International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 2628-2640 www.ijaem.net ISSN: 2395-5252

Econometric Modeling for Forecasting Steel Demand in India

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Submitted: 05-07-2021 Revised: 17-07-2021 Accepted: 20-07-2021

ABSTRACT : Steel plays a crucial role in the economic development of a nation. It is the most widely used metal in the modern society and plays a key role for improving the standard of living, industrialization and urbanization. Steel intensity in the economy is an indicator of the state of the economic development of a country as the per capita consumption of steel in the developed nations is higher compared to the same in the developing nations.

As steel is an intermediate product used for producing finished goods, its consumption is arrived at through the method of derived demand. As a result, predicting the demand for steel is more difficult and complex as compared to several other products. Forecasting demand for steel in India is considered necessary as steel industry is capital intensive with longer gestation periods. In view of this, unless actions are taken much in advance for enhancing the capacity of steel making, it would be difficult to meet the domestic demand for steel. It is also very important to develop a sophisticated forecasting technique for steel consumption as well, in order to match the demand and consumption levels.

In the present study, forecasting steel demand in India has been carried out through aggregative method, which is a top down approach. In this method, a relation between steel consumption and major economic parameters has been established. Various forecasting techniques like curve fitting, correlation and regression have been explored for arriving at the forecasts. Out of these, Auto Regressive Integrated Moving Averages (ARIMA), which are time series multivariate models have been found to be suitable for the present study. Data sets of Gross Domestic Product (GDP) of India for 70 years, consisting of primary, secondary and tertiary sectors of the economy and steel consumption from 1950 to 2019 are used for the analysis.

KEY WORDS : Apparent steel consumption, Crude steel production, Gross Domestic Product, Primary, Secondary and Tertiary sectors, Per capita steel consumption, Long products, Flat products, Auto Regressive Integrated Moving Averages (ARIMA).

I. INTRODUCTION

Forecasting steel demand with a long term perspective and ensuring availability of steel as per the need of economic development makes a nation self sustained. Steel Plants need several inputs on the supply side like raw materials and energy, technology, design and engineering support, equipment supplies, infrastructure and logistics, manpower, financing, environmental and social issues, etc. Economies of scale also plays an important role in the viability of a steel industry. Similarly, steel demand depends on a variety of factors like construction, infrastructure development covering road, rail and sea ports, shipping, steel intensity in construction and infrastructure, industrial applications in the sectors like automobile, capital goods and consumer durables, export opportunities, etc.

Unlike other manufacturing industries, integrated steel plants can not normally be shut off and on frequently, depending on the fluctuations in demand. It is also not possible to keep the integrated steel plants idle for longer durations, as it will adversely affect the thermal regime and damage to the equipment and idling of assets. Not

only continuous running, but also steady production from the units is necessary, as any frequent fluctuations in production will have a negative impact on the life of the equipment. In view of these factors, long terms plans and strategies for capacity augmentation in line with the projected demand is essential for the sustainability of steel industry.

At the time of Independence in 1947, India already had a small but viable iron and steel capacity of around one million tonne per annum. During the first four decades after Independence, large scale capacity creation in the Public Sector has taken place making India the 10th largest steel producer in the world as crude steel production reached a level of about 15 Mt by 1991. As a part of general economic programme, deregulation of the Indian steel industry was initiated in 1992. The new policy regime consisted of measures such as decontrol of pricing and distribution, de-licensing / de-reservation of capacity, progressive reduction of tariff barriers and removal of quantitative restrictions in international trade. After liberalization, significant changes took place in the Indian steel industry. The production of crude steel reached a level of 109 Mt in 2019-20. Production of finished steel and apparent steel consumption during the year has been 102 Mt and 100 Mt respectively.

With a view to taking the advantage of bright prospects of the steel sector, international steel giants like Pohang Iron and Steel Company (POSCO), South Korea, Arcelor-Mittal, Liberty Steel Group etc. have been showing interest in setting up of steel manufacturing facilities in India. At the same time, Indian steel industry also is spreading its wings abroad. Indian conglomerate Tata Steel's $12 billion takeover of Anglo-Duch steel giant Corus Group Plc., transformed Tata Steel Limited into the world's 9th largest steel producer in 2019. Acquisition of Arcelor by Mittal Steel is also another example of the strength of Indian steel industry. During 2019, Arcelor Mittal stood as the top steel producer in the world. Such developments are needless to stress that Indian steel industry has come a long way from having a small capacity at the time of Independence to attain the status of being the 2nd largest steel producer and consumer in the world in 2019, the first being China. This position continued in 2020 as well.

There is a large gap in per capita steel consumption in the developed regions/nations vis-a-vis developing regions/nations. In the year 2019, the average per capita steel consumption in the world and in Asia in terms of finished steel was 229 kg and 299 kg respectively. Against this, the per capita steel consumption in India was meager 75 kg. In contrast, the per capita steel consumption in China was 633 kg and as high as 1039 kg in South Korea. The world average apparent steel consumption per capita is three times more than that of India. This shows that there is a huge potential for increasing steel consumption in the country.

Indian economy is one of the fastest growing economies in the world. Growing population, improving standard of living, focus on urbanization etc. necessitate huge investments in these areas leading to increased steel usage. Steel is a universal intermediate, which finds use as an input to various economic activities. Industrial development is the primary requirement for transforming a nation from developing to developed state. In order to register accelerated growth of the economy, robust industrial growth is required, which necessitates increased consumption of steel. In India, construction, infrastructure, automobiles and capital goods sectors are projected to register accelerated growth rates, necessitating a boost in steel demand in the years to come.

Forecasting of future steel demand is an important and critical activity, in view of the fact that setting up of an integrated steel plant as has been mentioned, needs huge resources and longer implementation period. This is particularly true in countries like India, where setting up of steel plants involves obtaining clearances from several agencies both at the Central and State Government level. Besides, land acquisition, which is a major issue of concern, providing linkages for raw materials, infrastructure facilities like water, rail, road, port connectivity, forest and environmental clearances. etc. are also necessary. Majority of these activities are very time consuming and ground realities may undergo a great change with regard to steel demand projected at time the project is conceived and as prevailing at the time it is completed. Hence, there is a need for developing a reliable tool for forecasting steel demand over a considerably long period.

In India, although forecasts have been made by different agencies from time to time in the past, these were seldom close to the actual steel consumption. In view of varied forecasts by different agencies, it is felt desirable to adopt an econometric modeling for forecasting steel demand

with a long term perspective. In this study, an attempt has been made to develop such a model by analyzing large scale data for the past 70 years for forecasting steel demand in India by 2050.

II. LITERATURE SURVEY

Steel demand forecasting is carried out either through aggregative approach, which is a top-down method or dis-aggregative approach, which is bottom-up method. In the present study, aggregative method has been adopted. Different aggregative approaches adopted as per the available literature on this subject are as follows.

Abbott et.al., 1999, adopted co-integration analysis for forecasting steel demand in the long run. Variables such as steel consumption, manufacturing production index, foreign exchange rate, steel prices, automotive production and construction orders have been used for forecasting steel demand.

Rebiasz Bogdan, 2006, presented changes in apparent consumption of steel in Poland in the years 1974-2003. The steel demand forecasting has been done through regression analysis by using data for the period from 1992 to 2003.

Sajal Ghosh, 2006, examined co-integration and Granger causality between steel consumption and economic growth in India. The study confirmed that a growth in income is found to be responsible for a higher level of steel consumption.

Kwang-Sook Huh, 2011, adopted Vector Error Correction Model (VECM) and Vector Auto-Regression Model (VAR) for establishing long term and short term causal relationships between steel consumption and economic activity in Korea between 1975 and 2008.

S. Narayan et.al., 2011, brought out that in emerging economies, one of the characteristics of economic growth is sharp growth in steel consumption resulting from public investment outlays in infrastructure coupled with outlays in construction as the economy expands. In view of this, the study made an attempt to econometrically analyse the growth in market demand for steel in India using aggregate sectoral demand patterns.

Mark Evans et.al. 2011, applied Auto Regressive Fractionally Integrated Moving Average (ARFIMA) approach for forecasting steel demand in UK. It was mentioned that past research, based on anecdotal evidence and early work on co-integration analysis has lead to conflicting conclusions regarding relationship between crude steel consumption and economic activity.

Magdalena Barska, 2014, brought out that the iron and steel industry production is dedicated to serve mainly the other industries. This makes the exercise of demand forecasting different than for consumer goods. The Seasonal Auto Regressive Integrated Moving Averages with Exogenous Repressors (SARIMAX) model was applied for forecasting.

Paul Crompton, 2015, examined the main drivers of inter-temporal and cross-country variation in steel consumption using a fixed-effect panel model of 26 OECD countries over the period 1970-2012. The results indicate that the per capita GDP is the main driver of steel consumption. However, investment spending and the rates of industrialisation and urbanisation are also important determinants.

Amir Ikram et.al. 2016, brought out that in South Asia, steel and its production is one of the largest segments of the economy. This study investigates the forecasts of steel production in Pakistan for the first time, which is an important emerging economy of the South Asian region.

Hang Cho, Dr et. al., 2017, brought out that global steel demand will rise by around 1% for the next 20 years. Despite some concerns, global steel demand has not yet peaked and would not do so within the next two decades.

III. DATA ANALYSIS

The data in respect of various parameters like crude steel and finished steel production, apparent steel consumption, Gross Fixed Capital Formation (GFCF), Gross Domestic Product (GDP) and its components for the period under analysis has been collected. In order to obtain reliable results of forecasting large data in respect of different variables spread over a period of 70 years i.e. from 1950-51 to 2019-20 has been considered to improve accuracy of the forecasts.

The correlations amongst these parameters have been thoroughly studied. Crude steel and finished steel production and apparent steel consumption for a long period are quite consistent and indicated similar trends, primarily due to lower percentage of exports and imports of steel products. On analysis of data, prima facie, it is established that the macro economic variables i.e. GDP and its

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 2628-2640 www.ijaem.net ISSN: 2395-5252

components and the apparent steel consumption would give the desired results for forecasting the long term steel demand.

The values of primary (agriculture, forestry, fishing, mining and quarrying), secondary (manufacturing, construction, electricity, gas and water supply) and tertiary (trade, hotels, transport and communication, financing, insurance, real estate and business services, community social an personal services) sectors of GDP of India for the period from 1950-51 to 2018-19, which are considered for the present study are depicted at Figure-3.1.

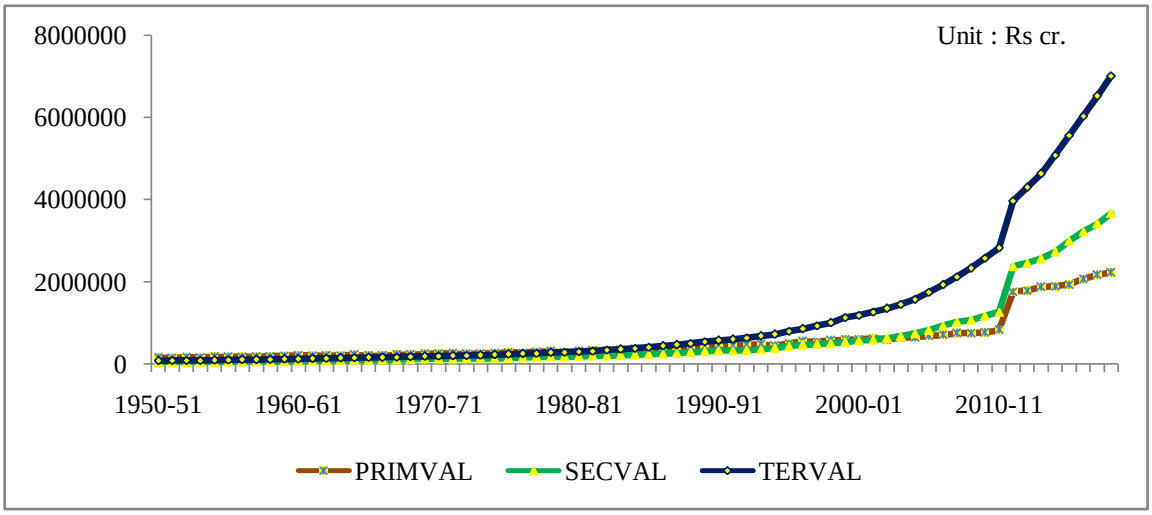

Fig.3.1 : Primary, secondary and tertiary sector values of GDP of India

Source : Economic Survey 2019-20, Ministry of Finance, GOI

It is observed from Fig. 3.1 that, while there has been a consistent growth over the years in all the three components of GDP, growth rate of primary sector is the lowest, which is quite natural. Growth in the secondary sector is moderate and the growth in the tertiary sector is the highest. It can be clearly seen that the growth rates have improved substantially, subsequent to liberalization. Focus on infrastructure sector growth during this period is also clearly visible. As steel intensity in the manufacturing sector is more compared to the other two sectors, growth in the secondary sector will have greater influence in the growth of steel consumption. Had the secondary sector grown at the levels of tertiary sector, the consumption of steel would have been much higher in India in line with the forecasts made by several agencies during the first decade of the 21st Century. In fact apparent steel consumption growth at phenomenal rates in China can be attributed to the growth in their manufacturing sector.

As the increase in steel intensity in the economy also increases GDP, there is a close correlation between these two parameters. Graph indicating the GDP and apparent steel consumption during the period from 1950-51 to 2018-19 is brought out at Figure-3.2.

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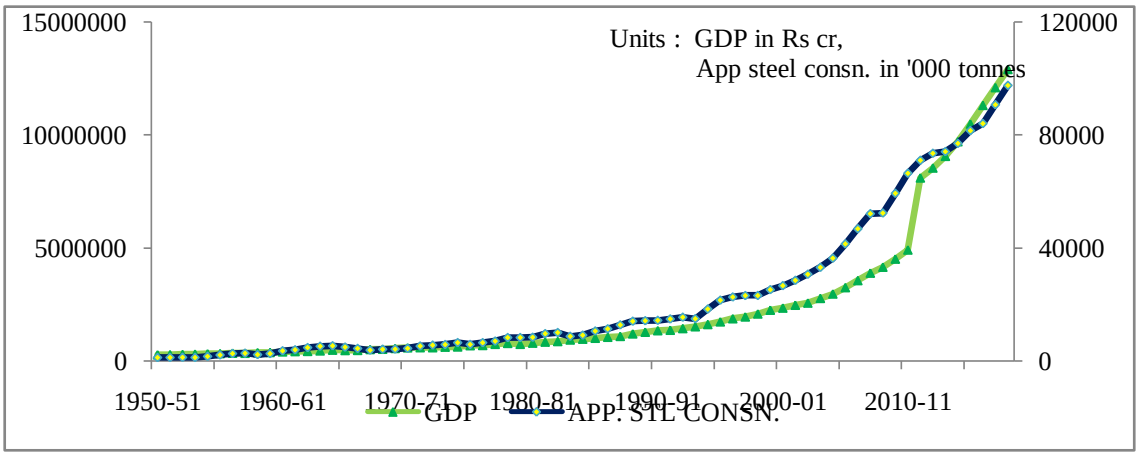

Fig. 3.2 : GDP and apparent steel consumption in India

Source : Economic Survey 2019-20, Ministry of Finance, GOI, JPC Statistics, Ministry of Steel, GOI

It is worthwhile to mention that the GDP and apparent steel consumption grew at similar levels till the early 1990s i.e. the period of introduction of new economic policy initiatives in the country. Subsequently, steel consumption registered healthy growth rates till 2015-16, compared to the GDP growth rates. In the last few years however, GDP and steel consumption have grown at similar levels, due to slow down in the economic growth in the country.

IV. RESEARCH METHODOLOGY

The present study has been carried out using the data collected from the Economic Surveys of Ministry of Finance, Five Year Plan documents, Government of India, steel statistics published by World Steel Association, Brussels, Belgium and Joint Plant Committee, Ministry of Steel, GOI. Data has also been collected from Annual Reports of various central Government departments and other publications. Data has been collected primarily from the secondary sources, which pertains to 70 years i.e. from 1950-51 to 2019-20.

Statistical analytical tools like Trends analysis, CAGR, Regression analysis, Auto-Regressive Integrated Moving Averages (ARIMA), ACF, PACF, MAE, MAPE, RMSE, etc. have been used in this project.

V. RESULTS AND DISCUSSION

Steel consumption depends on the growth in all the three sectors of GDP. The rationale underlying the assumption is that the mix of goods and services produced in the country changes with the economic status. As the economy evolves, the consumption of steel grows. Subsequent to the economy reaching higher maturity levels, the intensity of steel usage stagnates. This can be observed from the trends of steel consumption in developed nations/regions like US, UK, Canada, Japan etc.

In this approach, several options like Trend Curves and Regression Analysis have been considered for establishing correlation of apparent steel consumption with different economic parameters like the components of GDP i.e. primary, secondary and tertiary sectors, individually and together and Gross Fixed Capital Formation (GFCF). In all these cases, the predicted values for the past period were in variance with the actual apparent steel consumption, which is verified by analyzing the residues. In view of this, ARIMA Model, which resulted in obtaining reliable forecasts has been chosen as the best option.

Auto Regressive Integrated Moving Averages (ARIMA) Model

As per the literature survey, it is learnt that ARIMA models yielded better results compared to normal trend analysis and regression analysis. An ARIMA model can be viewed as a “filter” that tries to separate the signal from the noise, and the signal is then extrapolated into the future to obtain forecasts. These ARIMA models, also called Box-Jenkins models and are the most common class of models used for forecasting a time series trends. A Non-seasonal ARIMA model is classified as an "ARIMA (p,d,q)" model, where, p is the number of

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Volume 3, Issue 7 July 2021, pp: 2628-2640 www.ijaem.net ISSN: 2395-5252

autoregressive terms, d is the number of non-seasonal differences needed for stationarity, and q is the number of lagged forecast errors in the prediction equation.

At this stage, different models have been manifested and their parameters were estimated using the maximum likelihood method. An ARIMA model is one, where the time series was differenced at least once to make it stationary and combination of the AR and the MA terms is carried out. Accordingly, the equation for forecasting the future demand is as follows.

Predicted Yt = Constant + linear combination lags of Y (upto p lags) + linear combination of lagged forecast errors (upto q lags).

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + .. + \beta_p Y_{t-p} \epsilon_t + \phi_1$$

---------- (1)

ARIMA model brought out in the above equation may be represented in words as follows :

---------- (2)

Based on the model diagnostic tests, the best fitting model of ARIMA (1,1,1) was selected. As per this, the number of autoregressive terms (p), the number of seasonal differences (d) and the no. of lagged forecast errors (q) has been considered as 1.

It is observed from the data on the components of GDP i.e. primary, secondary and tertiary sectors have inter-dependency. In order to establish the level of inter-dependency, cross correlation of these variables has been derived and the coefficients of cross correlation are presented in Table-5.1.

Table-5.1 : Cross correlation matrix of GDP and its components
Unit : Correlation coefficient

Parameter	PRIMQRVAL	SECQRVAL	TERQRVAL	GDPQRVAL
PRIMQRVAL	1.000	0.994	0.987	0.993
SECQRVAL	0.994	1.000	0.997	0.999
TERQRVAL	0.987	0.997	1.000	0.999
GDPQRVAL	0.993	0.999	0.999	1.000

In view of high cross correlation amongst the variables, it has been felt desirable to arrive at a composite GDP, consisting of all the above three components. For, this, the projections of the three variables have been made and a composite GDP has been arrived at.

The economic growth over a long period has not been very uniform in India, which has been observed in the last several decades. Fluctuations have been taking place in the economic growth. Although, India has been registering healthy economic growth rates since implementation of economic reforms, on certain occasions, the growth has been slowed down primarily due to the internal economic conditions and occasionally due to extraneous factors. Currently, India is passing through one of its worst challenges of economic crisis due to the COVID-19 pandemic. A series of lockdowns and restrictions in the economic activity have resulted in a serious adverse impact on economic growth. This pandemic surfaced in India in March 2020 and is expected to continue for some time in future. In the past also, on various occasions like the Indian economic crisis in 1991, US subprime mortgage crisis in 2007-2010 and its impact on India, etc., the country witnessed severe economic turmoil. In order to take care of such unexpected economic crisis in the economic growth and favourable growth trends during some periods, it is felt appropriate to consider three levels of growth rates of economy i.e. low, moderate and high to forecast steel demand in the country.

In the present study, as per the available growth trends of different sectors of the economy, upto 2031-32, it is presumed that the economy will be on a relatively higher growth path. By the end of this period, India is expected to reach the status of a developed nation. At that point of time, steel consumption in economy is projected to reach maturity levels with majority of the infrastructure in the country put in place. From 2032-33 to 2041-42, slower growth rates have been considered. Further, from 2042-43 till 2050-51, the growth rates of economy are projected to be still lower, as

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the size of the economy is expected to grow substantially.

Considering the most likely scenario, i.e. moderate growth scenario, the GDP, which was around Rs 129 lakh cr. in 2018-19 is projected to increase to Rs 312 lakh cr. by 2031-32, representing a growth of 142%. The GDP is projected to reach a level of Rs 601 lakh cr. by 2041-42, representing a growth of 275% over that of 2018-19. Further, the GDP is projected to be Rs 1053 lakh cr. by 2050-51, representing a growth of 716% over that of 2018-19. Considering these parameters, forecast of steel consumption has been arrived at upto 2050-51, adopting Multivariate ARIMA (1,1,1).

For carrying out this exercise, IBM SPSS Predictive Analytics Enterprise Software has been used. Considering large volume of data analysis, this software has been found to be very useful for forecasting future trends with a long term perspective.

ARIMA Model Fit Parameters, Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) have been studied and found to be in order. A Graph representing residual ACF and PACF is brought out at Fig. 5.1 and model fit parameters are brought out at Table 5.2.

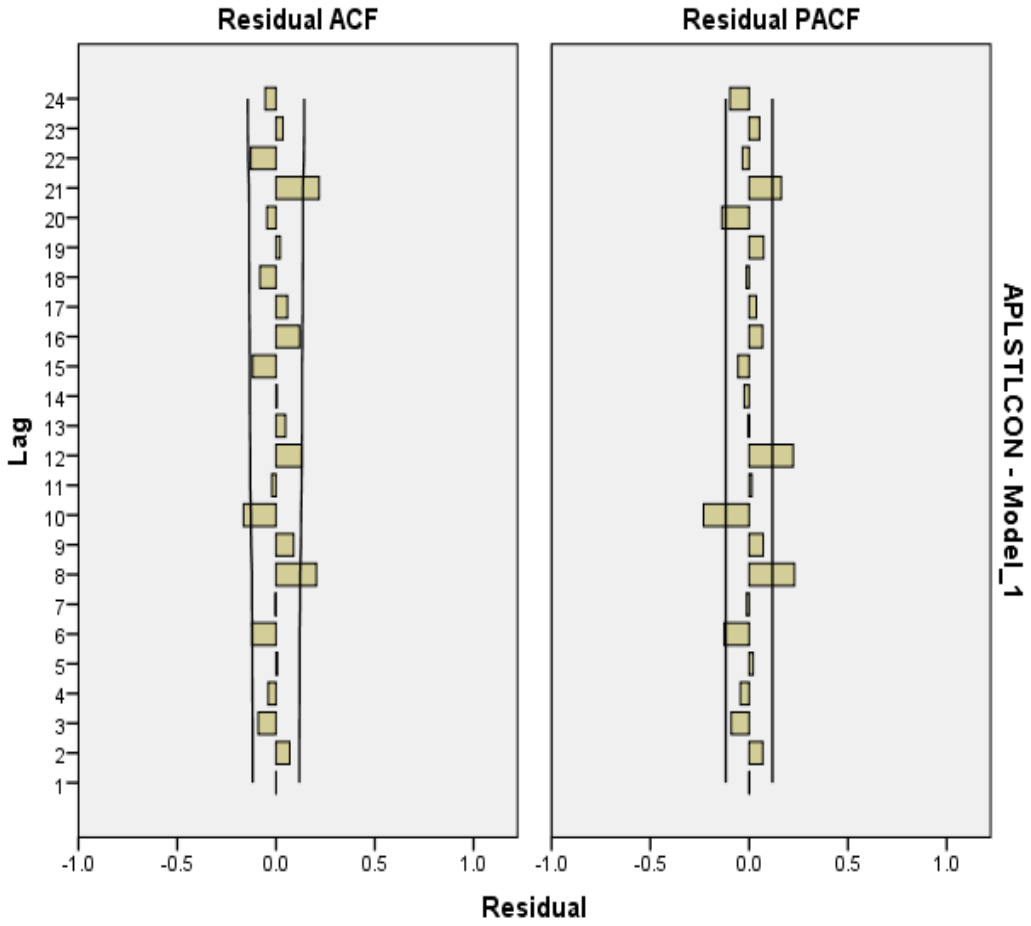

Fig. 5.1 : Residual ACF and PACF of ARIMA

Table 5.2 : Model fit parameters of ARIMA

Fit Statistic	Mean	SE	Minimum	Maximum	Percentile						
					5	10	25	50	75	90	95
Stationary R-squared	.486	.	.486	.486	.486	.486	.486	.486	.486	.486	.486

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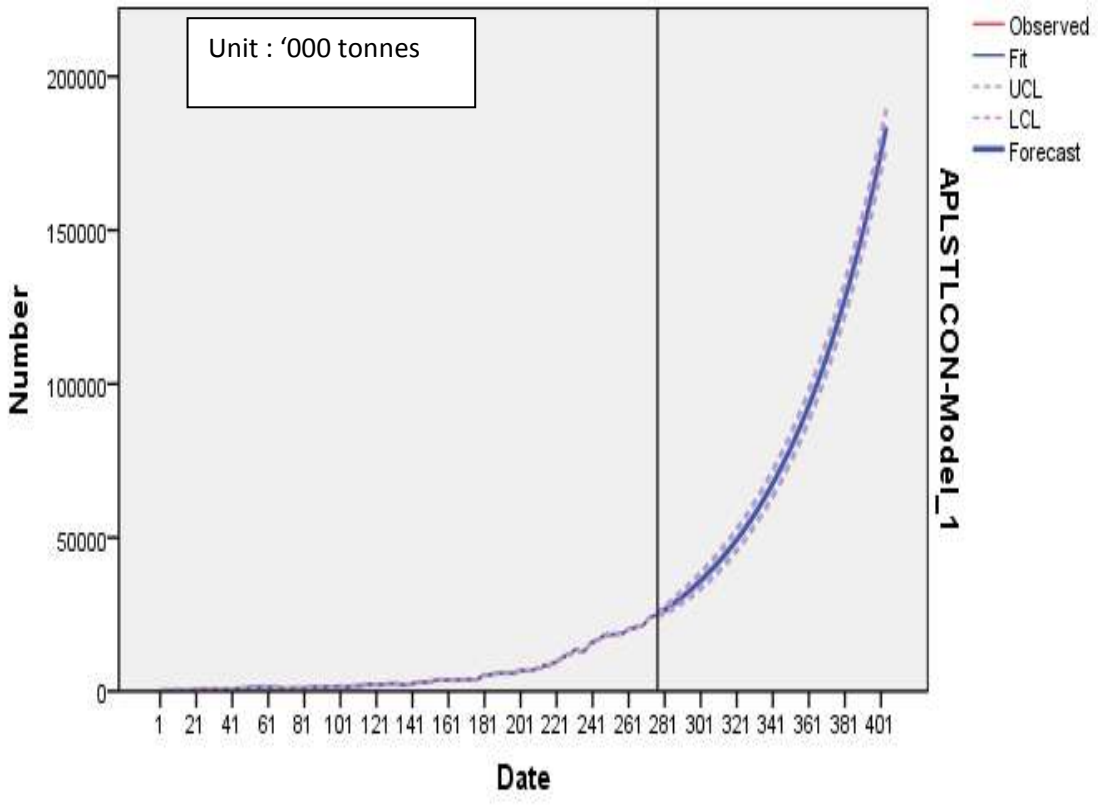
R-squared	1.000	.	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
RMSE	119.474	.	119.474	119.474	119.474	119.474	119.474	119.474	119.474	119.474	119.474
MAPE	1.995	.	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995	1.995
MaxAPE	12.717	.	12.717	12.717	12.717	12.717	12.717	12.717	12.717	12.717	12.717
MAE	67.764	.	67.764	67.764	67.764	67.764	67.764	67.764	67.764	67.764	67.764
MaxAE	662.433	.	662.433	662.433	662.433	662.433	662.433	662.433	662.433	662.433	662.433
Normalized BIC	9.648	.	9.648	9.648	9.648	9.648	9.648	9.648	9.648	9.648	9.648

The graph indicating the forecasts of steel demand upto 2050-51 in India i.e. with moderate growth rates are brought out at Figure-5.2.



|----------1950-51 to 2018-19----------|--2019-20 to 2050-51--|

Fig.5.2 : Steel demand forecast

It is worth mentioning that the apparent steel consumption estimates of the past period using the ARIMA equations are quite close to the actual values, indicating that the forecasts for the future period are also quite reliable. Actual and estimated values of apparent steel consumption for the period from 2000-01 to 2018-19 is brought out at Table 5.3.

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Table 5.3 : Apparent steel consumption (actual & estimated)
Unit : '000 tonnes

Sl. No.	Year	Steel conspn. (actual)	Predicted steel conspn.	Residual	Percentage of residual
1.	2000-01	26651	26857	-206	-0.8
2.	2001-02	27523	27528	-5	0.0
3.	2002-03	29677	29551	126	0.4
4.	2003-04	33119	33005	114	0.3
5.	2004-05	36377	36159	218	0.6
6.	2005-06	41433	40858	575	1.4
7.	2006-07	46783	46588	195	0.4
8.	2007-08	52125	51713	412	0.8
9.	2008-09	52351	52723	-372	-0.7
10.	2009-10	59339	58285	1054	1.8
Sl. No.	**Year**	**Steel conspn. (actual)**	**Predicted steel conspn.**	**Residual**	**Percentage of residual**
11.	2010-11	65610	65365	245	0.4
12.	2011-12	71021	70760	261	0.4
13.	2012-13	73482	74086	-604	-0.8
14.	2013-14	74096	74527	-431	-0.6
15.	2014-15	76994	76669	325	0.4
16.	2015-16	81525	81930	-405	-0.5
17.	2016-17	84042	84415	-373	-0.4
18.	2017-18	90706	89905	801	0.9
19.	2018-19	97536	98021	-485	-0.5

From the above, it can be seen that the maximum percentage of residue is 1.8%. Out of 19 observations, only twice, the residue is more than 1% and in all the other cases, it is less than 1% indicating that the forecasts are quite near to the actual.

With a view to validating the forecasts of steel demand arrived at through aggregative method, forecasts have been arrived at through dis-aggregative method. In this method, 6 major steel consuming sectors have been identified. These are i) Construction consisting of residential housing, commercial and industrial, ii) Infrastructure consisting of roads and bridges, urban infrastructure, shipping, sea ports and airports, iii) Railways, iv) Automobiles, v) Capital goods, vi) Consumer durables. Intensity of use of steel in these sectors has been analysed.

The projected growth trends in these sectors have been applied to the steel products in

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the longs and flats categories. Steel products are manufactured in various categories to meet the requirement of different sectors of economy. Although longs and flats are the broad categories, steel production and consumption of steel are monitored by grouping various products for easy monitoring. The long steel products consist of three groups i.e. i) Bars and Rods, ii) Structurals iii) Railway materials. The flat products consists of 6 products i.e. i) Plates, ii) Hot Rolled (HR)/Cold Rolled (CR) Coils and Sheets, iii) Galvanised Plan(GP)/Galvanised Corrugated (GC) Sheets, iv) Elect. Sheets, v) Tin Mill Black Plates (TMBP)/Tin Plates, vi) Pipes.

In order to arrive at steel demand forecasts, sector wise growth trends have been considered. Further, various plans and projections made by the Govt. of India in respect of infrastructure projects, railways, construction sector etc. have been considered. Growth projections of various industrial sectors like oil and gas, power, steel, automobiles, capital goods and consumer durables etc. have also been considered. Accordingly, product-wise demand upto 2050-51 for various steel product groups has been derived.

A comparative statement of the consumption forecasts arrived at through aggregative approach and dis-aggregative approach are brought out at Table 5.4.

Table 5.4 : Steel demand forecasts comparison

Unit : Mt

Model category	**2021-22**	**2025-26**	**2030-31**	**2035-36**	**2040-41**	**2045-46**	**2050-51**
Aggregative model	108	148	202	277	381	523	717
Dis-aggregative model	116	148	201	276	384	518	710

The forecasts arrived at through aggregative model in the mid case scenario i.e. moderate growth are close to the forecasts arrived at through dis-aggregative model. However, for the purpose of final forecasts the figures arrived at through aggregative approach have been taken into account as the approach adopted is scientific and based on large volume of historical data. An assumption in this forecasting exercise is that the demand for steel consumption includes domestic steel consumption and net of imports and exports.

Steel demand forecasts in India arrived at through ARIMA model with the three scenarios i.e. low, moderate and high growth rates starting from 2020-21 to 2050-51 with an interval of 5 years are brought out at Figure 5.3.

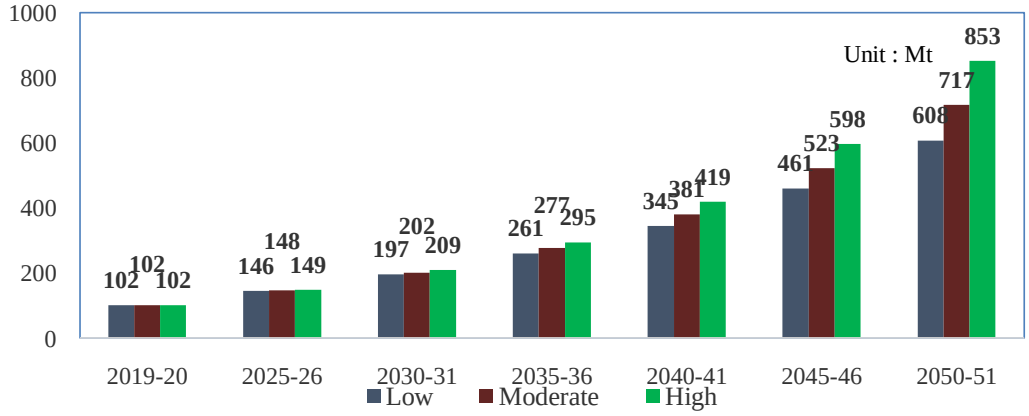

Fig. 5.3 **:** Steel demand forecast with the three scenarios

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Steel demand forecast for the year 2019-20 as per the ARIMA model has been 102 million tonnes. Against this, the actual steel consumption during 2019-20 has been 100 million tonnes. The forecast is very close to the actual steel consumption.

As per the present study, the steel consumption is projected to reach a level of about 200 million tonnes by 2030-31 considering the moderate growth alternative. Even by considering the high growth alternative, the steel demand in 2030-31 is projected to reach a level of 209 million tonnes only. This shows that the projection made in the National Steel Policy 2017 (NSP 17) also may not hold good.

VI. CONCLUSION

Long term forecasts of steel demand in India need to be quite reliable for long term sustainability of steel sector. In the past, it has been observed that several agencies made steel demand forecasts. Their projections have been found to be not only inconsistent but also appeared to be not close to the reality. Some of the projections made by various agencies and the actual steel consumption in the past are brought out at Table-6.1.

Table 6.1. Forecasts of steel demand made by various agencies

Unit : Mt

S.No.	Agency	2011-12		2019-20		2025-26	2030-31
		Forecast	Act.	Forecast	Act.	Forecast	Forecast
1.	NSP 2005			90.0			
2	NSP 2012					233.0	
3	NSP 2017						230.0
4.	India 2020 WSA 2007			150.0			
5.	India Steel Vision 2020 WSA 2012		71.0	141.0	100.1		
6.	JPC	66.1					
3.	SAIL	62.8		137.0			
4.	Tata Steel			118.0			
5.	CRISIL	81.7					

Source : Reports as mentioned above

It may be observed from the above that there are lot of variations in the forecasts and the actual steel consumption. The main reason for such kind of variations could be the models adopted for forecasting the steel demand and consideration of limited data. Further, in many of the forecasts, it was observed that the intuitive judgments of the Experts, who carried out the forecasting exercise might have influenced the results. The institutions / agencies might have made optimistic forecasts to give a boost to the steel sector. These issues of concern have been addressed in the present study to arrive at reliable forecasts. Steel demand projections with low, moderate and high growth rates with 5 year intervals from 2019-20 to 2050-51 are brought out at Table 6.2.

Table 6.2 **:** Steel demand forecast with the three scenarios

Unit : million tonnes

S.No.	Year	Growth rates		
		Low	Moderate	High
1.	2020-21	108.2	108.4	108.5
2.	2025-26	145.9	147.6	149.4
3.	2030-31	195.6	201.9	208.7

International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 7 July 2021, pp: 2628-2640 www.ijaem.net ISSN: 2395-5252

4.	2035-36	261.5	277.3	294.8
5.	2040-41	348.0	381.0	419.0
6.	2045-46	461.4	523.4	597.8
7.	2050-51	608.5	717.3	852.8

It is worthwhile to mention that actual and estimated values of steel consumption of moderate option for the period from 1951-52 to 2018-19 are very close. During this period, there are 276 observations. In respect of 48% of the observations, the value of the residual is less than 1% of the actual steel consumption. Further in respect of 77% of observations, the residual of actual and estimated steel consumption is less than 3%. Only in case of 5 observations, the residual is more than 10%. The number of observations falling within the range residual as a percentage of actual steel consumption is brought at Table 6.3.

Table 6.3 : No. of observations falling within the range of percentage of error

Percentage of error	**>1%**	**1 to 3%**	**3 to 5%**	**5-10%**	**>10%**	**Total**
No. of observations	131	81	40	19	5	276
Percentage of observations	48	29	14	7	2	100

As the estimates were very close to the actual values of apparent steel consumption for the past 69 years, the forecasts for the future are also expected to be quite reliable.

The finished steel demand is projected to reach a level of about 200 million tonnes by 2030-31, 300 million tonnes by 2037, about 400 million tonnes by 2041, about 500 million tonnes by 2045, about 600 million tonnes by 2048 and over about 700 million tonnes by 2050.

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