- Study the value sought by transport operators while purchasing multi-axle trucks and business models that enable manufacturers to provide value offerings.

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