IMPACT OF COVID-19 ON FISHERIES EXPORT AND IMPORT IN INDIA

By

HAZEEB HASHIM SIDDIQUE

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DISSERTATION

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DECLARATION

I hereby declare that this dissertation entitled "**IMPACT OF COVID-19 ON FIHERIES EXPORT AND IMPORT IN INDIA**" is a bonafide record of work done by me during the course of research and that the dissertation has not previously formed the basis of award of any degree, diploma, fellowship or other similar title of any other university or society.

Panangad HAZEEB HASHIM SIDDIQUE

31/08/2022 SME-2020-23-02

Dr. Joshy C.G

Senior Scientist

ICAR – Central Institute of Fisheries Technology, Cochin-29

CERTIFICATE

Certified that this Dissertation entitled "**IMPACT OF COVID-19 ON FISHERIES EXPORT AND IMPORT IN INDIA**" is a bonafide record of work done by Mr. Hazeeb Hashim Siddique (SME-2020-23-02) under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma or fellowship to him.

Cochin | Dr. JOSHY C G

31/08/2022 | Supervising Guide

Dr. Rajesh K

Assistant Professor

Department of Economics and Statistics

FFM, KUFOS

CERTIFICATE

Certified that this Dissertation entitled "**IMPACT OF COVID-19 ON FISHERIES EXPORT AND IMPORT IN INDIA**" is a bonafide record of work done by Mr. Hazeeb Hashim Siddique (SME-2020-23-02) under my guidance and supervision as a co-guide and that it has not previously formed the basis for the award of any degree, diploma or fellowship to him.

Panangad — Dr. RAJESH K

31/08/2022 — Co-Guide and Supervising Faculty

KERALA UNIVERSITY OF FISHERIES & OCEAN STUDIES
കേരള ഫിഷറീസ്-സമുദ്രപഠന സർവ്വകലാശാല
FACULTY OF FISHERIES MANAGEMENT
PANANGAD P.O., KOCHI 682 506, KERALA, INDIA

0484- 2700273; **Fax**: 91-484-2700337; ***e-mail***: schoolofmande@gmail.com***website***: www.kufos.ac.in

Prof. (Dr.) V. Ambilikumar,
Dean,
Faculty of Fisheries Management,
KUFOS

CERTIFICATE

Certified that this Dissertation entitled **"IMPACT OF COVID-19 ON FISHERIES EXPORT AND IMPORT IN INDIA"** is a bonafide research work of Mr. Hazeeb Hashim Siddique (SME 2020-23-02). He is permitted to submit the Dissertation in partial fulfilment for the degree of Master of Science in Statistics in Department of Economics and Statistics, FFM, KUFOS.

Panangad — Prof. (Dr.) V. Ambilikumar

31-08-2022 — Dean

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ABSTRACT

This work is an attempt to examine the effect of COVID-19 on the export and import of fish and fisheries products in India (quantity in tons). The study also discusses about the calculation of the compound annual growth rate of the export of fish and fisheries products from India. The data was taken for a period of 15 years from 2007 to 2021, for the study purpose. The analysis was done by using the software R, SPSS, and EXCEL. The time series model SARIMA (Seasonal Autoregressive Integrated Moving Average) was used to forecast the export and import of fish and fish products for the monthly data in 2020 and 2021. The SARIMA models were evaluated on the basis of their efficiency in modelling and providing an accurate forecast. After calculating the forecasted quantity, the expected price was also calculated using the actual price and quantity. The expected price was found to be greater than the actual price. This might be due to the export of less quantity than the forecasted quantity due to port closures, loss of access to cold storage, cessation of shipping and air freight, lack of fish catch, market, and delays in supply chain due to the COVID-19 lockdown. Therefore, it could be concluded that the commodities are affected by COVID-19. And also, in some months, the expected price is lower than the actual price. This might be due to the countries' hoarding of particular commodities before the spread of COVID-19 and the lockdown, price drops, international trading agreements, etc. The CAGR (Compound Annual Growth Rate) value of the export of fish and fisheries products before and after the COVID-19 was calculated. From the values, it was learned that the compound annual growth rate values decreased after the COVID-19 pandemic. This might be due to shops, eateries, factories, transport services, and business establishments being shuttered during the COVID-19 pandemic. And also, the lockdown had a negative impact to slow down fisheries the sector and the economy.

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CHAPTER 1
INTRODUCTION

Fisheries sector plays an important role in the Indian economy. It contributes to the national income through exports and imports; provides imports, food and nutritional security and employment generation. The Fisheries sector provides livelihood to more than 2.8 Crores Fishers and Fish farmers at the primary level and several more along the Fisheries value chain. This sector is also a principal source of livelihood for a large section of economically underprivileged population of the country, especially in the coastal areas. The fisheries sector in the country continues to be among the most important and fastest growing agriculture allied sector in this country. It has been observed that the sector is gradually diversifying towards high value enterprises including ambitious targets. It is evident to mention the contribution of fisheries sector to the GDP. This is due to a sustained annual growth rate for the last five decades and recorded highest as compared to the agricultural sector. The growing production of fish and employment generation, suggests that fisheries sector is booming and contributing to the economic growth of the nation. Fisheries is a promising sector playing an important role for development of economic ambiance in the country. The sector has exhibited strong growth of about 8% per year on the average with aquaculture growing at an annual average of more than 10%. The sector has been showing a steady growth in the total Gross Value-Added accounts for about 7.28% share of Agriculture GDP. According to Ministry of Commerce & Industry the export of Marine products stood at 12.9 lakh metric tons and valued at Rs. 46,662.85 crores (6.68 billion USD) during 2019-20. About 17% of agriculture exports of our country are fish and fish products. The Country has a long coastline of about 8,118 km and 2.02 million sq. km. The vast resources both marine and inland are indicative of the immersive growth and potential of the sector.

1.1. FISH AND FISHERIES PRODUCTS EXPORT FROM INDIA

India's exports of marine products had their beginning as early as 1938-39. The exports included dried, salted or smoked fish, aquatic animal oils and fish meal. Most of the dried fish is exported to east Asian countries such as Hong Kong, Singapore, Myanmar (Burma) and Sri Lanka as a result of these steps. India is among the top 5 fish exporting countries in the world. About 17% of India's agricultural exports are fish and fish products. In 2020-21, the country exported 1.15 million tonnes of fish and fishery products .The value of exports for the same year was US$ 5.96 billion. India mainly exports frozen shrimps, fish, cuttlefish, squids, dried items, and live and chilled items. Out of these, frozen shrimp is the largest exported marine product contributing to more than 50% of the total quantity and about 75% of the total export value (i.e., US$ 4.43 billion for 2020-21). In 2020-21, the frozen fish, cuttlefish and squid contributed 6.7%, 3.73% and 4.6%, respectively of the total marine products export value, respectively. The same contributed to 16.37%, 5.16% and 5.3%, respectively of the total quantity exported in the same year. The value of marine products exported in 2022 reached US$ 7.74 billion. This is an increase of about 30% over the previous year (Hand book on fisheries statistic,2020). This is a great achievement considering the challenges posed by the Covid-19 pandemic and other difficulties related to logistics. (Website: https://dof.gov.in/)

1.2. FISH AND FISHERIES PRODUCTS IMPORT TO INDIA

India imports fish and fishery products nearly from 80 countries. The value of Fish imports in 2020-2021 (Apr-Nov) was 435.43 USD Million; which was 2505.68 USD Million in 2018, which shows a growth of 132.05% from the previous year's import value which was 1079.82 USD Million in 2017 (Hand book on fisheries statistic,2020). Most preferred countries export fish and fish products to India were Singapore (241.26 USD Million), United Arab Emirates (47.36 USD Million), Bangladesh (24.19 USD Million), Sri Lanka (23.54 USD Million), and Oman (12.5 USD Million). These 5 countries in total exported 348.85 USD Million value of Fish to India which rounds up to 80.12% of the total fish imported into India. In the year 2020-2021 (Apr-Nov). Among the top importing countries, India imported the highest dollar worth of Fish from Singapore with shipments in 2020-2021 (Apr-Nov) valued at 241.26 USD Million which is greater than the previous years' Fish shipments from Singapore into India. Second place was the United Arab Emirates, from where India imported around 47.36 USD Million worth of Fish. The top 10 countries shared 91.24% of the Fish imported to India. Of the Fish importing nations of India, Greece recorded the fastest growth in their Fish export to India with a 0.01% rise in the Fish import to India. The major ports for Fish import to India are NHAVA SHEVA SEA (164.8915 USD Million), CHENNAI SEA (112.5265 USD Million), and KOLKATA SEA (59.598 USD Million). So, imports of fish and fisheries products perform a major role in food production, nutritional security, employment, and income in India. (Website: https://www.cift.res.in/)

1.3. COVID-19 IN INDIA

The Coronavirus disease (COVID-19) is an infectious disease caused by the SARS-CoV-2 virus was discovered in December 2019 in Wuhan, China. It is very dangerous and has quickly spread around the world. With over 2.5 million confirmed cases and thousands of deaths, India has one of the highest COVID-19 infection rates in the world (WHO,2021). The first case of COVID-19 was identified on January 30, 2020 in Kerala in a student who had returned from Wuhan, China (18). However, since March 2020, there has been an upsurge in the spread of the infection. In response, the government imposed a nationwide lockdown to prevent community transmission of the infection. The impact of the coronavirus pandemic on India has been largely disruptive in terms of economic activity as well as a loss of human lives. GDP growth had dropped by 23.9% as a result of the COVID-19 due to the centre's lockdown. India's GDP shrank 7.3% in 2020–21. This was the worst performance of the Indian economy in any year since independence. As of now, India's GDP growth rate is likely to be below 10 percent. Almost all sectors have been adversely affected by COVID-19. So, it badly affects the economy. The impact of the pandemic is also seen in the fisheries sector, which is economically important to India's coastal states. (Website: https://covid19.who.int/)

1.4. IMPACT OF COVID-19 IN THE FISH AND FISHERIES PRODUCTS IN INDIA

COVID-19 and the subsequent lockdown has left India's fisheries in the lurch. The outbreak in India has resulted in emergency lockdown in the country for more than 2 months, and that caused decline in the catch, demand, and supply of fish. The complete lockdown in the fishing harbours including fish landing centres (FLCs) is reported to have affected the daily earnings of the fisherfolk population across all the coastal districts in the country. According to a report by the M S Swaminathan Research Foundation (MSSRF,2021), the daily loss of the fishers was estimated to be in the range of ₹500 to ₹2000 (USD 7 to 27 approximately) per person corresponding to approximately 50% of their normal daily income. In line with the requirement for social distancing norms of the “COVID-19 Guidelines” communicated by the Government of India, the insistence on personal quarantining as well as the need to maintain a distance of 2 m proved disadvantageous to the fish sellers, predominantly the fisherwomen, who were unable to buy fish from the landing centres and sell it in the market as per the usual practise (MSSRF, 2020a). The operational hours at the fish markets were also reduced to contain the coronavirus infection which was a major factor responsible for the reduction in the buying/selling/trading of fishes. Studies conducted by MSSRF in some villages nearer to Chennai reported that fishers are forced to sell the fishes at just ₹300 to ₹350 (USD 4 to 5 approximately) per kg while the actual rate was ₹500 (USD 7 approximately) per kg corresponding to a lowering of about 60 to 70% of the fishers' incomes (MSSRF, 2020a). According to the report of Central Institute of Fisheries Technology (CIFT,2020), the marine fishery sector faced an economic loss of ₹224 crores daily during the complete lockdown phase, imposed by GoI (Kumar, 2020). The total loss from the mechanised sector was reported to be ₹6008 crores while from the non-mechanised sector, it was reported to be ₹830 crores during the lockdown phase (Balasubramanian, 2020). Apart from this, the large-scale suspension of land-based activities at different research institutes (including INCOIS), developmental programmes, management meetings, consciousness and dissemination programmes across the country, has also been reported to hamper the entire growth of the marine fishery sector (Purkait et al., 2020). In the first half of 2020, the pandemic entered all regions of the world, some worse than others, including many major fish-producing and/or fish-consuming countries and global suppliers of fish feed. While fishing and aquaculture and the distribution of their products are considered an essential activity in most countries, the measures adopted to contain the spread of infection cause significant direct and indirect challenges to the sector.

1.5. RESEARCH GAP

There is a lack of research which studied the effect of the covid-19 on export and import of fish and fisheries products to India. The researcher gained significant insights into several aspects, dimensions of impacts, prospects of covid-19 impact.

1.6. TIME SERIES ANALYSIS

A time series is a set of observations measured sequentially through time. These measurements may be made continuously over time. A time series is said to be continuous when the observations are continuous over time and it is discrete if the measurement is specific over time. In the analysis of time series, time is the most important factor because the variables are related to time which may be year, month, week, day and hour or even minute or seconds. Time series are used in statistics, signal processing, econometrics, mathematical finance, weather forecasting, intelligent transport and trajectory forecasting (Chris Chatfield). we estimate the future values of the series. In time series analysis it is very important for the analyst to make the time series data stationary. A stationary process has the property that the mean, variance and autocorrelation structure do not change over time. Conversely, non-stationarity is the status of a time series whose statistical properties are changing through time. In time series forecasting, past observations are collected and analysed to develop a suitable model. The future events are predicted using the model. Time series forecasting has important applications in different fields.

1.7. OBJECTIVES OF THE STUDY

1) To study the effect of covid-19 on the export of fish and fisheries products from India.

2) To study the effect of covid-19 on the import of fish and fisheries products to India.

3) To study the effect of covid-19 on the growth rate of export of fish and fisheries products.

CHAPTER 2
REVIEW OF LITERATURE

This chapter presents review of literature related to marine products exports for time series modelling which are based on the published information. In general, review of literature presents a summary of particular area of research or topic. The literature review is compiled relevant studies carried out in the production and trade of fish and fishery products.

2.1. FISH PRODUCTION IN INDIA

Paul and Das (2010) studied the statistical modelling of inland fish production in India. The autoregressive integrated moving average (ARIMA) model was applied for modelling and forecasting of total inland fish production in India. The model was built using annual inland fish production data from 1951 to 2000, and it was validated using data from 2001 to 2008. The study concluded that the forecast of inland fish production in India for the years 2009 and 2010 has been found to be 4360 and 4610 thousand tonnes respectively.

Raman et al. (2017) investigated the seasonal ARIMA model for modelling and forecasting marine fish production in Odisha. The total marine fish landings (quaterwise) in Odisha during the period 1985–2012 have been analysed to estimate the effect of possible intervention and also for short-term forecasting by fitting the ARIMA model in two situations: one by accounting for intervention in the model and the other with log transformed data. The ARIMA model with log transformed data performed better than the model with an intervention component based on the Akaike information criterion and Bayesian information criterion of model selection. The model was used to forecast fish landings for the years 2013–2015.

Sathianandan (2017) investigates marine fish production in India-Present Status. India, being a tropical country, is blessed with a highly diverse nature of marine fishery resources in its 2.02 million square kilometre exclusive economic zone with an estimated annual harvestable potential of 4.414 million metric tonnes. The marine fisheries sector provides livelihood to nearly 4.0 million people in India and meets the food and nutritional requirements of a significant proportion of the population. The study concluded that sustainable harvest of the marine fishery resources is necessary as over exploitation of the resources is likely to harm the diversity and cause a reduction in the availability of some of the resources.

Panikkar *et.al* (1989) investigated the marine fish marketing trend in Kerala. The paper deals with the fish marketing system prevailing in Kerala, the price structure, seasonal and spatial price variations; marketing margins of commercially important varieties of fish; and the share of fishermen as well as middlemen in the consumer's rupee. During the 1984-86 season, which included the pre-monsoon, monsoon, and post-monsoon seasons, data on fish prices at the primary market (landing center), wholesale, and consumer markets were gathered through direct observation at the time of actual transaction, and information on transportation and handling charges, as well as other marketing aspects, were gathered from middlemen involved in various stages of marketing. The landing-wholesale-retail price relationship has also been studied. The study revealed that due to a lack of infrastructure facilities, the supply of fish at the landing centre is highly inelastic, which often results in the disposal of fish at throw-away prices at the time of heavy landings. The involvement of a number of middlemen in the marketing chain adversely affects the interests of both fishermen and consumers. The fisherman's share of the consumer's rupee varied from an average of about 40% for cheaper varieties of fish to about 65% for high-priced varieties. There has been a considerable increase in marketing expenditure over recent years.

Sathiadhas *et.al* (2012) explained that fish production highly depends on the growth and development of demand-driven markets both on the domestic and export fronts. The study was concluded that the marine product export marketing system has achieved tremendous development over the years and is, to a greater extent, on par with many developed nations in maintaining quality standards at an international level. Furthermore, the export trade gained momentum through recent trade liberalisation measures, which opened up opportunities for new markets and products meeting the quality standards in the international market. The establishment of several modern processing plants and the development of infrastructural facilities along the coast are mostly oriented towards catering to the needs of our lucrative foreign markets. However, it is distressing that the domestic marketing system in the country is still highly disorganised and complex with the dominance of a multitude of intermediaries and a lack of hygienic handling, preservation, grading, and quality control measures.

2.2. IMPORT AND EXPORT OF FISH AND FISHERIES PRODUCTS IN INDIA

Sakthivel (1999) discussed the strategy to enhance export promotion of fish and fish products , especially in value added form, will pay a rich dividend to the rural poor fisherman, fish farmers and our country on the whole and the study was during 1950- 1998. The value of the marine products export from India substantially increased from 25 million.

Perumal (2003) studied that the growth trends of marine fish production and export in Tamil Nadu. The study observed that the export of marine products from Tamil Nadu is nearly 10 percent (1998- 99). Further the study found that the marine fish and fish products export trend increases at the increasing rate. Hence, the study argued that the nature provides long shoreline. So, the government can construct some more major fishing harbors and so more mechanized trawlers can be operated in Tamil Nadu.

Rajeev and Supriya (2008) studied the fisheries sector in India an overview. This chapter discusses the contribution of the fisheries sector to the Indian economy in terms of the generation of income and employment over the years. It also talks about the export performance and the tariff and non-tariff barriers faced by the sector. The study concluded that the sector contributes to the livelihood of more than 16 million fishermen at the primary level and twofold the number across the supply chain. The fisheries sector, comprising marine, inland, and brackish water fish, is also an important source of food security and nutrition in the country, with fish being an affordable and rich source of animal protein (Kumar et al. in World Aquac 41:45–51, 2010). The importance of the fisheries sector is also reflected in its increasing contribution to both the gross domestic product (GDP) and foreign exchange earnings of the country. In 2017–18, the share of the sector in GDP was 1.03%, a 157% increase from its 0.4% contribution in 1950–51, while its share in agricultural GDP was 6.58%. The contribution of fisheries to exports has also been steadily increasing, with the sector accounting for 5% of total exports and 19.23% of total agricultural exports in 2017–18 (MOPSI, 2020, as cited in GoI in National Fisheries Policy 2020 Draft. Department of Fisheries, Government of India, 2020). This chapter discusses the contribution of the fisheries sector to the Indian economy in terms of the generation of income and employment over the years. It also talks about the export performance and the tariff and non-tariff barriers faced by the sector.

Krishna (2004) found that the export of marine products had grown to greater proportion as one of the important items of India's exports accounting for approximately 4 per cent of the total exports from India. Dried fish was the prominent item exported during the 1950s and 1960s but in the seventies, it gave way to frozen and canned products. During the eighties the canned items slowly disappeared and frozen items, became the prominent one in India's seafood trade. Amongst the frozen items also, there were changes in the demand from various countries. Due to the introduction of scientific shrimp farming, the export of frozen value-added shrimp is continuing as the major foreign exchange earner among marine products.

Hrishikes (2002) studied that fish products export of India suffers from high fluctuations. The level of fluctuations is higher by value than by quantity. These high fluctuations make the seafood export business riskier as compared to other manufacturing industries engaged in exports. All these fluctuations are to a large extent can controllable, and hence should be considered as an overriding condition of the industry. The major risks to the Indian seafood industry are proceeding from the abroad markets in the form of fluctuations in demand and in prices. All these factors ultimately affect the sales.

Geethalakshmi et.al (2010) discussed the trend in shrimp export price in the major markets, Japan , USA and the UE countries. The competitiveness of Indian shrimp export to the US market was studied and it is found that the countries relative competitiveness was less compared to its competing countries. An analysis of prices of frozen shrimp exports from India to the major international markets is also presented. India's advantage is that it can increase its production of shrimp by extending the farming area. Indian exporters should take up value addition of products. Diversification of markets has to be explored to bring the Indian shrimp trade to benefit.

Das et.al (2016) showed that marine products export from India mainly focused to less desirable and least desirable destinations. The marine products export from India was highly unstable and results of ARIMA model showed an increasing trend in forecasted quantity of export in future Forecast of India's marine products export was done by fitting univariate Auto Regressive Integrated Moving Average (ARIMA) models. Export growth in terms of quantity and value was low.

M. and Gururaj (2020) created the volume of fish and fish products exported during 2014- 15 was 1051243 tonnes. The growth in Indian marine exports was assessed using time series data from 1995-96 to 2014- 15 and it showed an increasing trend in marine exports indicating scope for fishery sector. The analysis of direction of trade has revealed that China and South East Asia to be the most stable importer. There is tremendous scope for increasing the export of quality fish products from India. There was a huge demand for Indian marine products, therefore government need to give attention for the sustainability of fishery sector.

2.3. IMPACT OF COVID-19 IN THE IMPORT AND EXPORT OF FISH AND FISHERIES PRODUCTS IN INDIA

Rajamohan and Kanchana (2021) investigated the effect of COVID-19 on the fisheries industry. The impact of COVID-19 on the fishing industry's demand is highlighted in this paper. The purpose of this informative paper is to update knowledge on the impact of the COVID-19 pandemic on the fisheries industry in the Tamilnadu region. This descriptive study adopts a conceptual approach to find out the impacts of COVID-19 on the fisheries sector, especially in the Tamilnadu region. In this study, the data has been collected from various secondary sources, such as journal articles, newsletters, working papers, etc. The present study provides us with a vast knowledge about the status of the fishing sector, especially in the state of Tamilnadu, i.e., how the COVID-19 pandemic has impacted on it. So, the state government of Tamilnadu has various schemes for the development of the fishing sector. The Brackish water fisheries development agency (BFDA) is an organisation that provides scientific training with modern technical inputs and guides fishermen to improve fishing techniques. The government has also proposed fisheries policies and infrastructure facilities to protect the entire sector from a pandemic situation, and appropriate steps have been taken to provide alternative income sources to fishermen during the closed season of fishing, thereby improving their economic standard and way of life.

Firdousie et.al (2021) discussed the impact of Covid-19 lockdown on India's Fisheries Sector. As a result of COVID-19, food systems have been severely disrupted, affecting many lives and their livelihoods. Fish and fish products that are highly dependent on international trade suffered quite early in the development of the pandemic from the restrictions and closures of global markets. The national lockdown has not only foretold that the aquaculture sector depends heavily on migrant labour, but it has also highlighted the need to strengthen the skills of local workers. Some governments have realized the importance of developing rural markets and have begun selling fish in rural areas through government vehicles to increase the consumption of fish and improve market connectivity. Due to the country's current state of emergency, there is an urgent need to increase fish consumption. With its effective governance, India has taken the threat seriously and is doing everything it can to combat the pandemic. In the post-COVID era, the government and policymakers must be prepared to mitigate the impact of shocks and monetary growth.

Alam et.al (2021) studied the effects of COVID-19 on the Fisheries and Aquaculture Sector in Developing Countries and Ways Forward. Fish and fish products are among the most traded food products in the world, with 38 percent of fish/seafood entering international trade. At the same time, fishing and fish farming are important at local level for the livelihoods of many fish-dependent communities, as well as for low-income countries and small island developing states. It also has linkages with the economic and supply-chain dimensions of these countries. This literature has revealed that Covid -19 pandemic has had a detrimental effect on the fisheries sector, which serves as the major source of income and employment for numerous people globally. The study has employed a systematic literature review of the overall impacts of COVID-19 on the fisheries and aquaculture sector in developing countries using the PRISMA approach. This study reveals that COVID-19 has posed numerous challenges to fish supply chain management, including a shortage of inputs, a lack of technical assistance, an inability to sell the product, a lack of transportation for the fish supply, export restrictions on fish and fisheries products, and a low fish price. These challenges lead to inadequate production, unanticipated stock retention, and a loss in returns. COVID-19 has also resulted in food insecurity for many small-scale fish growers. Fish farmers are becoming less motivated to raise fish and related products as a result of these cumulative consequences. Because of COVID-19's different restriction measures, the demand and supply sides of the fish food chain have been disrupted, resulting in reduced livelihoods and economic vulnerability. To assist stakeholders to cope with, adapting to, and building resilience to pandemics and other shocks, this analysis offers policy recommendations to address the COVID-19-induced crisis in the fisheries and aquaculture sector.

Nigam (2021) studied that; A Brief Review of the Effects of Covid -19 on Fisheries. It shows the side effect of the total shutdown on the fishery industry which included the seafood fishery sector, and the fresh and backwater fishery sector which encompassed the economy completely. According to The Central Institute of Fisheries Technology (CIFT), it is estimated that in Kerala alone there will be an income loss of approximately Rs. 130 crores to fishermen (The Hindu business news). According to CIFT experts, due to the closure of landing centres, many fishermen have been stranded in the sea onboard trawlers. It is estimated that there are about 22,000 crafts that ply on the Kerala coast with a fish production of about 6.4 lakh tons, which was at a standstill.

Avtar et.al (2021) studied that Impact of COVID-19 Lockdown on the Fisheries Sector: A Case Study from Three Harbours in Western India. It has severely shrunk the global economy in the year 2020, including India. The blue economy and especially the small-scale fisheries sector in India have dwindled due to disruptions in the fish catch, market, and supply chain. This research presents the applicability of satellite data to monitor the impact of COVID-19 related lockdown on the Indian fisheries sector. Three harbours namely Mangrol, Veraval, and Vankbara situated on the north-western coast of India were selected in this study based on characteristics like harbour's age, administrative control, and availability of cloud-free satellite images. To analyse the impact of COVID in the fisheries sector, we utilized high-resolution Planet Scope data for monitoring and comparison of the "area under fishing boats" during the pre-lockdown, lockdown, and post-lockdown phases. A support vector machine (SVM) classification algorithm was used to identify the area under the boats. The classification results were complemented with socio-economic data and ground-level information for understanding the impact of the pandemic on the three sites. During the peak of the lockdown, it was found that the "area under fishing boats" near the docks and those parked on the land area increased by 483%, 189%, and 826% at Mangrol, Veraval, and Vankbara harbour, respectively. After phase-I of lockdown, the number of parked vessels decreased, yet those already moved out to the land area were not returned until the southwest monsoon was over. A quarter of the annual production is estimated to be lost at the three harbours due to lockdown. Our last observation (September 2020) result shows that regular fishing activity has already been re-established in all three locations. Planet Scope data with daily revisit time has a higher potential to be used in the future and can help policymakers in making informed decisions vis-à-vis the fishing industry during an emergency like COVID-19.

2.4. CAGR OF EXPORT OF FISH AND FISHERIES PRODUCTS

Jayanthi and Nikita (2012) revealed that India's scampi export was concentrated mainly to those countries, which is either less desirable (low growth & high risk) or least desirable (low growth & low risk) category which affects the economic growth of the country. Scampi export was mainly focused to less desirable and least desirable destinations and attempts at identifying competitive and stable market destinations. Instability in quantity has largely influenced the scampi export. Hence there is a need to increase scampi production and ensure steady supply of raw material to the seafood processing industry.

Liya and Ramachandran (2012) investigated the export trend of the industry for the past ten years shows a declining state which is also reflected in the annual and compound annual growth rate. Ornamental fish industry has enormous potential in tropical countries like India. To expand trade, new technologies and policies will have to be developed which will help in attaining a sustainable industry. The study was carried out between 2009 and 2011. The method for data collection consisted of information gathering from various ornamental fish exporters in India using an e-mail survey.

Vinod (2020) studied the growth and export performance of fish and fisheries products from India. The study concluded that Fishery sector provides livelihood to about 16 million fishers and fish farmers at the primary level and almost twice the number along the value chain. India is the world's second-largest fish-producing and second-largest aquaculture nation after China. The total fish production in the country has increased from 3.84 MMT in 1995-91 to 13.76 MMT in 2018-19, registering an annual growth rate of 4.05 per cent. Fish and fish products during 2019-20 emerged as the largest group in agricultural exports from India, with 1328991 MT in terms of quantity and Rs.47618 crore in value terms. The USA and Southeast Asia are the major export markets for Indian seafood, with a share of 34.81 percent and 22.67 percent, respectively, in value terms during 2018-19. Also, the outbreak of COVID-19 is expected to have a negative impact on fisheries trade among key exporters and importers in 2020.

Faria (2016) studied an analysis of marine production and exports of goa's fisheries sector .The study endeavours to make a comparative analysis of the annual growth rate and compounded annual growth rate of fish production in Goa and India from 2001–2014. It also examines the percentage of jetty-wise fish and variety-wise marine and inland fish catch in Goa from 1998 to 2015. The study focuses on the growth performance in major item-wise exports of Goa‘s marine products during the years 2005 to 2014. Secondary data was analysed by using statistical tools, i.e., descriptive statistics, i.e., mean, standard deviation, coefficient of variation, ANOVA, and simple regression analysis to study the contribution of the fisheries sector to Goa‘s economy. The gross domestic product of Goa is highly influenced by the contribution made by the fisheries sector in Goa.

CHAPTER 3

MATERIALS AND METHODS

3.1. ABOUT THE DATA

The study mainly uses secondary data. The data set contains monthly data of exports and imports from the period of January 2007 to December 2021. The data are taken from website of Ministry of Commerce and Industry.

Table 3.1: The following commodities are used in the study.

NO	HSCODE	COMMODITY
1	HSCODE-0301	Live fish
2	HSCODE-0302	Fish, fresh or chilled, excluding fish fillets and other fish meat of heading 0304
3	HSCODE-0303	Fish frozen excluding fish fillets and other fish meat of heading no 0304
4	HSCODE-0304	Fish fillets and other fish meat (whether or not minced), fresh, chilled or frozen
5	HSCODE-0305	Fish dried salted or in brine; smoked fish cooked or not before or during the smoking process; fish meal fit for consumption
6	HSCODE-0306	Crustaceans, whether in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; crustaceans, in shell, cooked by steaming or by boiling in water, whether or not chilled, frozen, dried, salted or in brine; flours, meals and pellets, of crust
7	HSCODE-0307	Molluscs, whether in shell or not, live, fresh, chilled, frozen, dried, salted or in brine; aquatic invertebrates other than crustaceans and molluscs, live, fresh, chilled, frozen, dried, salted or in brine; flours, meals and pellets of aquatic invertebrate

3.2. TIME SERIES

Time series analysis is a specific way of analyzing a sequence of data points collected over an interval of time. Time series analysis comprises methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data. In time series forecasting, past observations are collected and analysed to develop a suitable model. The future events are predicted using the model. Time series forecasting has important applications indifferent fields. In time series analysis it is very important for the analyst to make the time series data stationary. A stationary process is said to be stationary only if the mean and varianceis constant over the time. If the time series is not stationary, then it will give the value of mean and variance for the time series.

3.3. STATISTICAL MODELS

Models for time series data can have many forms and represent different stochastic processes. When modeling variations in the level of a process, three broad classes of practical importance are the autoregressive (AR) models, the integrated (I) models, and the moving average (MA) models. These three classes depend linearly on previous data points. Combinations of these ideas produce autoregressive moving average (ARMA), autoregressive integrated moving average (ARIMA) models and seasonal autoregressive integrated moving average (SARIMA) models.

3.3.1. AUTOREGRESSIVE MODEL

Autoregressive models are based on the idea that the current value of the series Z_t can be explained as a function of the past values Z_{t-1}, Z_{t-2},..., Z_{t-p}, where p determinesthe number of steps into the past needed to forecast the current value. $\{Z_t\}$ is an autoregressive process of order p abbreviated as AR(p) if

$$Z_t = \emptyset_1 Z_{t-1} + \emptyset_2 Z_{t-2} + \cdots + \emptyset_q Z_{t-p} \quad (3.1)$$

where $\{Z_t\} \sim WN\,(0, \sigma^2)$ and $\emptyset_1, \emptyset_2, \dots, \emptyset_p$ are constants.

3.3.2. MOVING AVERAGE MODEL

Z_t is a moving average process of order q or MA(q)

$$Z_t = a_t - \theta_1 a_{t-1} - \cdots - \theta_q a_{qat-q} \quad (3.2)$$

where $\{Z_t\} \sim$ WN (0, σ^2) and $\theta_1, \theta_2, \theta_3, \ldots, \theta_q$are constants.

3.3.3. AUTOREGRESSIVE MOVING AVERAGE MODEL

The series *Zt* is an Autoregressive Moving Average Model (ARMA (*p*, *q*) model) if *Zt*

is stationary and if for every *t*,

$$Z_t = \emptyset_1 Z_{t-1} + \emptyset_2 Z_{t-2} + \cdots + \emptyset_q Z_{t-p} + a_t - \theta_1 a_{t-1} - \cdots - \theta_q a_{qat-q} \quad (3.3)$$

where {Zt} ~ WN (0, σ^2) and the polynomials $(1 - \emptyset_1 B - \cdots - \emptyset_p B^p)$ and $(1 + \theta_1 B + \cdots + \theta_q B^q)$ have no common factors. It can be written more concisely as,

$$\emptyset(B) Z_t = \theta(B) a_t \quad (3.4)$$

where $\emptyset(B)$ and $\theta(B)$ are the pth and qth degree polynomials and B is the backwardshift operator.

3.3.4. AUTOREGRSSIVE INTEGRATED MOVING AVERAGE METHOD

A process Zt is said to be Autoregressive Integrated Moving Average (ARIMA(p, d, q))

if $\nabla^{\mathrm{d}} Zt = (1 - B)^d Zt$ is ARMA(p, q). In general, the model can be written as

$$\emptyset(B)(1 - B)^d Z_t = \theta(B) a_t \quad (3.5)$$

where $\{Zt\} \sim$ WN (0, σ^2).

3.3.5. SEASONAL ARIMA MODEL

If d and D are non-negative integers, then $\{Zt\}$ is a Seasonal ARIMA (p, d, q) (P,D,Q) process with period s if the differenced series $Y_t = (1 - B)^d (1 - B^s)^D X_t$ is a causal ARMA process defined by,

$$\Phi_p(B^s) \emptyset_p(B) \square_s^D \square^d Z_t = \Theta_{\mathrm{Q}}(B^s) \theta_q(B) a_t \quad (3.6)$$

Where $\Phi_p(B^s) = \left(1 - \emptyset_1 B^{12} - \Phi\emptyset_2 B^{12} - \ldots - \emptyset_p B^{12}\right)$

$$\emptyset_p(B) = \left(1 - \Phi_1 B - \Phi_2 B^2 - \ldots - \Phi_p B^p\right)$$

$$\square^d = (1 - B)^d$$

$$\square_s^D = (1 - B^{12})^D$$

$$\Theta_Q(B^s) = (1 - \Theta_1 B^{12} - \Theta_2 B^{12} - \ldots - \Theta_Q B^{12})$$

$$\theta_q(B) = (1 - Q_1 B - Q_2 B^2 - \ldots - Q_q B^q)$$

Here, the ordinary auto-regressive and moving average components are represented by polynomials $\emptyset$(B) and θ(B) of orders p and q respectively. Similarly, the seasonal autoregressive and moving average components by Φ(B) and Θ(B) of orders P and Q respectively. The above model is called seasonal ARIMA of order (p, d, q) (P, D, Q)s.

Where, p is the order of autoregressive process

d is the order of differencing.

q is the order of moving average process.

P the order of seasonal auto regressive process.

D is the order of seasonal differencing.

Q is the order of seasonal moving average process.

When fitting a seasonal model to data, the first task is to assess values of d and D which reduce the series to stationary and remove most seasonality. Then the values of p, P, q, Q need to be assessed by looking at the ACF& PACF.

3.4. MODEL SELECTION CRITERIA

While analysing a time series, we may have several models, which are adequate forthe data. We choose the one which fits best for the data. Some of the popular criteria used for model selection are Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), Schwartz's Bayesian criteria, Parzen's criteria for autoregressive transfer functions etc. In this study Akaike Information Criteria (AIC) is used for model selection procedure. The selection procedure is such that we select the model with minimum AIC value.

3.4.1. Akaike Information Criteria (AIC)

Assume that a statistical model with m parameters is fitted to the data. Akaike proposed the following information criteria to assess the model.

$$AIC = -2ln(L) + 2m \tag{3.7}$$

where *m* is the number of model parameters. The model with minimum AIC is preferred.

3.4.2. Bayesian Information Criteria (BIC)

Bayesian information criterion (BIC) is a criterion for model selection among a finite set of models. When fitting models, it is possible to increase the likelihood by adding parameters, but doing so many results in over fitting. The BIC resolves this problem by introducing penalty term and BIC can be widely used for model identification in time series analysis and linear regression. Mathematically BIC can be defined as ;

$$BIC = ln(n)k - 2ln(L) \tag{3.8}$$

L is the maximum value of the likelihood function of the model, n is the number of data point and k is the number of free estimated parameters.

3.4.3. AUTOCORRELATION FUNCTION

The covariance between Z_t and Z_{t-k} is known as the autocovariance function at lag k and is defined by,

$$\gamma_k = Cov\ (Z_t, Z_{t-k}) = E\ \left(Z_t - E(Z_t)\right) E\ (Z_{t-k} - E(Z_{t-k})) \tag{3.9}$$

The correlation coefficient between $\{X_t\}$ and $\{X_{t-k}\}$ is called Autocorrelation function (ACF) at lag *k*, is given by,

$$\rho_k = Corr(Z_t, Z_{t-k}) = \frac{Cov(Z_t, Z_{t-k})}{\sqrt{V(Z_t)}\sqrt{V(Z_{t-k}}} \tag{3.10}$$

3.4.4. PARTIAL AUTOCORRELATION FUNCTION

The Partial Autocorrelation function (PACF) of a given time series $\{Z_t\}$ Is the partialcorrelation coefficient between $\{Z_t\}$ and Z_{t+h} obtained by fixing the effects of $Z_{t+1}, Z_{t+2}, Z_{t+3}, \dots, Z_{t+h-1}$

3.5. MODEL EVALUATION CRITERIA

In selecting a suitable Time series model, the researcher wants to be responsive that numerous altered models may have comparable properties. A good model will fit the data well.

3.5.1. Box-Jenkins Method

The Box-Jenkins method refers to the iterative application of the following three steps:

Model Identification: Using plots of the data, autocorrelations, partial autocorrelations, and other information, a class of simple ARIMA models is selected. This amounts to estimating appropriate values for p, d and q. In case of identifying the seasonal parameters, we follow the same technique of looking at the ACF and PACF signatures at the seasonal lags.

Estimation: The $\varphi(\Phi)$ and $\theta(\Theta)$ of the selected model is estimated using maximum likelihood techniques, back-casting, etc., as outlined in Box-Jenkins (1976). It involves the selection of the model using Akaike Information Criterion (AIC). We select the model with minimum AIC value.

Diagnostic Checking: The fitted model is checked for inadequacies by considering the autocorrelations of the residuals (the series of residuals, or error, values).These steps are applied iteratively until step three does not produce any improvement in the model.

3.5.2. Augmented Dickey Fuller

Augmented Dickey Fuller test is used to test the stationary of a time series.

H_0: The series is non-stationary

v/s

H_1: The series is stationary

The test statistic is given by

$$DF_{\tau} = \frac{\hat{\gamma}}{SE(\hat{\gamma})} \tag{3.11}$$

3.5.3. Ljung-Box Test

The Ljung-Box test is used to test whether the autocorrelations of a time series aredifferent from zero. The test statistic is,

$$Q = n(n+2)\sum_{k=1}^{h}\frac{\widehat{\rho_k^2}}{n-k} \tag{3.12}$$

Where n is sample size, ρ^k is the sample autocorrelation at lag k and h is the number of lags being tested. Reject H_0 when p value is less than 0.05.

3.5.4. NORMALITY TEST FOR RESIDUALS

SHAPIRO WILK NORMALITY TEST

The normality assumption of the residuals is checked using Shapiro-Wilk Normality test.

The test statistic is defined as,

$$W = \frac{\left(\sum_{i=1}^{n} a_i x_{(i)}\right)^2}{\sum_{i=1}^{n}\left(x_i - \bar{X}\right)^2} \tag{3.13}$$

H_0: The residuals are normal

v/s

H_1: The residual is not normal

If the p-value obtained is greater than 0.05. So, we will accept the null hypothesis that the residuals normal.

HISTOGRAM OF THE RESIDUALS

If the histogram shows that residuals follow normal distribution. Then we accept it. Otherwise, it is not normally distributed.

NORMAL Q-Q PLOT OF RESIDUALS

In the normal Q-Q plot. If the residual values are lie in the straight line. Which means that residuals are normally distributed. Otherwise, it is not normally distributed.

3.6. FORECASTING

One of the objectives of analysing time series is to forecast its future behaviour. That is, based on the observation up to time t, we should be able to predict the value of the variable at a future time point. The method of Minimum Mean Square Error (MMSE) forecasting is widely used when the time series follows a linear model. The l-step ahead forecast of linear process $\{Z_t\}$ is $E(Z_{t+1} | Z_t, Z_{t-1}, \ldots)$

3.7. CONVERTING UNIT PRICE

After finding the forecasted quantity of each commodity. Then calculate actual price and expected price. So, if expected price is greater than the actual price. Therefore, it can be concluded that there was an impact. Otherwise, it can be concluded that there is no impact.

UNIT PRICE = ACTUAL PRICE / ACTUAL QUANTITY (EXPORT OR IMPORT) (3.14)

EXPECTED PRICE = UNIT PRICE * FORECASTED QUANTITY (EXPORT OR IMPORT) (3.15)

3.8. COMPOUND ANNUAL GROWTH RATE (CAGR)

CAGR is used to study the growth rate of area, productivity, import, export, etc of a particular commodity.

$$CAGR = \left(\frac{EV}{BV}\right)^{\frac{1}{n}} - 1 * 100 \qquad (3.16)$$

where: EV = Ending value

BV = Beginning value

n = Number of years

3.9. TOOLS USED

The present was done by using the software R, EXCEL and SPSS (version 20).

R is a programming language and free software environment for statistical computing and graphics supported by the R foundation for statistic environment. The R language is widely used among statisticians and data minors for developing statistical software and statistical analysis. R and its libraries implement a wide variety of statistical and graphical technique including linear and nonlinear modelling, time series analysis clustering etc.

SPSS is a widely used programme for statistical analysis in social science. SPSS is used by market researchers, health researchers, survey companies, government entities, education researchers, marketing organizations and data miners.

Microsoft Excel is one of the most popular applications for data analysis. Equipped with built-in pivot tables, they are without a doubt the most sought-after analytic tool available. It is an all-in-one data management software that allows you to easily import, explore, clean, analyse, and visualize your data. In this article, we will discuss the various methods of data analysis in Excel.

CHAPTER 4

RESULT AND DISCUSSION

4.1.TIME SERIES ANALYSIS OF THE EXPORT OF FISH AND FISHERIES PRODUCTS FROM INDIA

This section discusses the time series modelling of export of fish and fisheries products from India (quantity in ton) based on the data taken from 2007 to 2021 of 15 years.

4.1.1. HSCODE-0301

Fig 4.1 depicts the time series plot of commodities in hscode-0301 of exports. It is visible that there is a trend. The export of hscode-0301 was found to be increasing in 2016-17 but started to decrease in 2018-19.

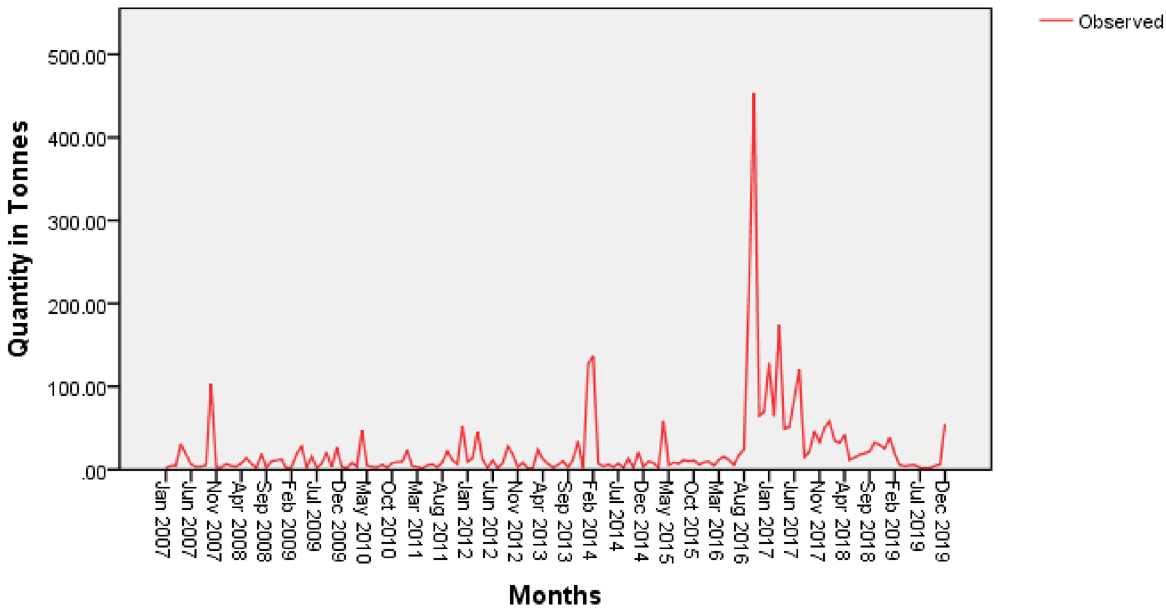


Fig 4.1: Time series plot of commodities in hscode-0301 of export (quantity) from 2007 to 2019

Different types of time series models were fitted to the data on hscode-0301 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented:

The best model was ARIMA (1,1,2) (0,0,1) [12]. The model coefficients are given in Table 4.1.

Table 4.1: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0301 of export.

ARIMA (1,1,2) (0,0,1) [12]	
AIC	1602.18
BIC	1617.396

According to Bayesian information criteria ARIMA (1,1,2) (0,0,1) model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.2.

Table 4.2: SARIMA models along with their corresponding parameters for the commodities in hscode-0301 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY -Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		.067	.730	.092	.927
			AR	Lag 1	-.516	.128	-4.036	.000
			Difference		1			
			MA	Lag 1	-.029	.100	-.288	.774
				Lag 2	.694	.070	9.927	.000
			MA, Seasonal	Lag 1	.044	.083	.532	.595

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} - 0.516(Z_{t-1} - Z_{t-2}) + a_t - 0.044\, a_{t-12} - 0.0278(a_{t-1} + 0.044\, a_{t-13}) + 0.694(a_{t-2} + 0.044\, a_{t-14}) \quad (4.1)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.8514. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot, it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 2.2e-16. Therefore, the fitted model satisfies all the required assumptions.

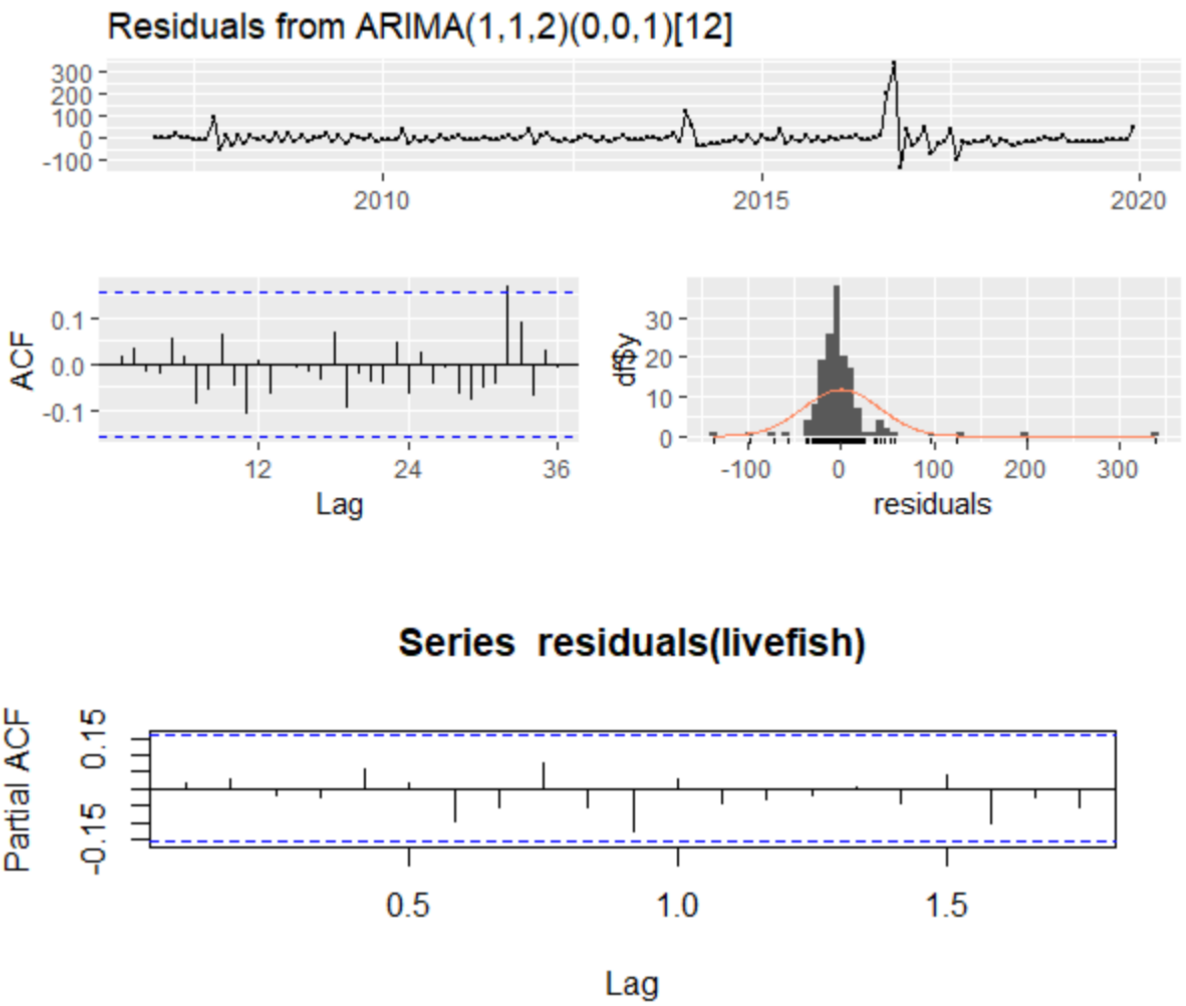


Fig.4.2:ACF,PACF and Histogram plot of residuals of commodities in hscode-0301 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the histogram of residuals is normal.

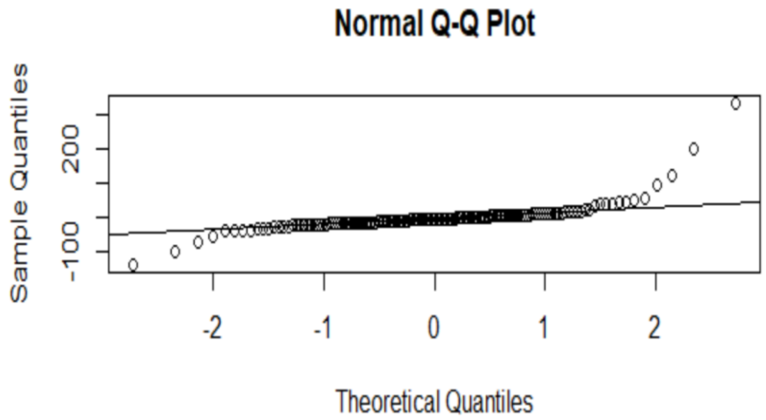


Fig.4.3:Q-Q plot of residuals of commodities in hscode-0301 export.

Also, from the above normal Q-Q plot the most of the residual values lie on the straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 1, 2) × (0, 0, 1) model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0301 for the next 24 months is forecasted using the ARIMA (1,1,2) (0,0,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.4 depicts the forecasted quantity of commodities in hscode-0301.

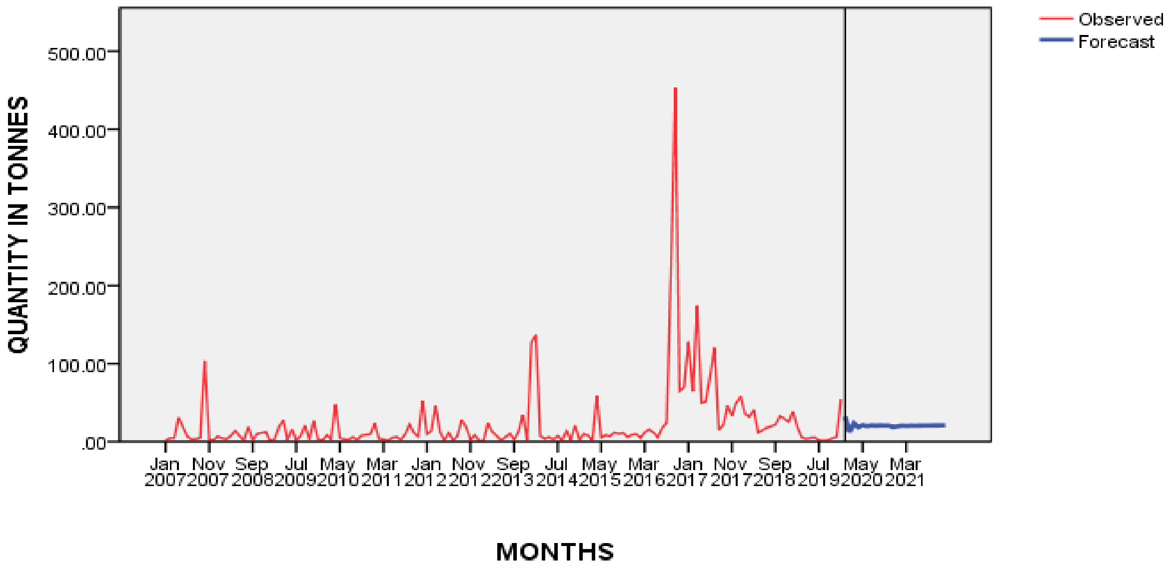


Fig.4.4: Forecasted value(quantity) plot of commodities in hscode-0301 from 2007 to 2021 of export.

From the above graph, it is clear that there is a linear trend in exports in 2020 and 2021.

Fig 4.4 shows the actual and fitted prices plot of commodities in hscode-0301 export. The blue line shows the actual values and the orange line shows the fitted values.

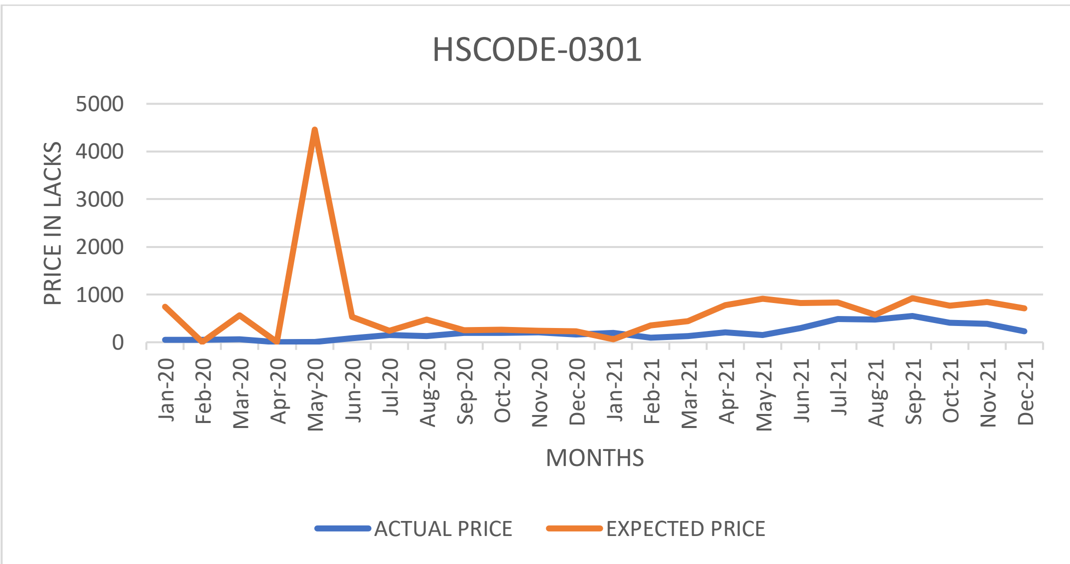


Fig.4.5:actual and expected price(quantity) plot of commodities in hscode-0301 from 2007 to 2021 *of export.*

From the above graph, it is clear that the expected price is greater than the actual price in 2020–21. Also, there was a very large increase in May 2020.

4.1.2. HSCODE-0302

Fig 4.6 depicts the time series plot of commodities in hscode-0302 of exports. It is visible that there is a trend. The export of hscode-0302 was found to be increasing in 2008-12 but started to decrease in 2018-19.

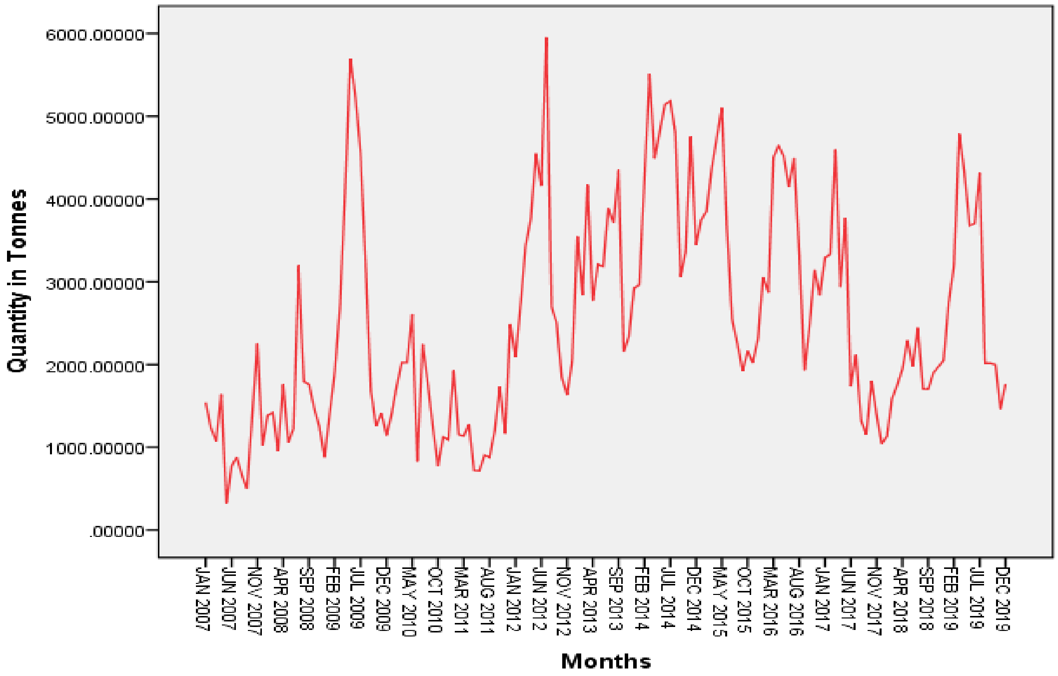


Fig 4.6: Time series plot of the commodities in hscode-0302 of export from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0302 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,0,0) (0,1,1) [12]. The model coefficients are given in Table 4.3.

Table 4.3: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0302 of export.

ARIMA (1,0,0) (0,1,1) [12]	
AIC	2338.84
BIC	2347.754

According to Bayesian information criteria ARIMA (1,0,0) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.4

Table 4.4: SARIMA models along with their corresponding parameters for the commodities in hscode-0302 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	AR	Lag 1	.819	.09	16.18	.000
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	.905	.128	7.045	.000

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-12} - 0.891(Z_{t-1} - Z_{t-13}) + a_t - 0.905\, a_{t-12} \quad (4.2)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.05884. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the Normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 0.004046. Therefore, the fitted model satisfies all the required assumptions.

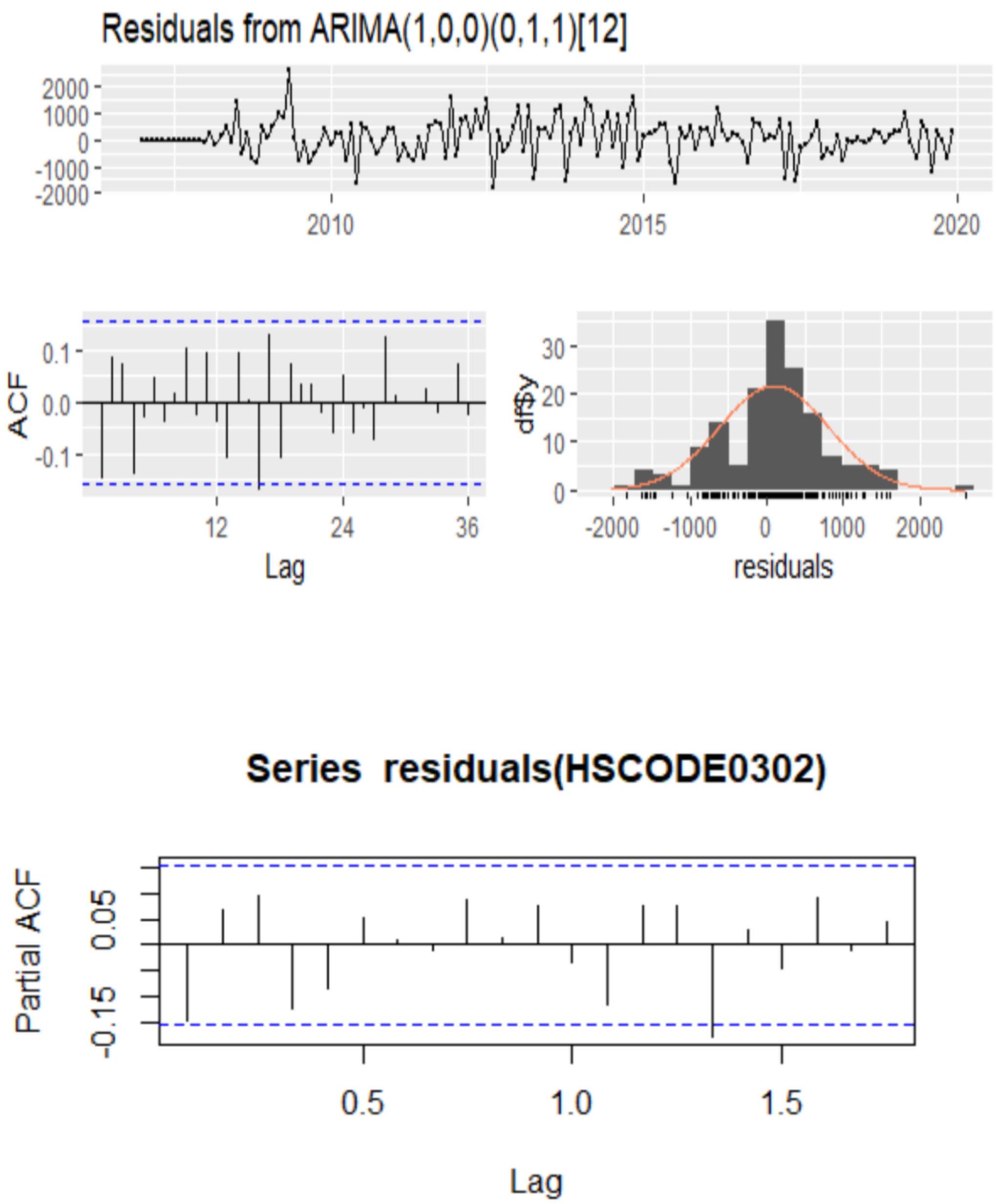


Fig.4.7:ACF,PACF and Histogram plot of residuals of commodities in hscode-0302 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the histogram of residuals is normal.

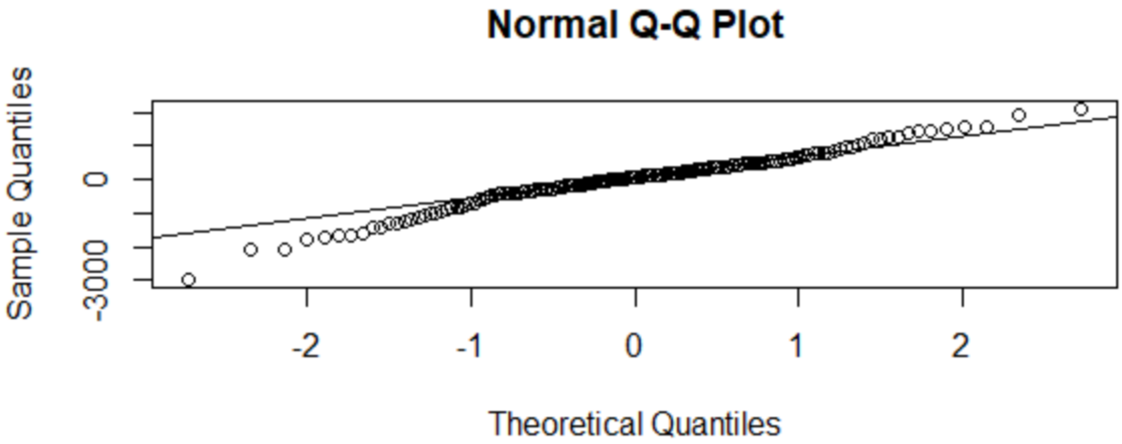


Fig.4.8:Q-Q plot of residuals of commodities in hscode-0302 of export

Also, from the above normal Q-Q plot . It can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 0, 0) × (0, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0302 for the next 24 months is forecasted using the ARIMA (1,0,0) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.9 depicts the forecasted quantity of commodities in hscode-0302 of export.

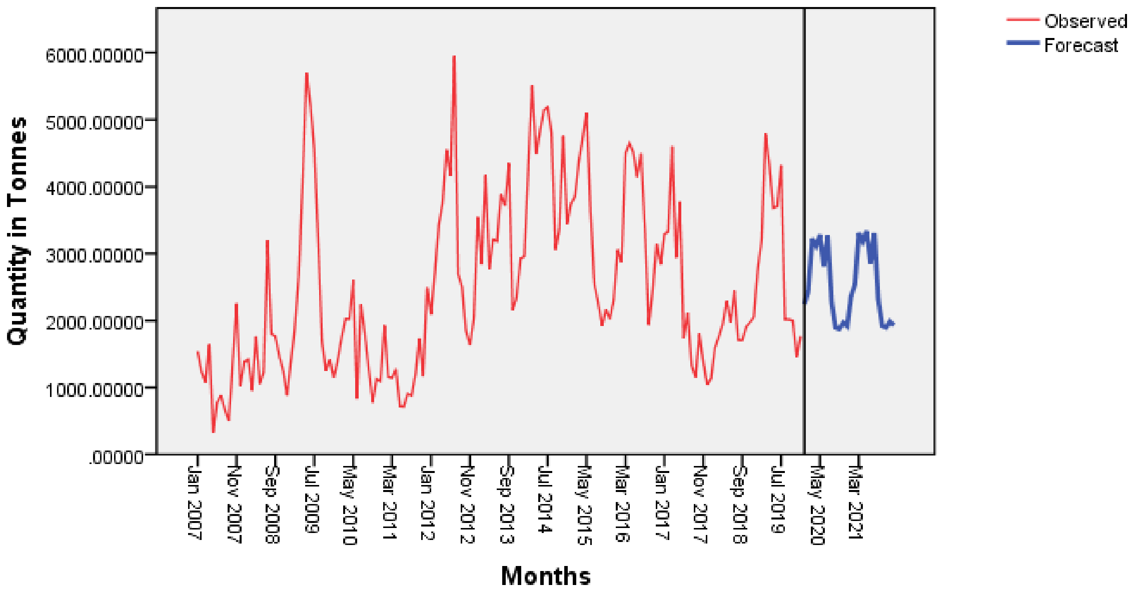


Fig.4.9:forecasted value(quantity) plot of commodities in hscode-0302 of export from 2007 to 2021.

From the above graph, it is clear that there is a trend in 2020 and 2021.

Fig 4.10 shows the actual and fitted prices plot of commodities in hscode-0302 of export. The blue line shows the actual values and the orange line shows the fitted values.

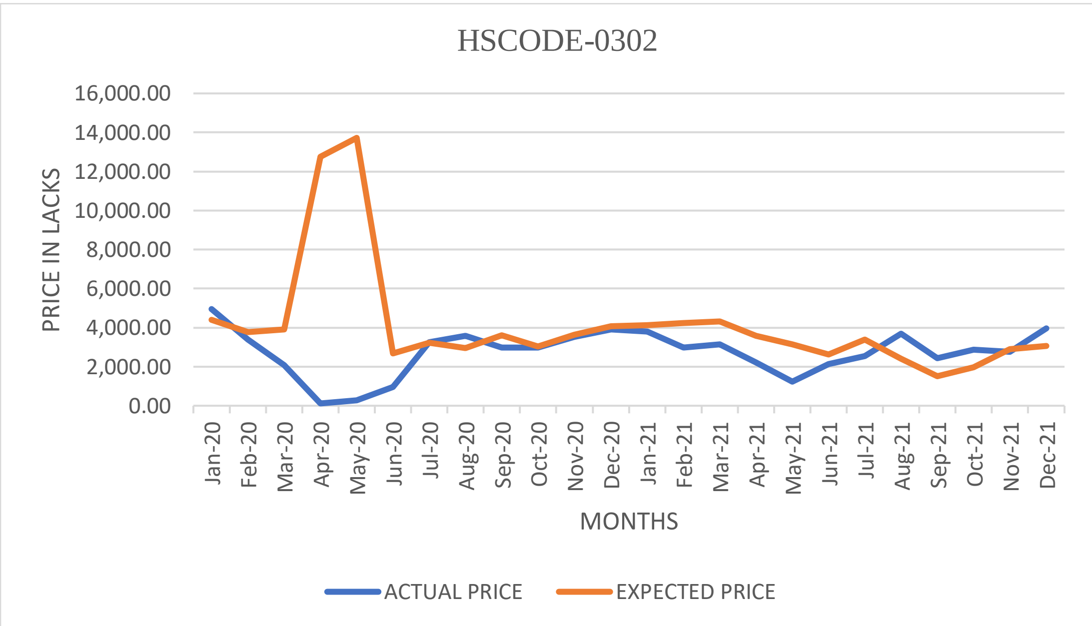


Fig.4.10:actual and expected price plot of commodities in hscode-0302 of export from 2020 to 2021.

From the above graph, it is clear that the expected price is greater than the actual price in 2020-21. Also, there was a very large increase in May and April 2020.

4.1.3. HSCODE-0303

Fig 4.11 depicts the time series plot of commodities in hscode-0303 of exports. It is visible that there is a trend. The export of hscode-0303 was found to be increasing in 2007-18 but started to decrease in 2019.

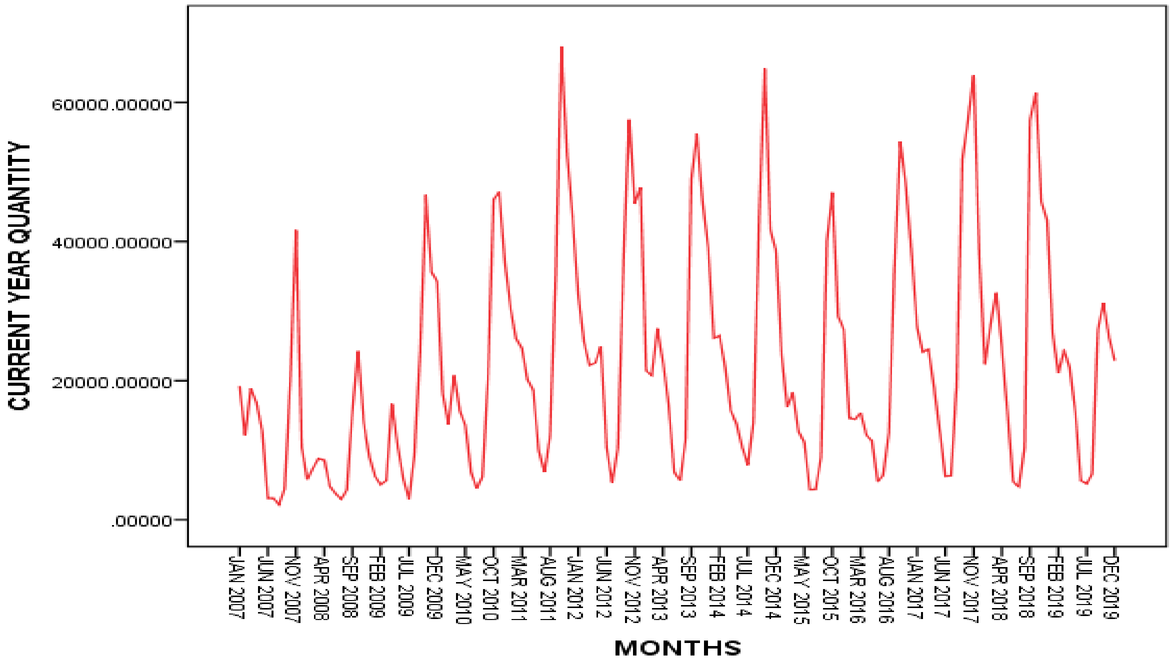


Fig 4.11: Time series plot of commodities in hscode-0303 of export from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0303 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (0,0,4) (0,1,1) [12]. The model coefficients are given in Table 4.5.

Table 4.5: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0303 of export.

ARIMA (0,0,4) (0,1,1) [12]	
AIC	2957.023
BIC	2977.812

According to Bayesian information criteria ARIMA (0,0,4) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.6.

Table 4.6: SARIMA models along with their corresponding parameters for the commodities in hscode-0303 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		833.03	672.85	1.238	.218
			MA	Lag 1	-0.693	.086	-6.642	.000
				Lag 2	-0.454	.093	-4.140	.000
				Lag 3	-0.280	.093	-3.972	.000
				Lag 4	-0.366	.087	-1.953	.053
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	. 0.563	.084	6.916	.000

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-12} + a_t - 0.693(0.563\ a_{t-13} - a_{t-1}) - 0.454(0.563\ a_{t-14} - a_{t-2}) - 0.280(0.563\ a_{t-15} - a_{t-3}) - 0.366(0.563a_{t-16} - a_{t-4}) \quad (4.3)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.9504. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.04671. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 1.53e-05. Therefore, the fitted model satisfies all the required assumptions.

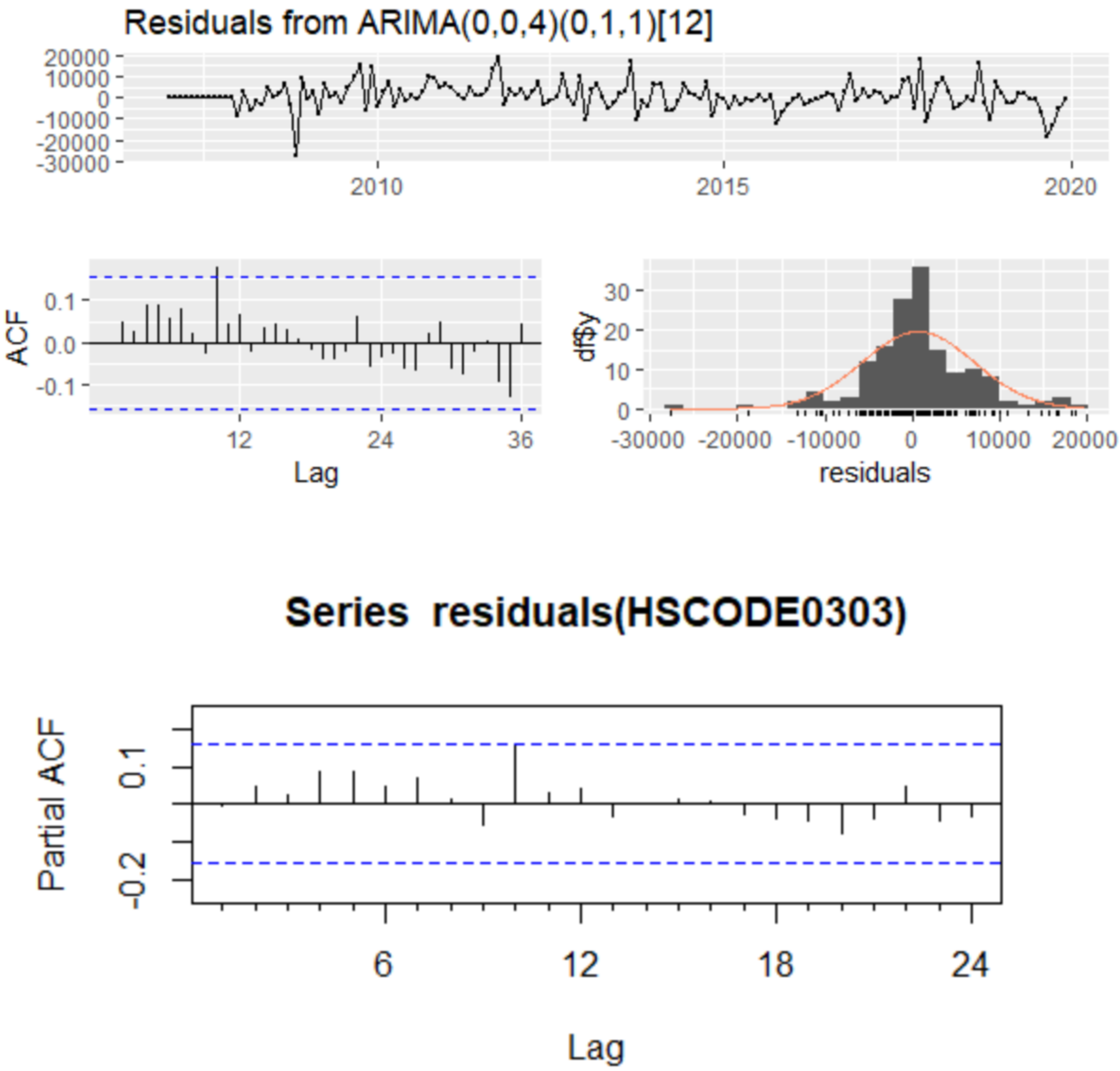


Fig.4.12:ACF,PACF and Histogram plot of residuals of commodities in hscode-0303 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

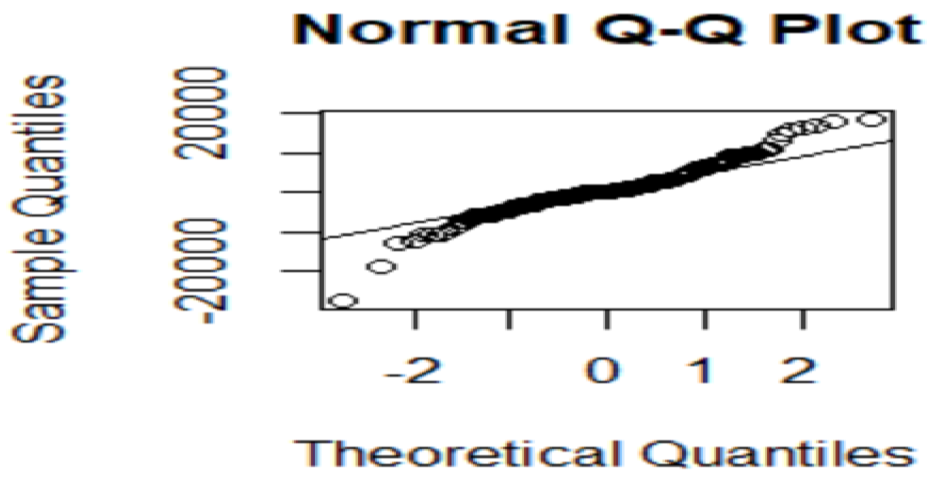


Fig.4.13:Q-Q plot of residuals of commodities in hscode-0303 of export.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (0, 0, 4) × (0, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0303 for the next 24 months is forecasted using the ARIMA (0,0,4) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.14 depicts the forecasted quantity of commodities in hscode-0303 of export.

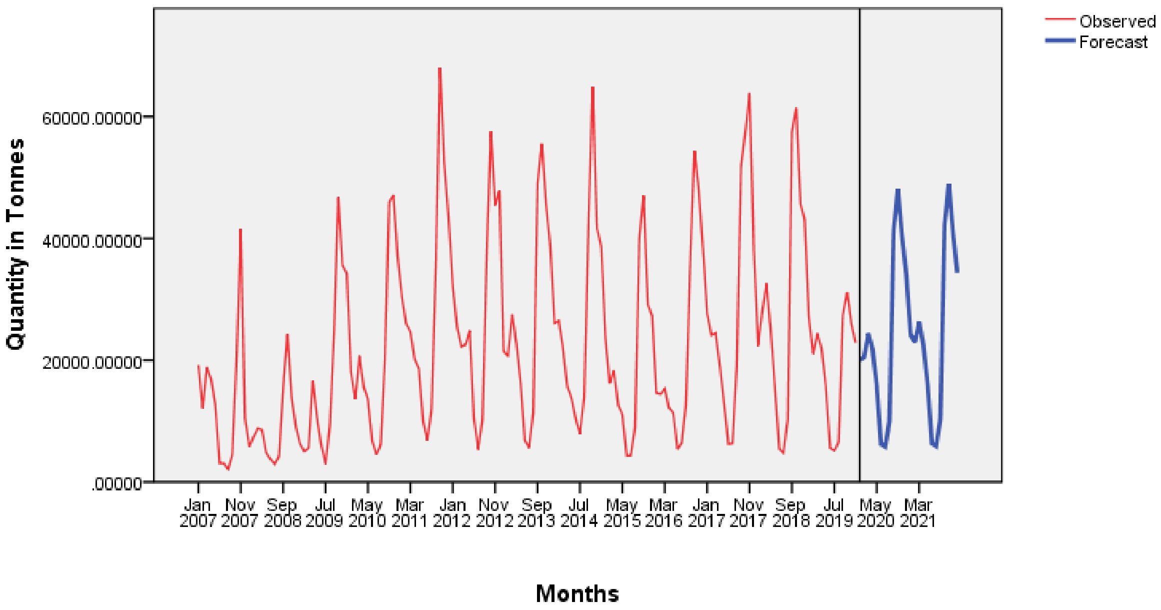


Fig.4.14:forecasted value(quantity) plot of commodities in hscode-0303 of export from 2007 to 2021.

From the above graph, it is clear that there is trend in 2020 and 2021.

Fig 4.15 shows the actual and fitted prices plot of commodities in hscode-0303 of export. The blue line shows the actual values and the orange line shows the fitted values.

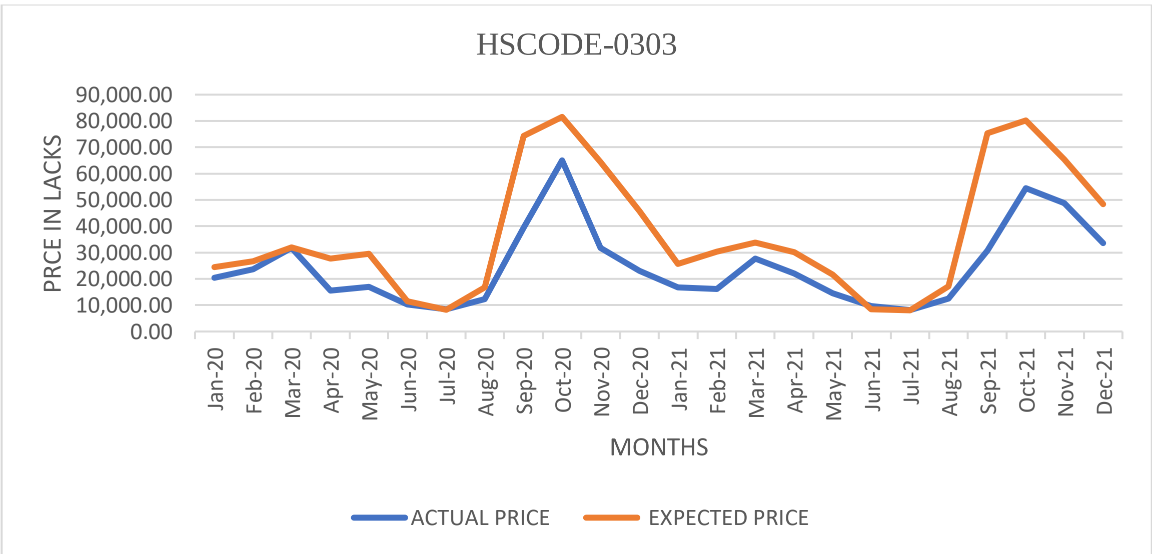


Fig.4.15:actual and expected price(quantity) plot of commodities in hscode-0303 of export from 2020 to 2021.

From the above graph, it is clear that the expected price is greater than the actual price in 2020-21. Also, there is large increase in October 2020 and October 2021.

4.1.4. HSCODE-0304

Fig 4.16 depicts the time series plot of commodities in hscode-0304 of exports. It is visible that there is a trend. The export of hscode-0304 was found to be increasing in 2011-13 but started to decrease in 2014-19.

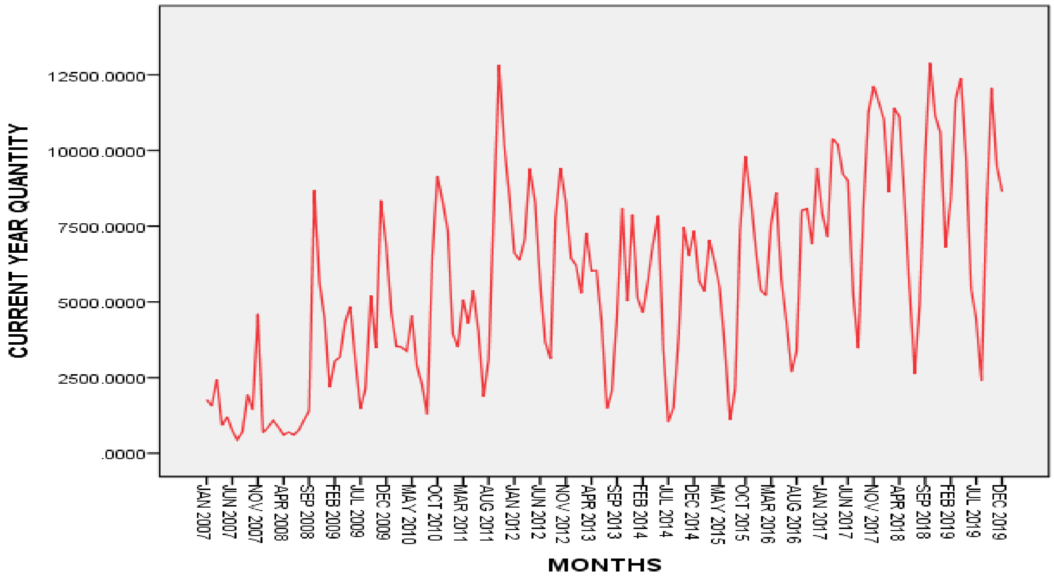


Fig 4.16: Time series plot of commodities in hscode-0304 of export from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0304 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,0,1) (0,1,1) [12]. The model coefficients are given in Table 4.7.

Table 4.7: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0304 of export.

ARIMA (1,0,1) (0,1,1) [12]	
AIC	2524.82
BIC	2536.7

According to Bayesian information criteria ARIMA (1,0,1) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.8

Table 4.8: SARIMA models along with their corresponding parameters for the commodities in hscode-0304 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		521.972	152.958	3.413	.001
			AR	Lag 1	.828	.078	10.561	.000
			MA	Lag 1	.412	.125	3.295	.001
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	.700	.083	8.488	.000

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-13} + 0.828(Z_{t-1} + Z_{t+13}) + a_t - 0.7\, a_{t-12} - 0.412(a_{t-1} + a_{t-13}) \qquad (4.4)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.8535. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 0.004194. Therefore, the fitted model satisfies all the required assumptions.

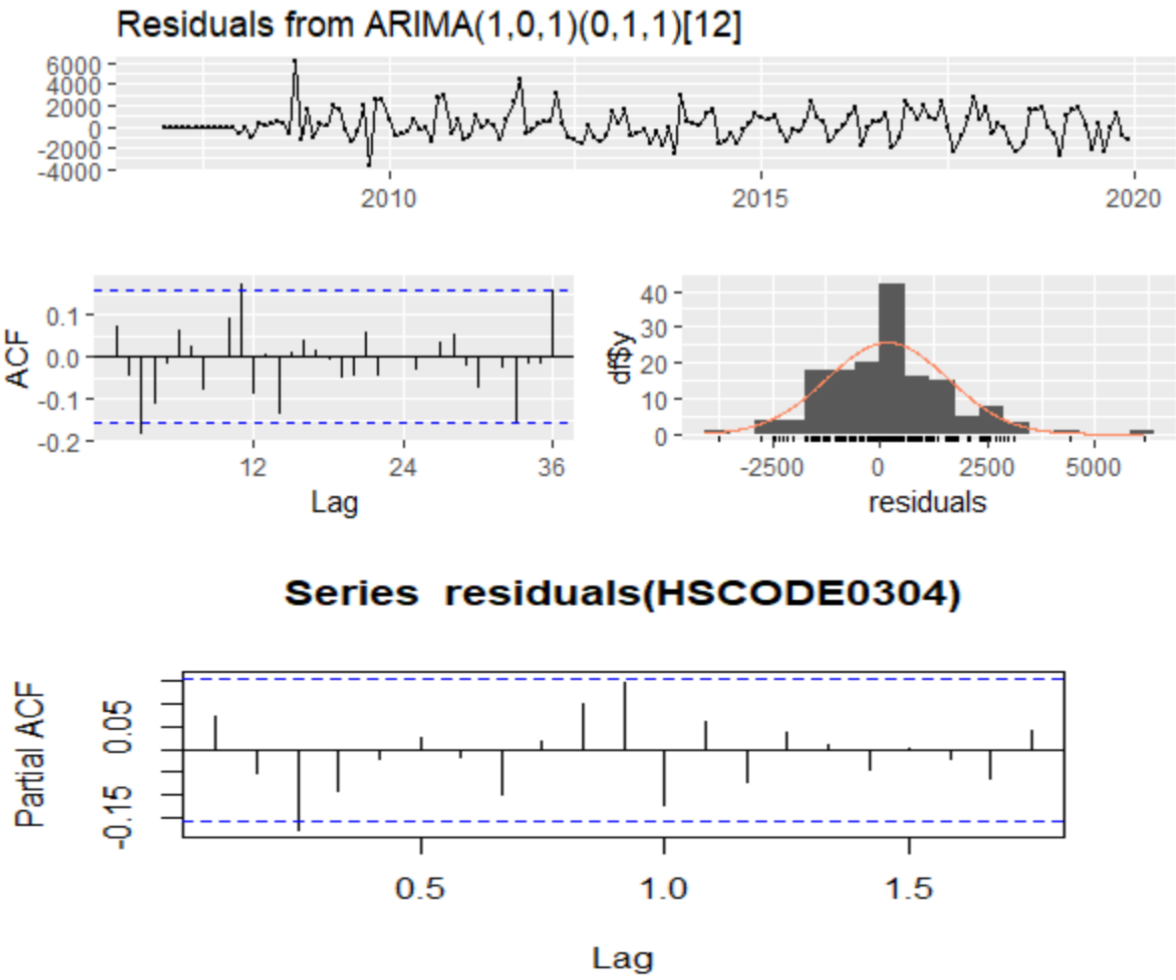


Fig.4.17:ACF,PACF and Histogram plot of residuals of commodities in hscode-0304 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

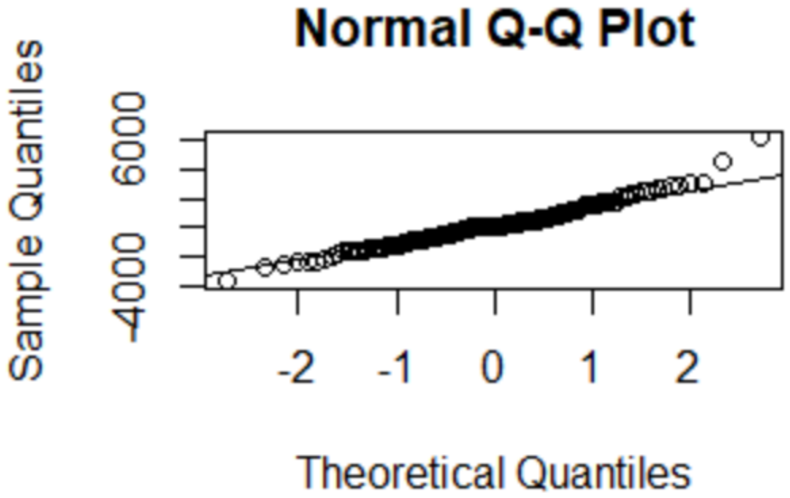


Fig.4.18:Q-Q plot of residuals of commodities in hscode-0304 of export.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 0, 1) × (0, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0304 for the next 24 months is forecasted using the ARIMA (1,0,1) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.19 depicts the forecasted quantity of commodities in hscode-0304 of export.

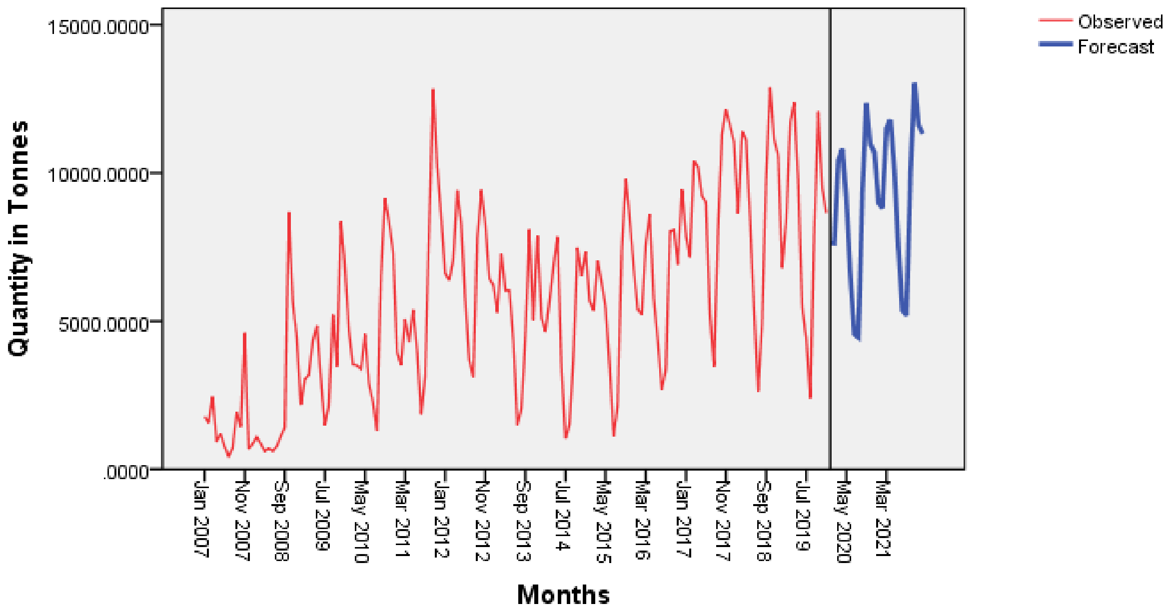


Fig.4.19:forecasted value(quantity) plot of commodities in hscode-0304 of export from 2007 to 2021

From the above graph, it is clear that there is a trend in 2020 and 2021.

Fig 4.20 shows the actual and fitted prices plot of commodities in hscode-0304 of export. The blue line shows the actual values and the orange line shows the fitted values.

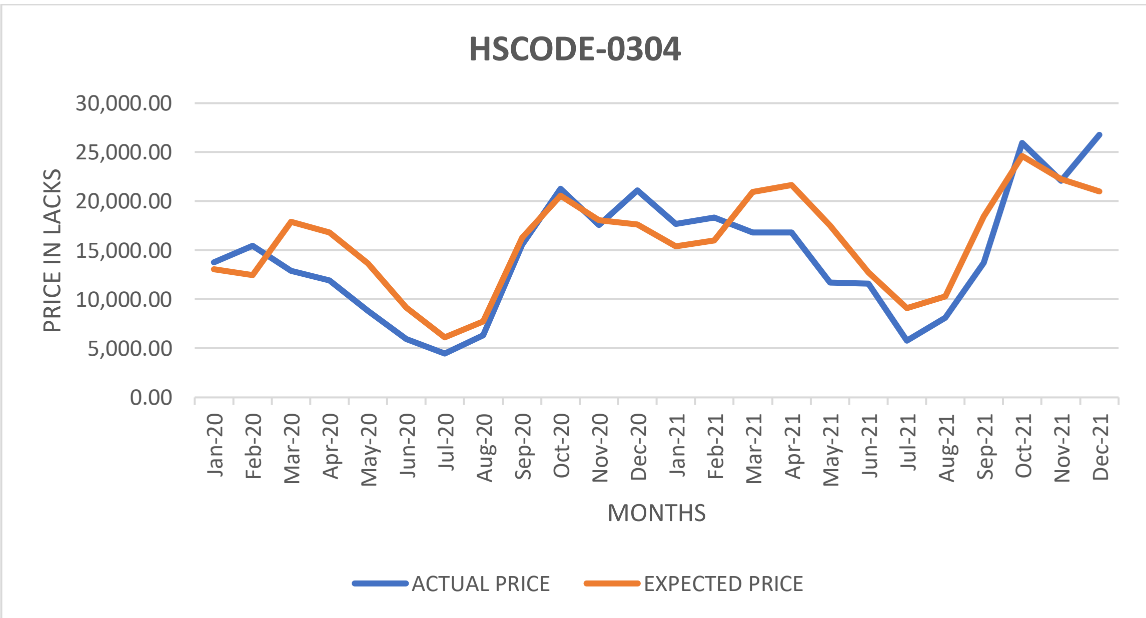


Fig.4.20:actual and expected price(quantity) plot of commodities in hscode-0304 of export from 2020 to 2021

From the above graph, it is clear that the expected price is greater than the actual price in almost every month. But a large decrease was seen in December 2021.

4.1.5. HSCODE-0305

Fig 4.21 depicts the time series plot of commodities in hscode-0305 of exports. It is visible that there is a trend. The export of hscode-0305 was found to be increasing in 2018-19 but started to decrease in 2019.

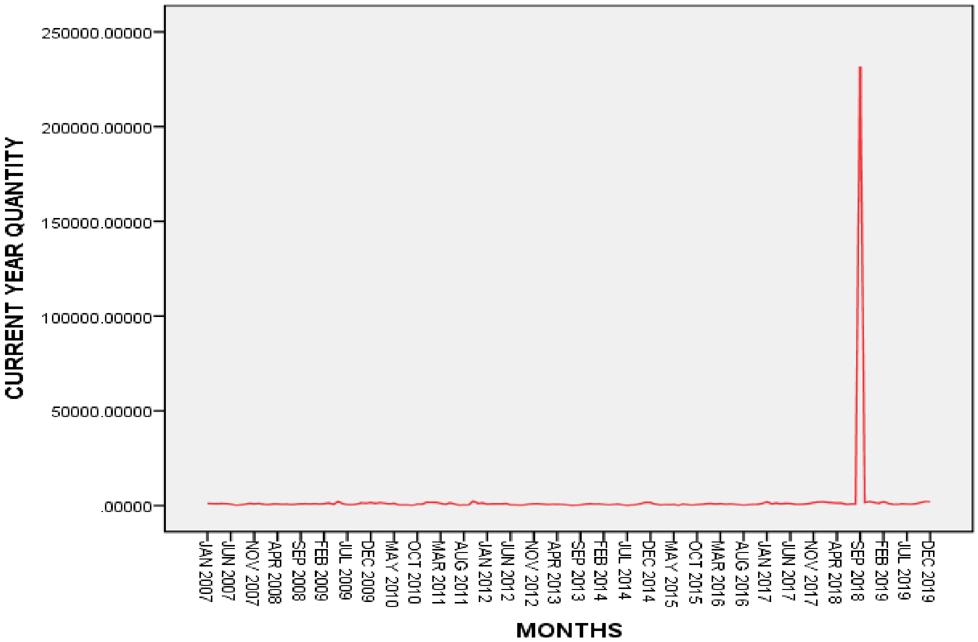


Fig 4.21: Time series plot of commodities in hscode-0305 of export from 2007 to 2019.

Different types of time series models were fitted to the fish dried salted or in brine; smoked fish cooked or not before or during the smoking process; fish meal fit for consumption export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,0,0) (1,0,1) [12]. The model coefficients are given in table 4.9.

Table 4.9: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0305 of export.

ARIMA (1,0,0) (1,0,1) [12]	
AIC	3517.213
BIC	3532.462

According to Bayesian information criteria ARIMA (1,0,1) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.10.

Table 4.10: SARIMA models along with their corresponding parameters for the commodities in hscode-0305 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		2302.273	1934.997	1.190	.236
			AR	Lag 1	-.004	.081	-.050	.960
			AR, Seasonal	Lag 1	.976	4.574	.213	.831
			MA, Seasonal	Lag 1	.997	17.256	.058	.954

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1}0.976 + 0.004(Z_{t-1} - 0.976\, Z_{t-2}) + a_t - 0.997\, a_{t-12} \qquad (4.5)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.9803. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 2.2e-16. Therefore, the fitted model satisfies all the required assumptions.

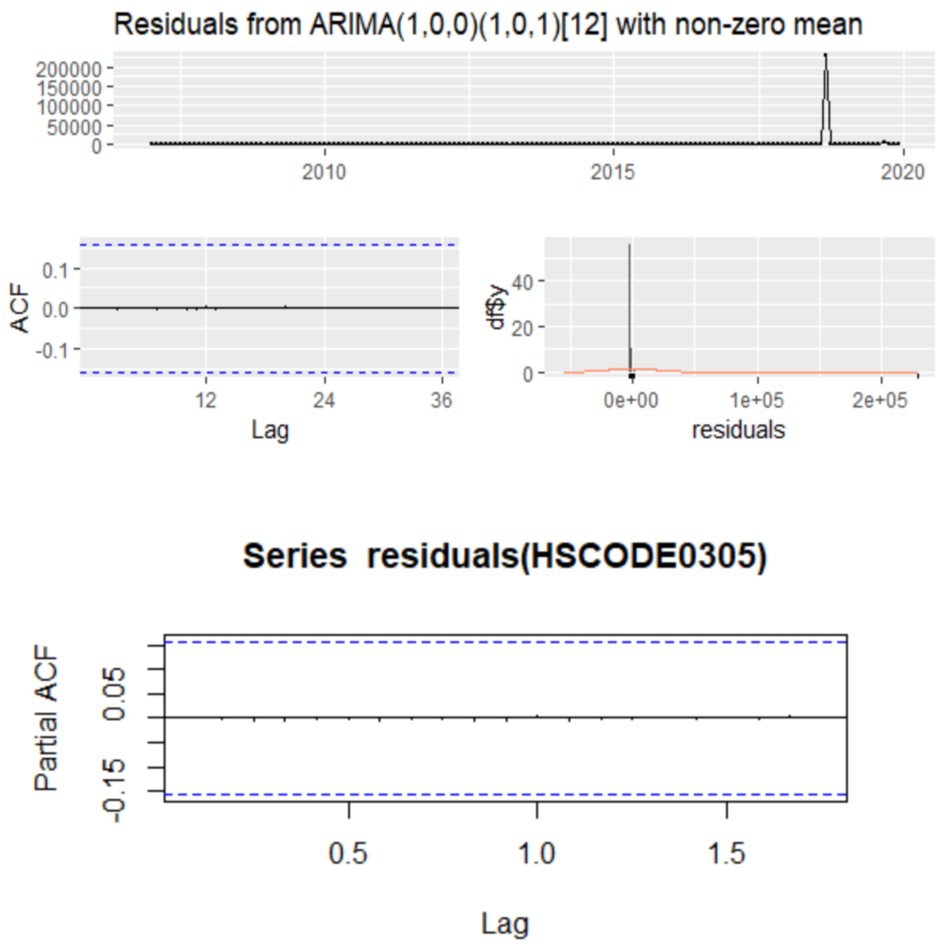


Fig.4.22:ACF,PACF and Histogram plot of residuals of commodities in hscode-0305 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

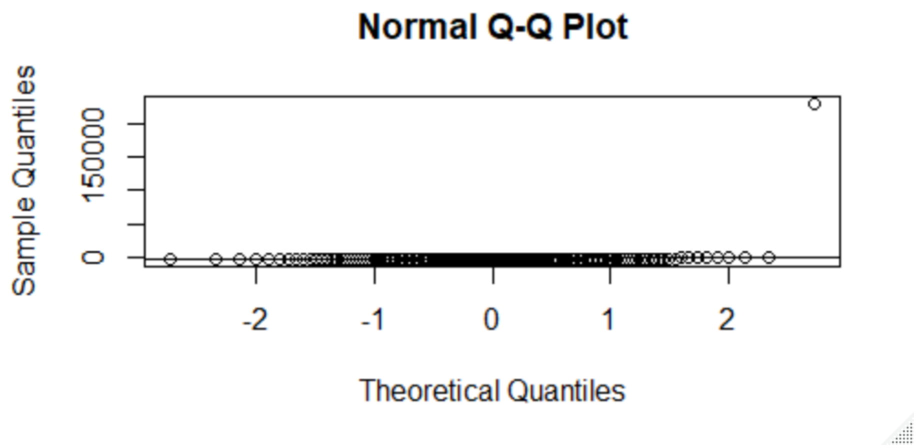


Fig.4.23:Q-Q plot of residuals of commodities in hscode-0305 of export

Also, from the above normal Q-Q plot, it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 0, 0) × (1, 0, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0305 for the next 24 months is forecasted using the ARIMA (1,0,0) (1,0,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.19 depicts the forecasted quantity of commodities in hscode-0305 of export.

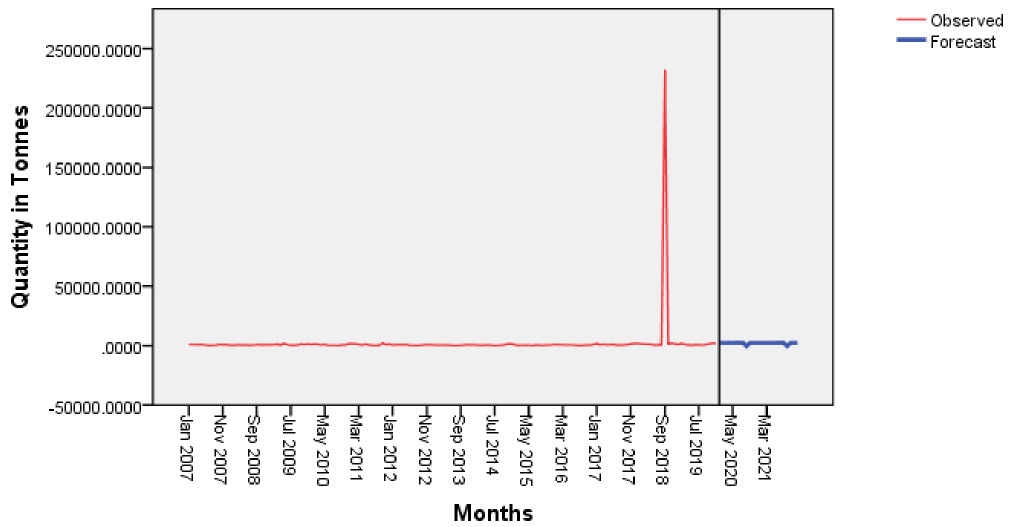


Fig.4.24:forecasted value(quantity) plot of commodities in hscode-0305 of export from 2007 to 2021

From the above graph it is clear that there is a linear trend in 2020 and 2021.

Fig 4.25 shows the actual and fitted prices plot commodities in hscode-0305 of export. The blue line shows the actual values and the orange line shows the fitted values.

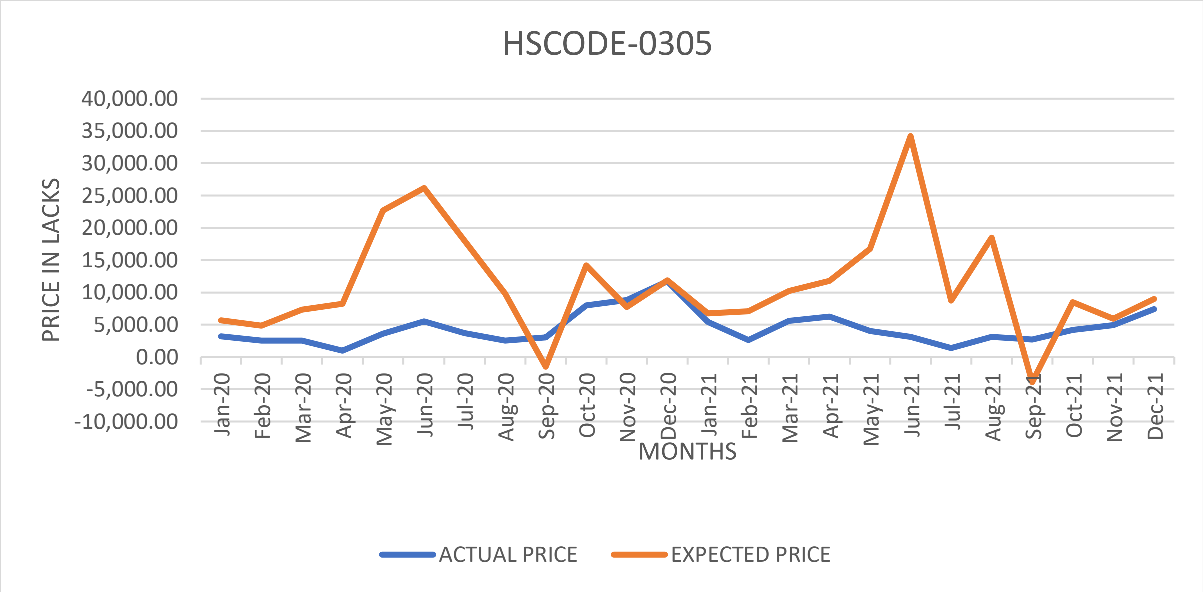


Fig.4.25:actual and expected price(quantity) plot of commodities in hscode-0305 of export from 2020 to 2021

From the above graph, it is clear that in most of months the expected price is greater than the actual price in 2020 and 2021. Also, there was large increase in June 2020 and 2021.

4.1.6. HSCODE-0306

Fig 4.26 depicts the time series plot of commodities in hscode-0306 of export. It is visible that there is a trend. The export of hscode-0306 was found to be increasing in 2007-19 but started to decrease in 2019.

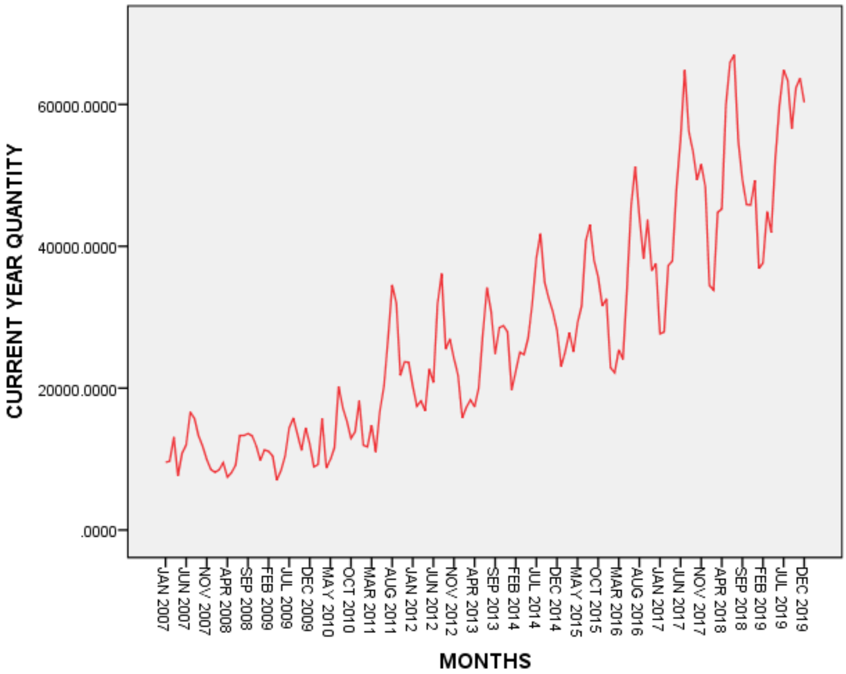


Fig 4.26: Time series plot of commodities in hscode-0306 of export from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0306 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,1,1) (0,1,1) [12]. The model coefficients are given in table 4.11.

Table 4.11: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0306 of export.

ARIMA (1,1,1) (0,1,1) [12]	
AIC	2736.445
BIC	2748.296

According to Bayesian information criteria ARIMA (1,1,1) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.12.

Table 4.12: SARIMA models along with their corresponding parameters for the commodities in hscode-0306 of export.

ARIMA Model Parameters

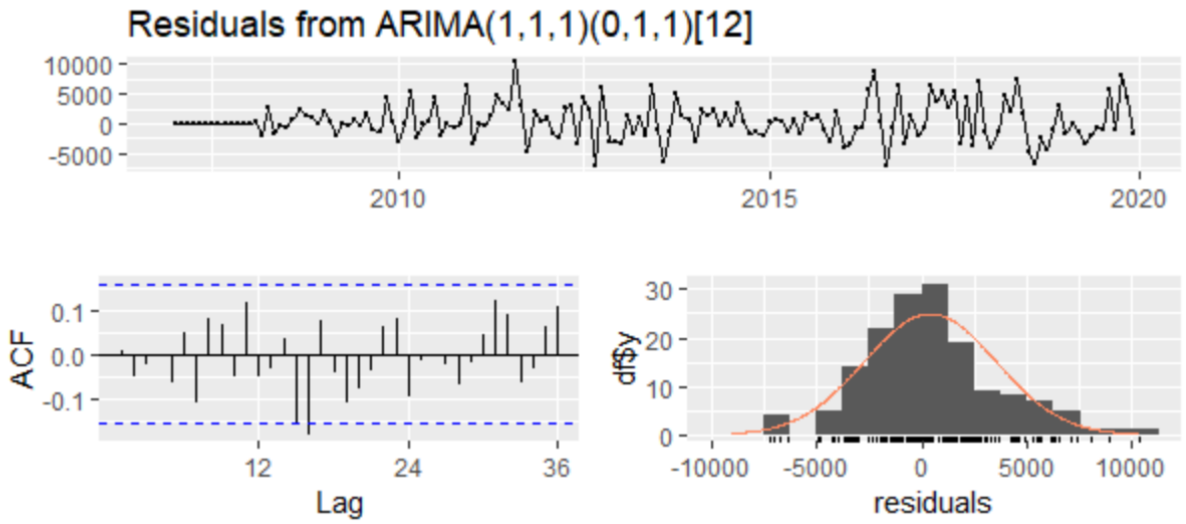
					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		37.987	13.020	2.918	.004
			AR	Lag 1	.705	.078	8.984	.000
			Difference		1			
			MA	Lag 1	.997	.310	3.213	.002
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	.552	.081	6.808	.000

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} - 0.705(Z_{t-1} - Z_{t-13} - Z_{t-2} - Z_{t-13}) + a_t - 0.997\, a_{t-1} - 0.552(a_{t-12} - 0.997a_{t-13}) \quad (4.6)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.9478. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 0.004609. Therefore, the fitted model satisfies all the required assumptions.



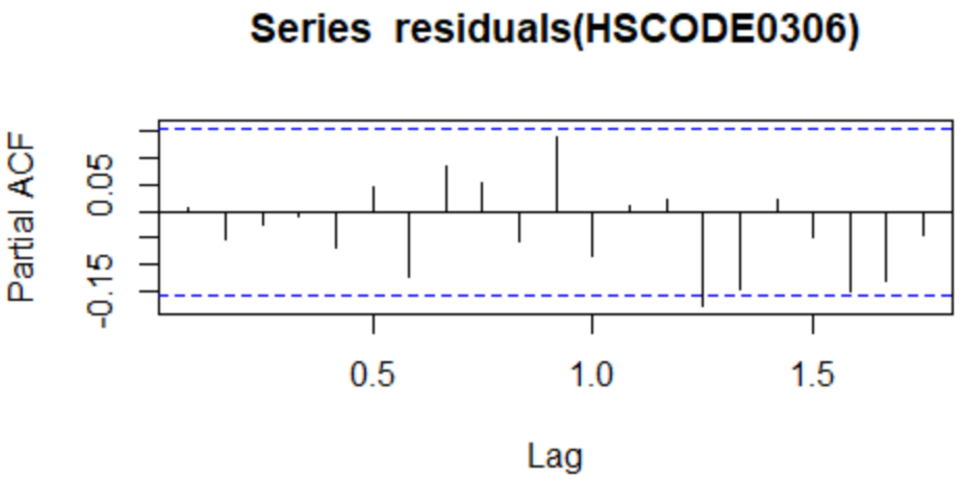


Fig.4.27:ACF,PACF and Histogram plot of residuals of commodities in hscode-0306 of export.

From the above PACF and histogram plot, it can be concluded that see that it is normally distributed. Therefore, the distribution of the residuals is normal.

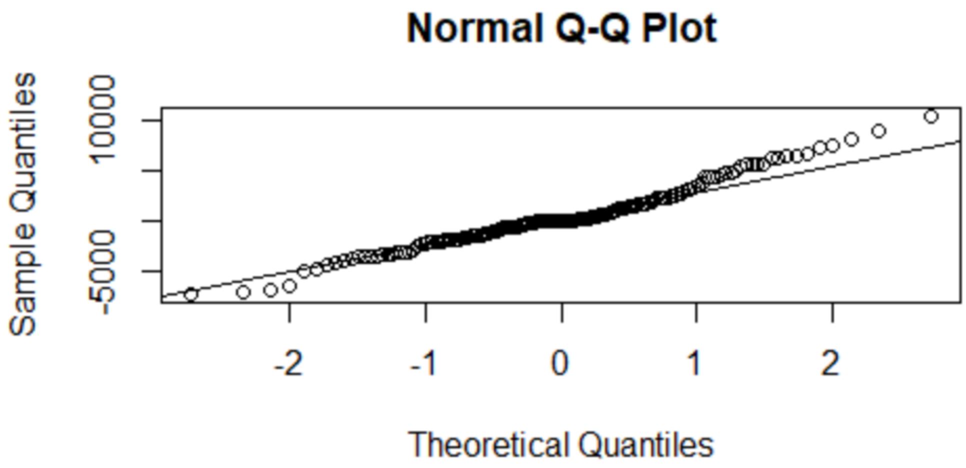


Fig.4.28:Q-Q plot of residuals of commodities in hscode-0306 of export.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 1, 1) × (0, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0306 for the next 24 months is forecasted using the ARIMA (1,1,1) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.29 depicts the forecasted quantity of commodities in hscode-0306 of export.

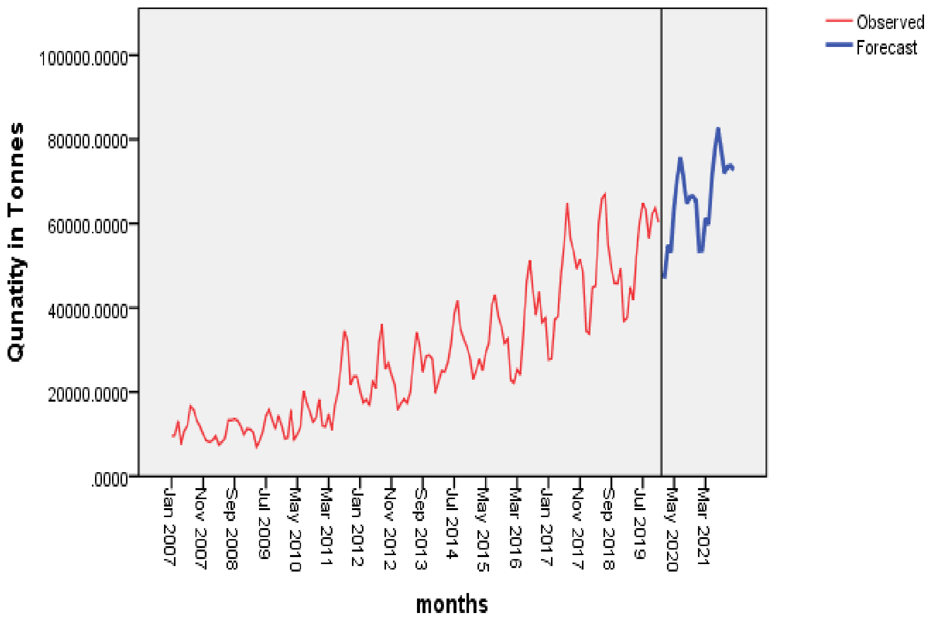


Fig.4.29:forecasted value(quantity) plot of commodities in hscode-0306 of export from 2007 to 2021.

From the above graph, it is clear that there is trend in 2020 and 2021.

Fig 4.30 shows the actual and fitted prices plot commodities in hscode-0306 of export. The blue line shows the actual values and the orange line shows the fitted values.

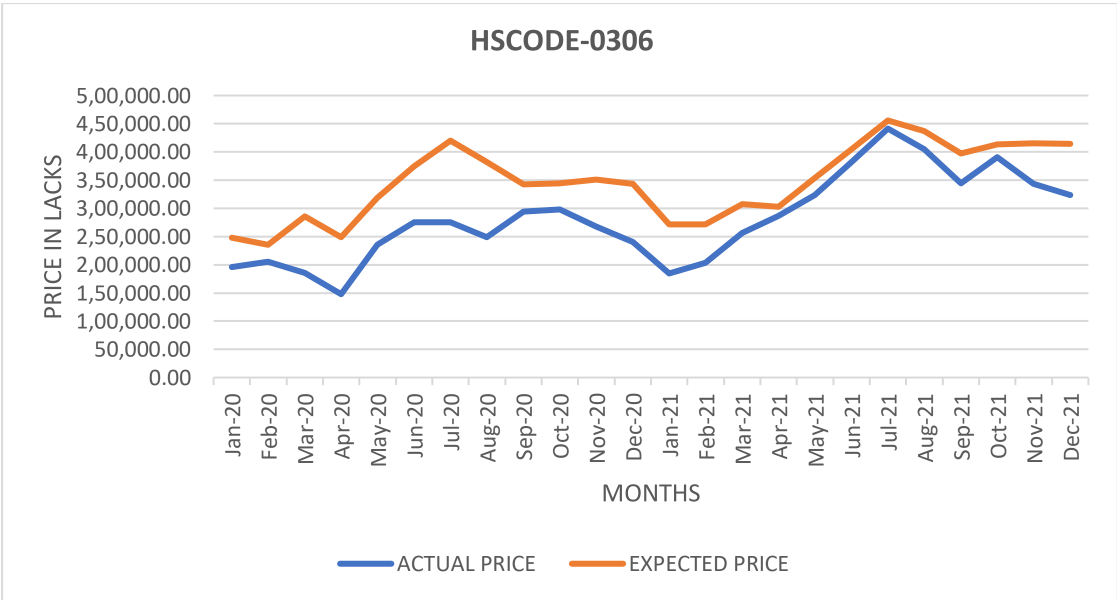


Fig.4.30:actual and expected price(quantity) plot of commodities in hscode-0306 of export from 2020 to 2021.

From the above graph it is clear that expected price is greater than actual price in 2020-21. Also, there is a linear increase in December 2021.

4.1.7. HSCODE-0307

Fig 4.31 depicts the time series plot of commodities in hscode-0307 of export. It is visible that there is a trend. The export of hscode-0307 was found to be increasing in 2013-18 but started to decrease in 2019.

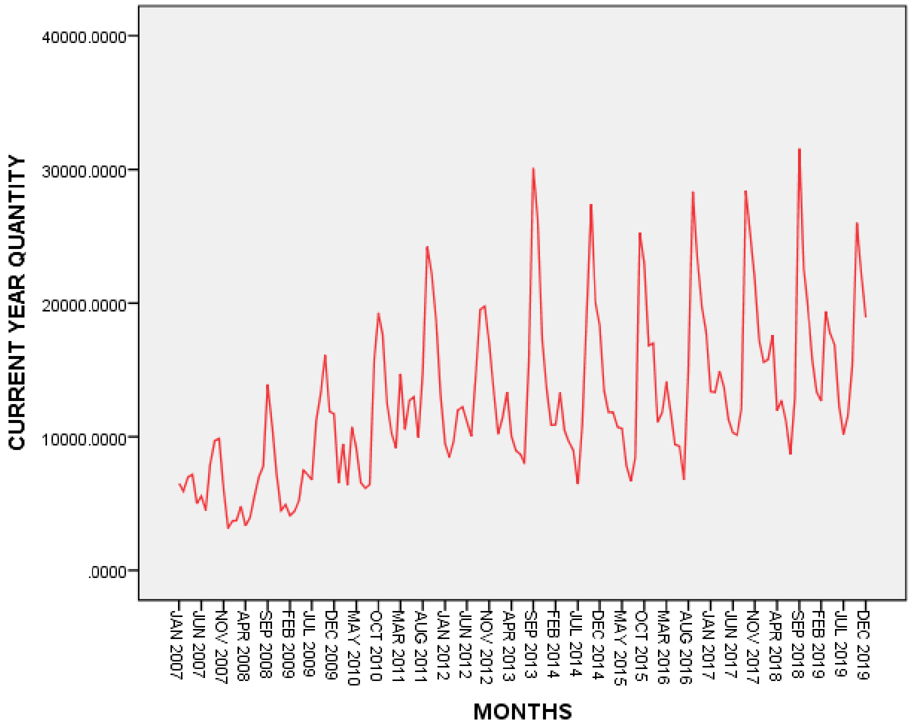


Fig 4.31: Time series plot of commodities in hscode-0307 of export from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0307 of export from India for the years 2007 to 2019 and the best model was selected. Then the future exports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,0,2) (0,1,1) [12]. The model coefficients are given in table 4.13.

Table 4.13: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0307 of export.

ARIMA (1,0,2) (0,1,1) [12]	
AIC	2702.508
BIC	2717.357

According to Bayesian information criteria ARIMA (1,0,2) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.14.

Table 4.14: SARIMA models along with their corresponding parameters for the commodities in hscode-0307 of export.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	Natural Log	Constant		.076	.016	4.735	.000
			AR	Lag 1	.660	.116	5.702	.000
			MA	Lag 1	.090	.133	.674	.502
				Lag 2	-.195	.106	-1.846	.067
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	.819	.088	9.273	.000

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-12} - 0.660(Z_{t-1} + Z_{t-13}) + (a_t - (0.660\ a_t * 0.090\ a_{t-2})\ (a_t - 0.819\ a_{t-12})) \tag{4.7}$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.6651. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 2.23e-07. Therefore, the fitted model satisfies all the required assumptions.

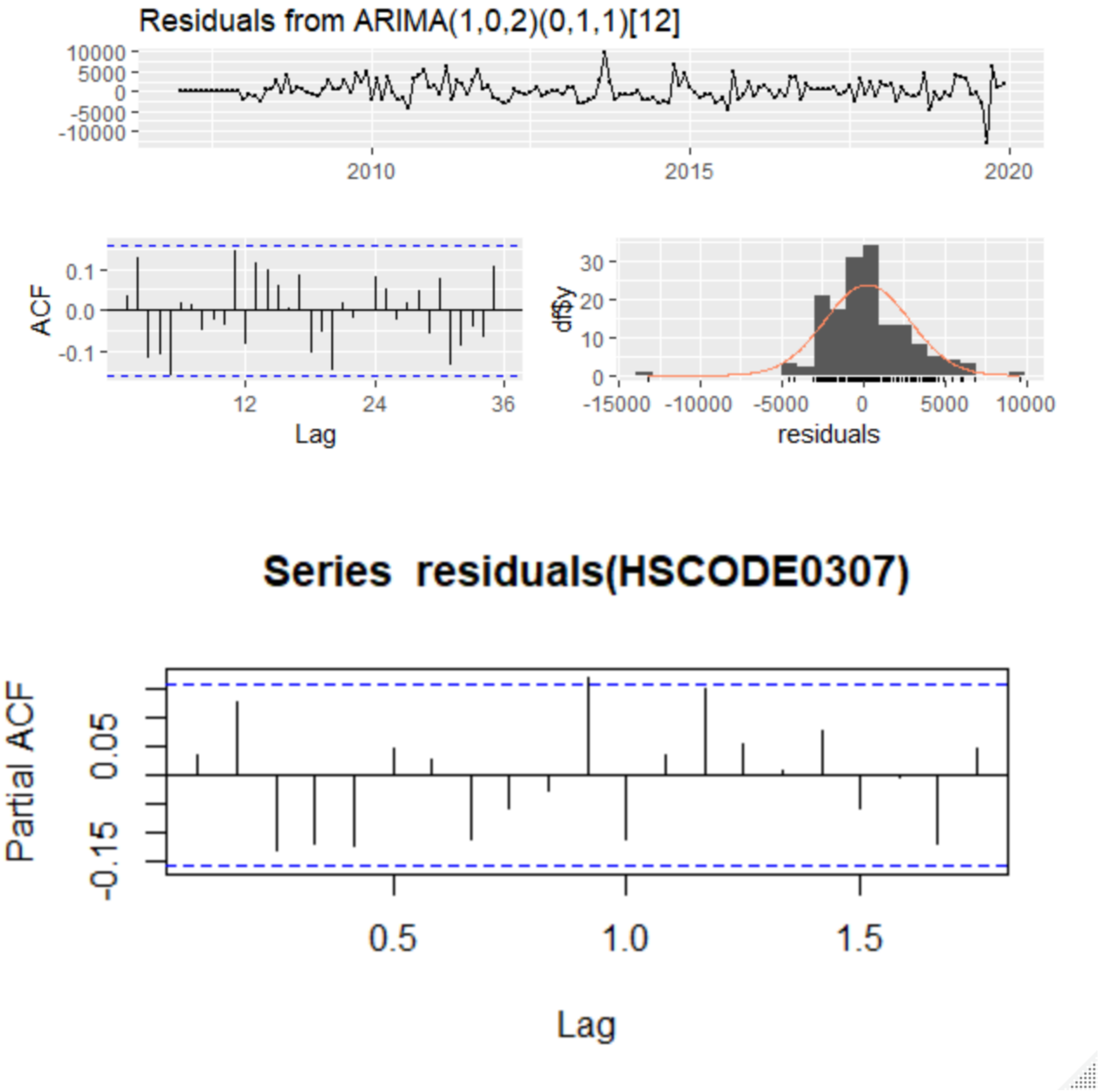


Fig.4.32:ACF,PACF and Histogram plot of residuals of commodities in hscode-0307 of export.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

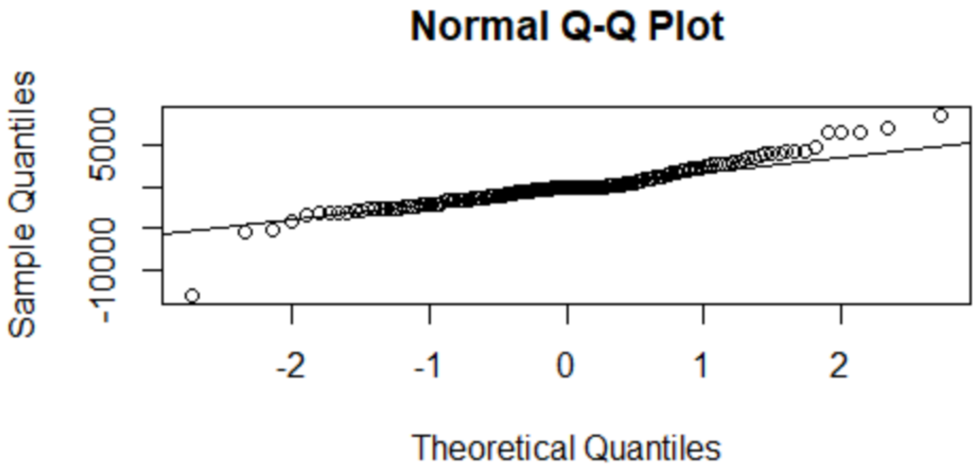


Fig.4.33:Q-Q plot of residuals of commodities in hscode-0307 of export.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 0, 2) × (0, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The export of hscode-0307 for the next 24 months is forecasted using the ARIMA (1,0,2) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.29 depicts the forecasted quantity of commodities in hscode-0307 of export.

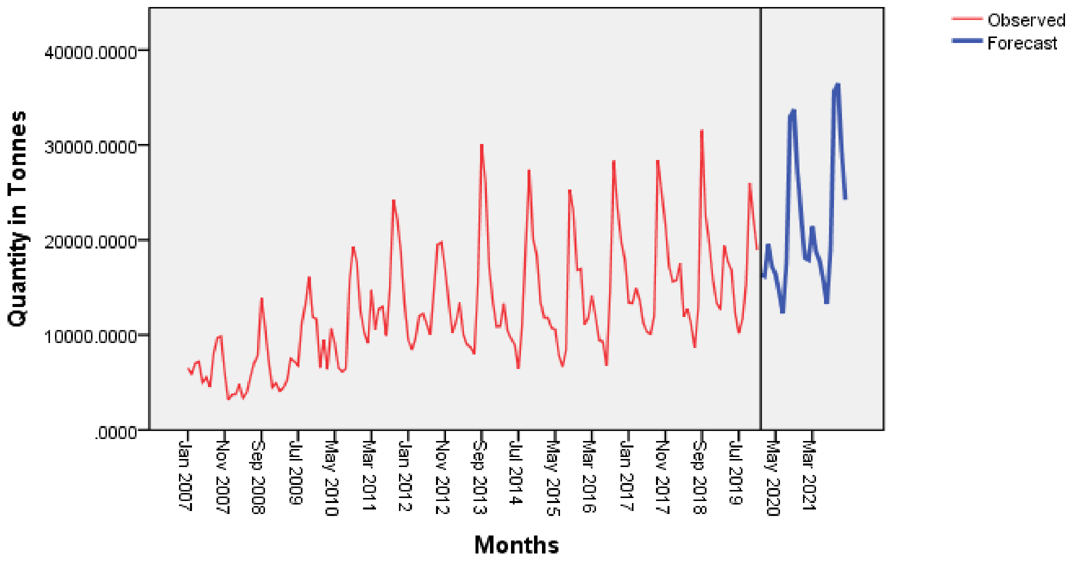


Fig.4.34:forecasted value(quantity) plot of commodities in hscode-0307 of export from 2007 to 2021.

From the above graph, it is clear that there is a trend in 2020 and 2021.

Fig 4.35 shows the actual and fitted prices plot of commodities in hscode-0307 of export. The blue line shows the actual values and the orange line shows the fitted values.

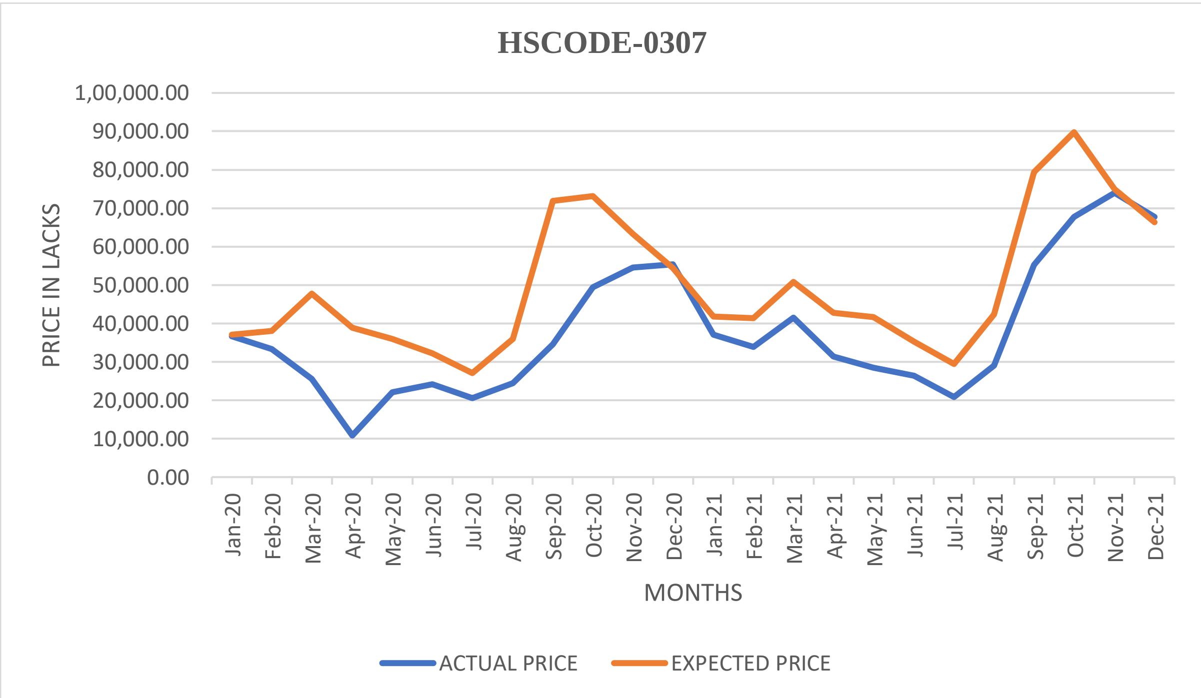


Fig.4.35:actual and expected price(quantity) plot of commodities in hscode-0307 of export from 2020 to 2021

From the above graph it is clear that, in almost all month the expected price is greater than actual price. Also, there was a very large increase in October 2020 and 2021.

4.2. TIME SERIES ANALYSIS OF THE IMPORT OF FISH AND FISHERIES PRODUCTS TO INDIA

This sector discusses the time series modelling of import of fish and fisheries products to India (quantity in ton) based on the data taken from 2007 to 2021 of 15 years.

4.2.1. HSCODE-0301

Fig 4.36 depicts the time series plot of commodities in hscode-0301 of imports. It is visible that there is a trend. The import of hscode-0301 was found to be increasing in 2017-18 but started to decrease in 2019.

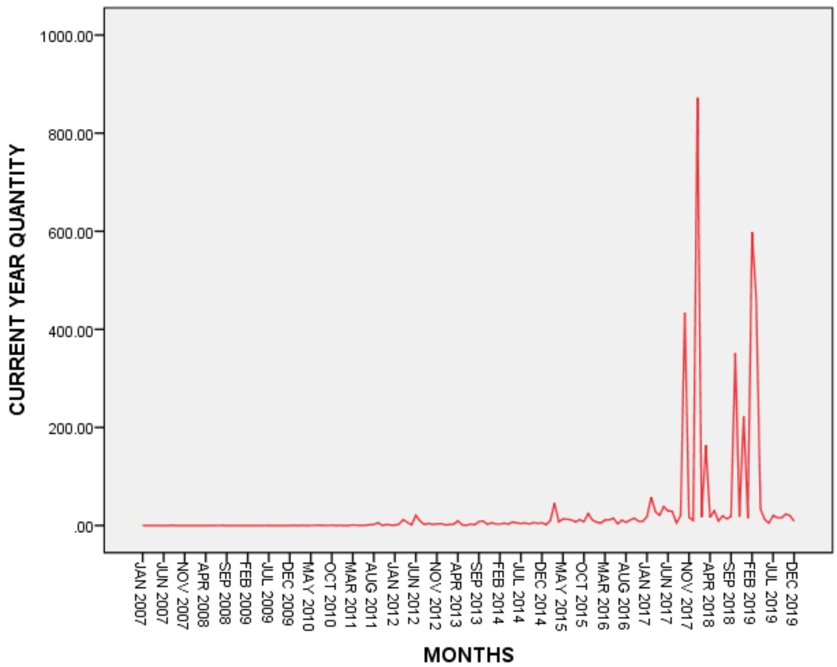


Fig 4.36: Time series plot of commodities in hscode-0301 of import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0301 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented:

The best fitted model was ARIMA (0,1,1) (1,0,0) [12]. The model coefficients are given in table 4.15.

Table 4.15: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0301 of import.

ARIMA (0,1,1) (1,0,0) [12]	
AIC	1868.4
BIC	1877.535

According to Bayesian information criteria ARIMA (0,1,1) (1,0,0) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.16.

Table 4.16: SARIMA models along with their corresponding parameters for the commodities in hscode-0301 of import.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		0.525	.730	1.304	.194
			Difference		1			
			MA	Lag 1	.943	.029	32.774	.000
			AR, Seasonal	Lag 1	.044	.99	.441	.660

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} - 0.943(Z_{t-1} - Z_{t-2}) + a_t - 0.044\, a_{t-1} \tag{4.9}$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.8557. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01Also, from the normal

Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 2.2e-16. Therefore, the fitted model satisfies all the required assumptions.

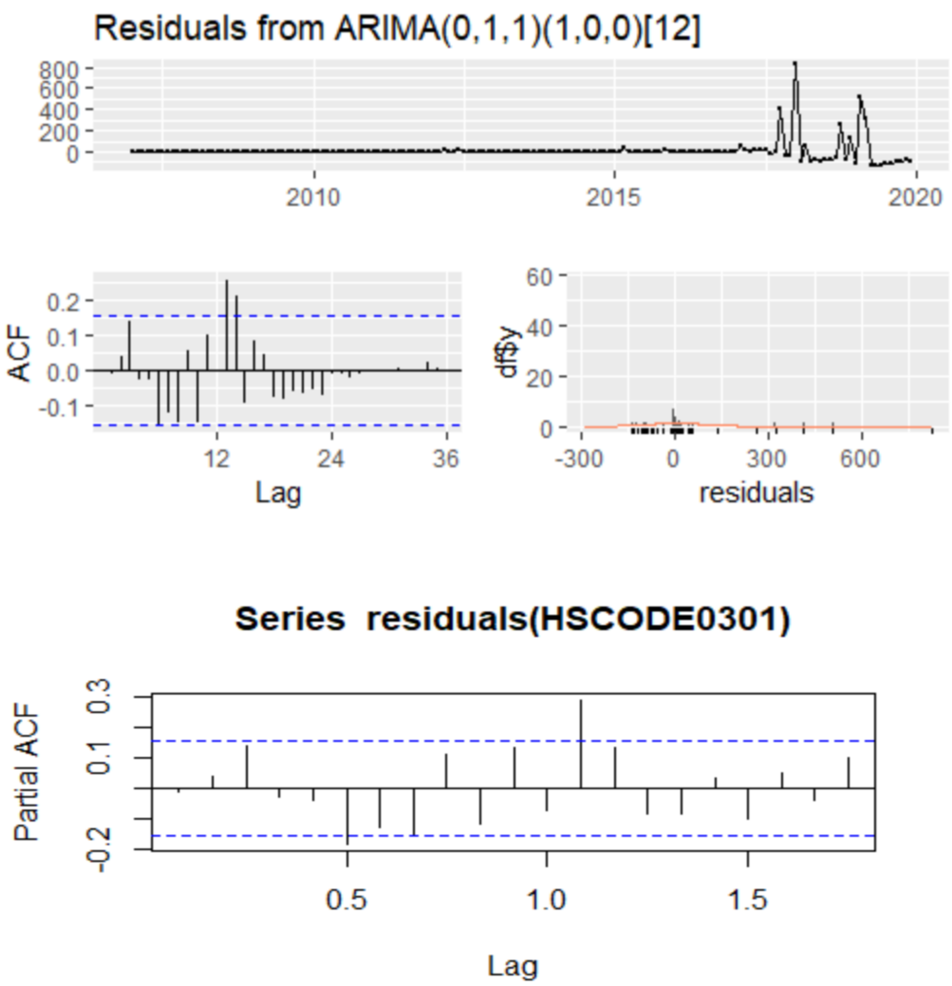


Fig.4.37: ACF,PACF and Histogram plot of residuals of commodities in hscode-0301 of import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

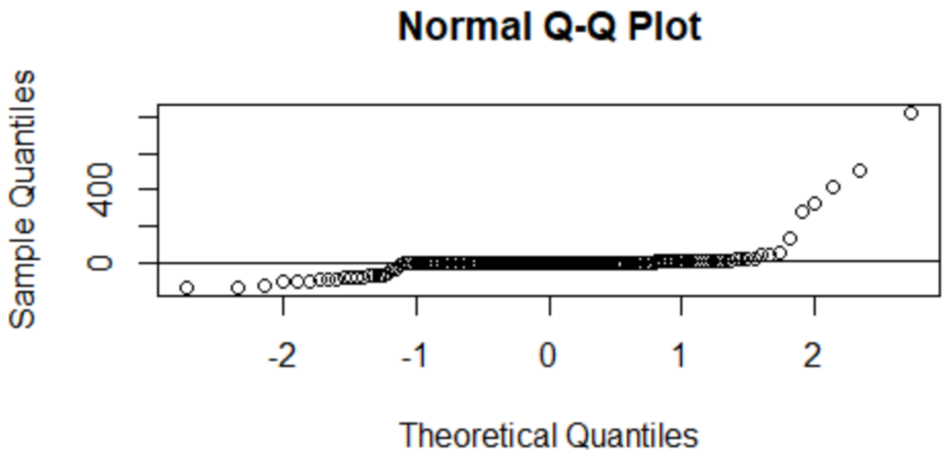


Fig.4.38: Q-Q plot of residuals of commodities in hscode-0301 of import.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (0, 1, 1) × (1, 0, 0) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0301 for the next 24 months is forecasted using the ARIMA (0,1,1) (1,0,0) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.39 depicts the forecasted quantity of commodities in hscode-0301 of import.

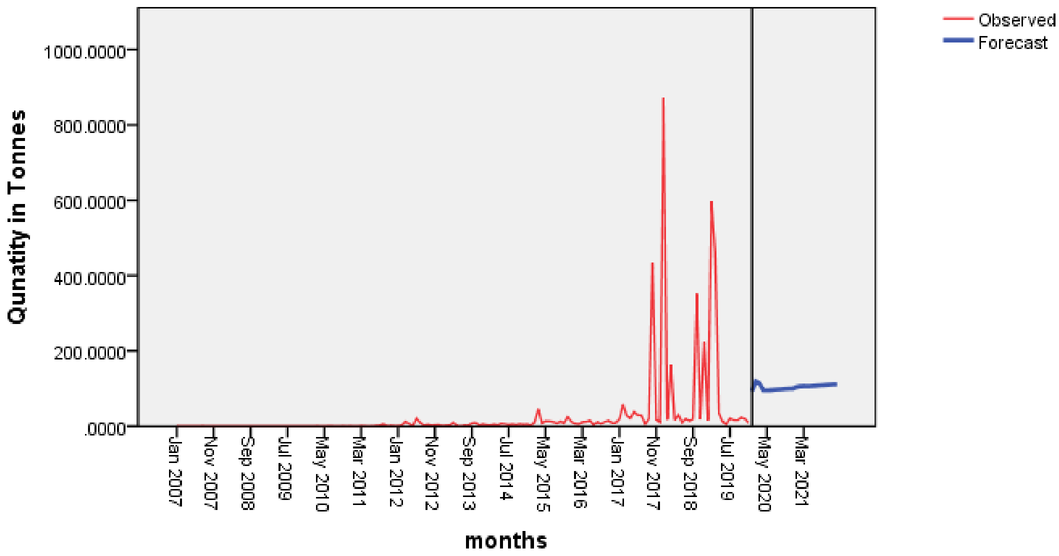


Fig.4.39:forecasted value(quantity) plot of commodities in hscode-0301 of import from 2007 to 2021

From the above graph it is clear that there is upward trend in 2020 and 2021.

Fig 4.40 shows the actual and fitted prices plot of commodities in hscode-0301 of import. The blue line shows the actual values and the orange line shows the fitted values.

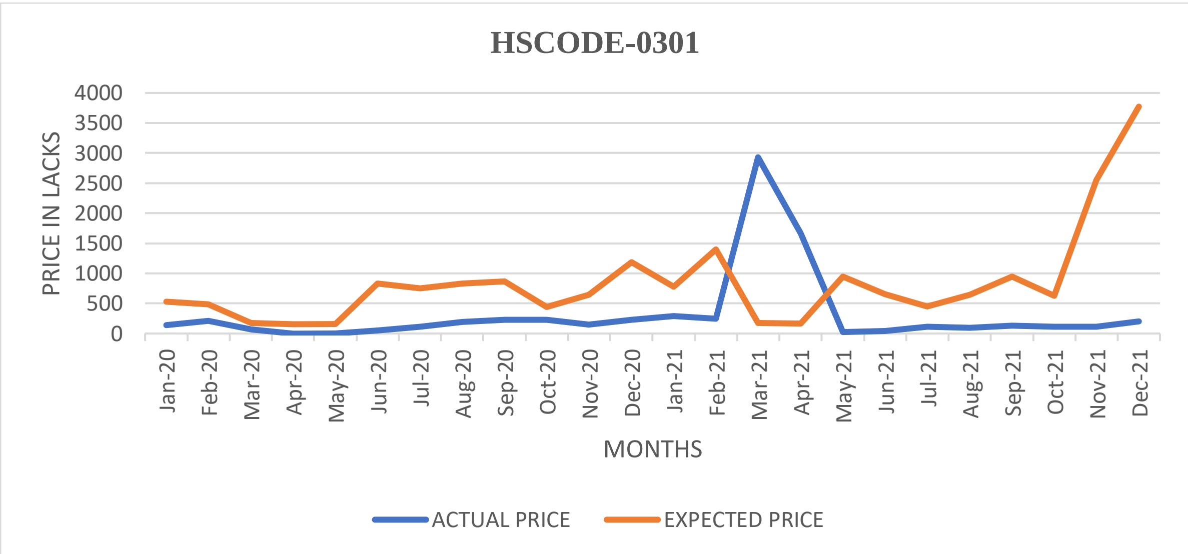


Fig.4.40:actual and expected price(quantity) plot of commodities in hscode-0301 of import from 2020 to 2021

From the above graph it is clear that, in almost all month the expected price is greater than actual price. Also, there was large increase in December 2021.

4.2.2. HSCODE-0302

Fig. 4.41 depicts the time series plot of commodities in hscode-0302 of import. It is visible that there is a trend. The import of hscode-0302 was found to be increasing in 2009-12 but started to decrease in 2018-19.

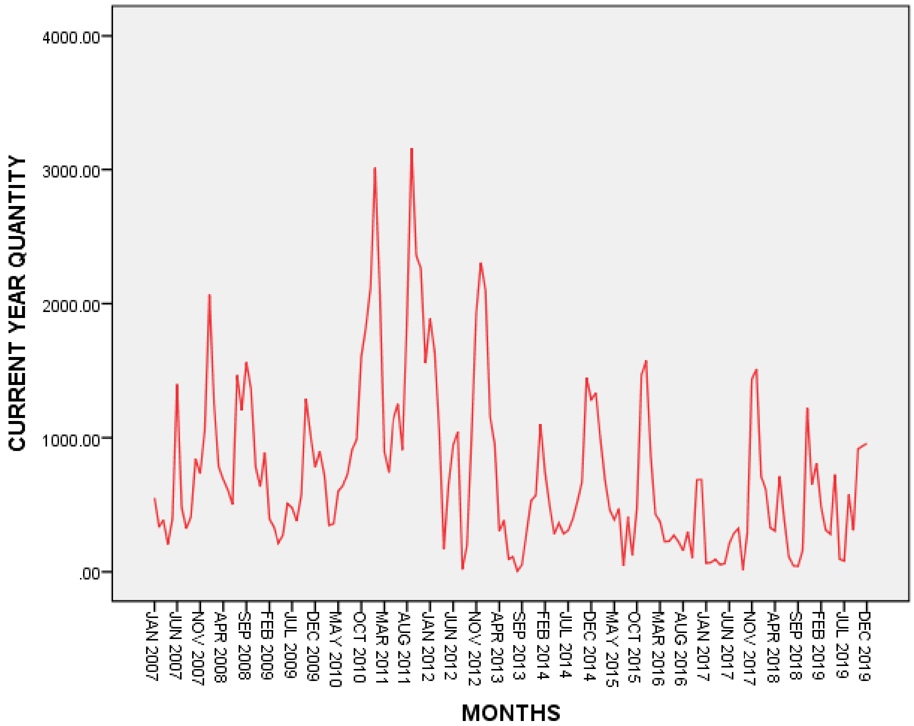


Fig 4.41: Time series plot of commodities in hscode-0302 of import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on commodities in hscode-0302 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (0,1,3) (2,0,1) [12]. The model coefficients are given in table 4.17.

Table 4.17: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0302 of import.

ARIMA (0,1,3) (2,0,1) [12]	
AIC	2300.794
BIC	2322.098

According to Bayesian information criteria ARIMA (0,1,3) (2,0,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.18

Table 4.18: SARIMA models along with their corresponding parameters for the commodities in hscode-0302 of import.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENTYEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		2.864	20.999	.136	.892
			Difference		1			
			MA	Lag 1	.184	.082	2.250	.026
				Lag 2	.319	.080	3.970	.000
				Lag 3	.170	.084	2.035	.044
			AR, Seasonal	Lag 1	.692	.217	3.195	.002
				Lag 2	.146	.125	1.175	.242
			MA, Seasonal	Lag 1	.574	.214	2.685	.008

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} - 0.692(Z_{t-1} + Z_{t-2}) - 0.146(Z_{t-1} + Z_{t-2}) + a_t - 0.574\, a_{t-12} - 0.814(a_{t-1} + 0.574\, a_{t-13}) - 0.319(a_{t-2} + 0.574\, a_{t-14}) - 0.170(a_{t-3} + 0.574\, a_{t-15}) \quad (4.9)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.9411. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 0.0005663. Therefore, the fitted model satisfies all the required assumptions.

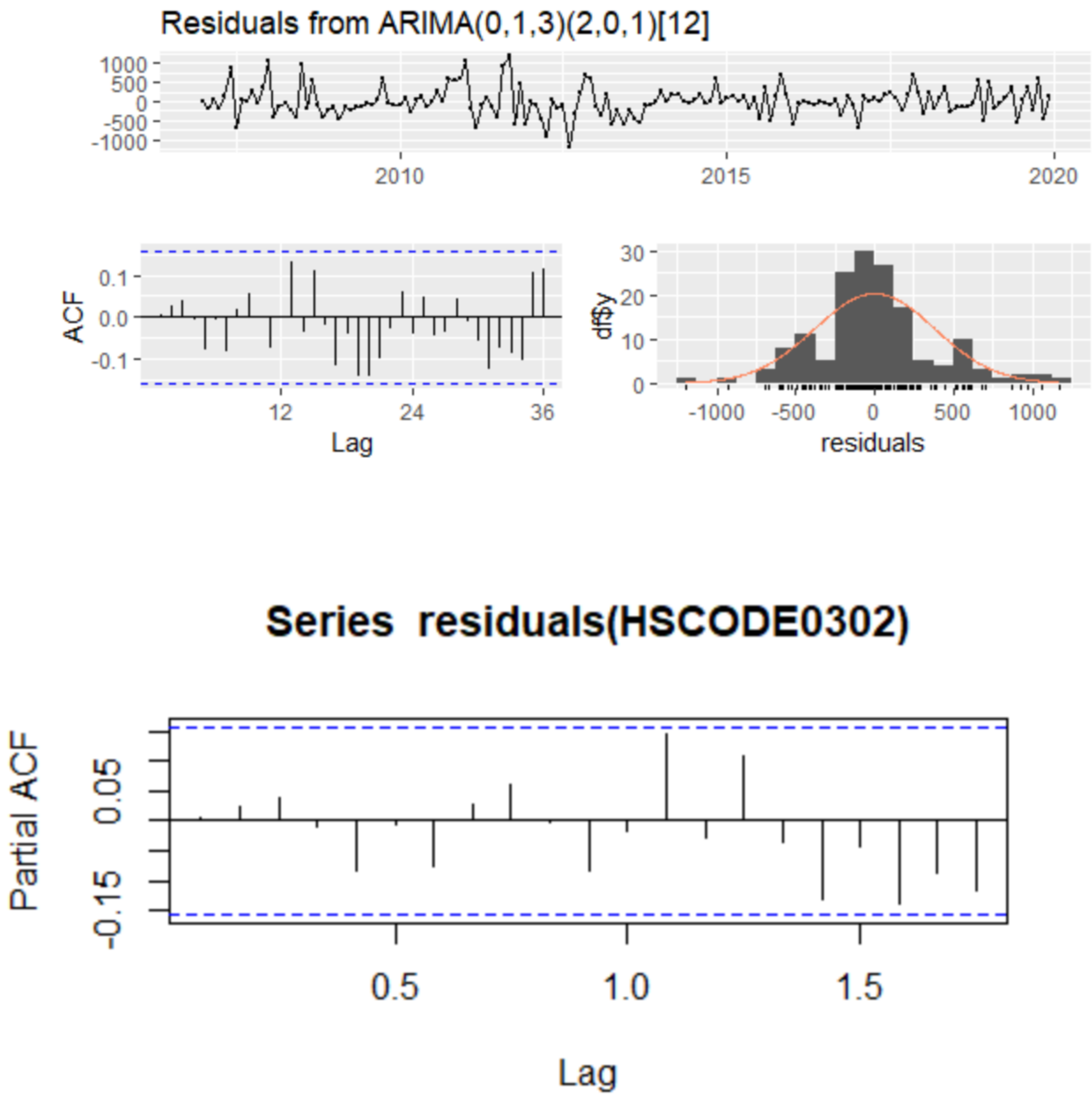


Fig.4.42:ACF,PACF and Histogram plot of residuals of commodities in hscode-0302 of import.

From the above PACF and histogram plot, we can see that it is normally distributed. Therefore, the distribution of the residuals is normal.

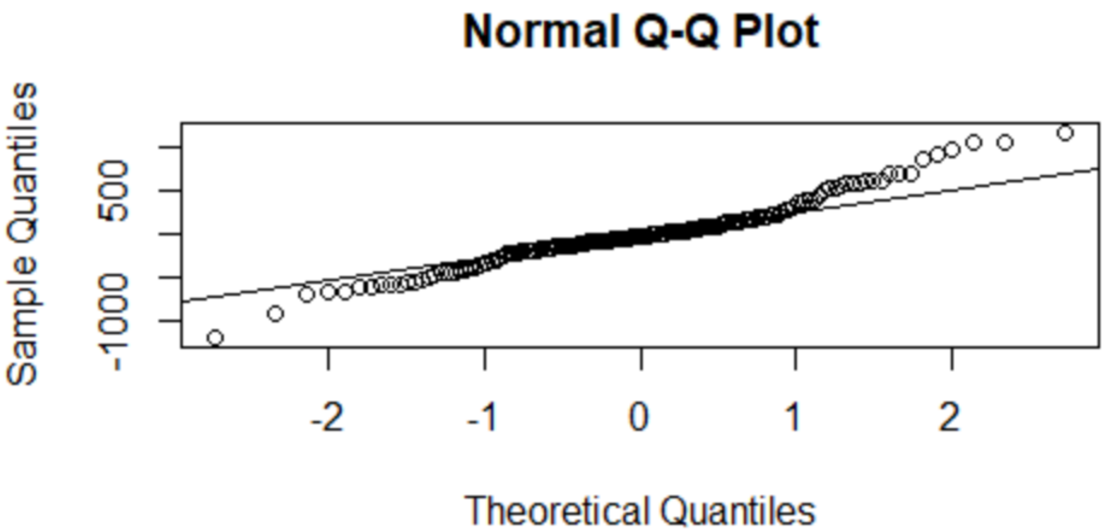


Fig.4.43:Q-Q plot of residuals of commodities in hscode-0302 of import.

Also, from the above normal Q-Q plot . It can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (0, 1, 3) × (2, 0, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0302 for the next 24 months is forecasted using the ARIMA (0,1,3) (2,0,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.44 depicts the forecasted quantity of commodities in hscode-0302 of import.

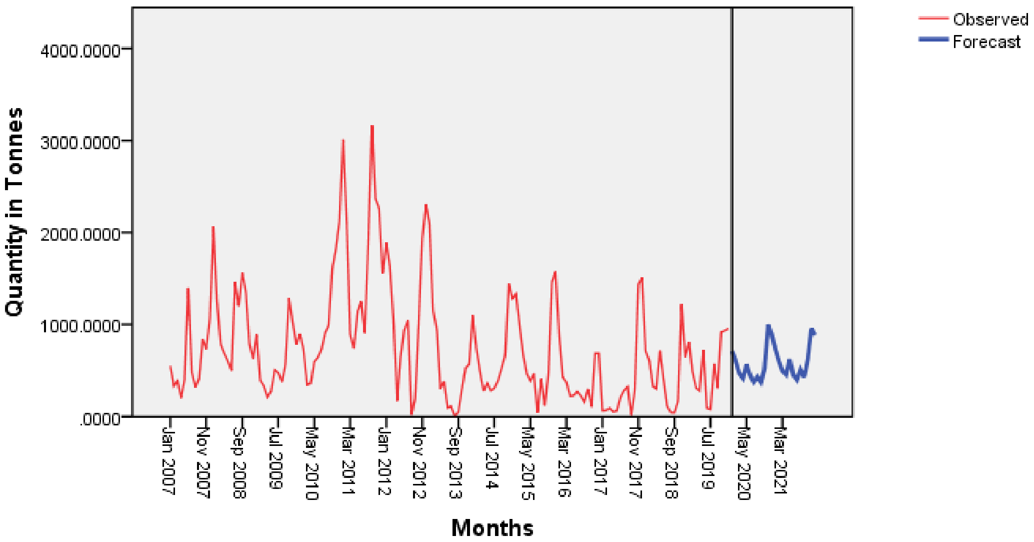


Fig.4.44:forecasted value(quantity) plot of commodities in hscode-0302 of import from 2007 to 2021.

From the above graph, it is clear that there is a trend in 2020 and 2021.

Fig 4.45 shows the actual and fitted prices plot commodities in hscode-0302 of import. The blue line shows the actual values and the orange line shows the fitted values.

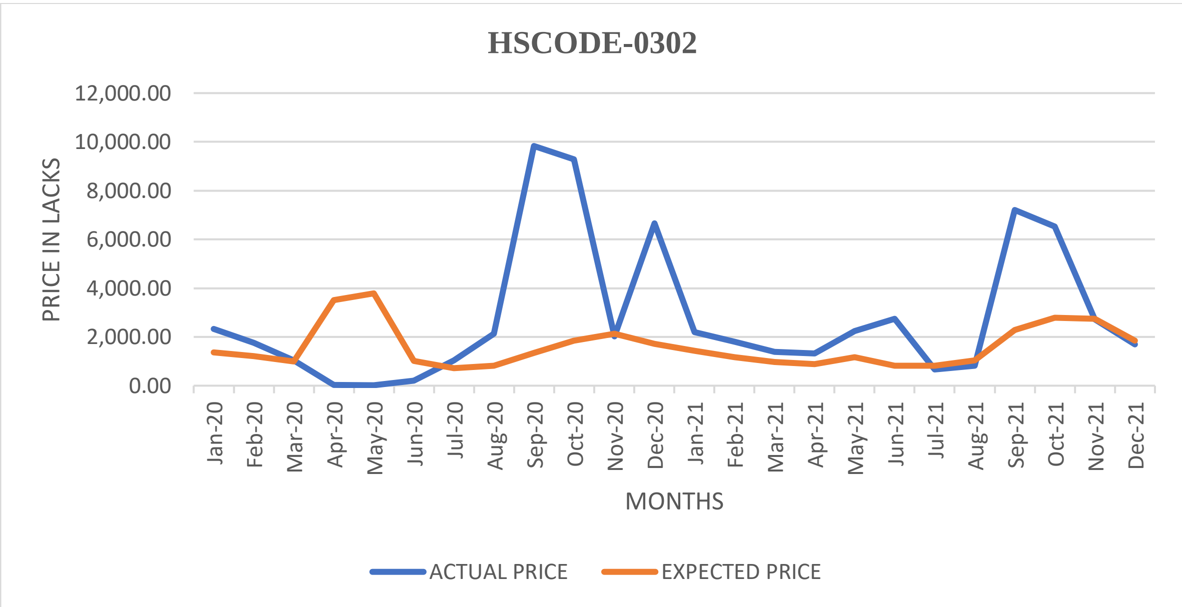


Fig.4.45:actual and expected price(quantity) plot of commodities in hscode-0302 of import from 2007 to 2021.

From the above graph, in almost all month the expected price is lower than the actual price in 2020 and 2021.

4.2.3. HSCODE-0303

Fig 4.46 depicts the time series plot of commodities in hscode-0303 of import. It is visible that there is a trend. The import of hscode-0303 was found to be increasing in 2015-17 but started to decrease in 2017-2019.

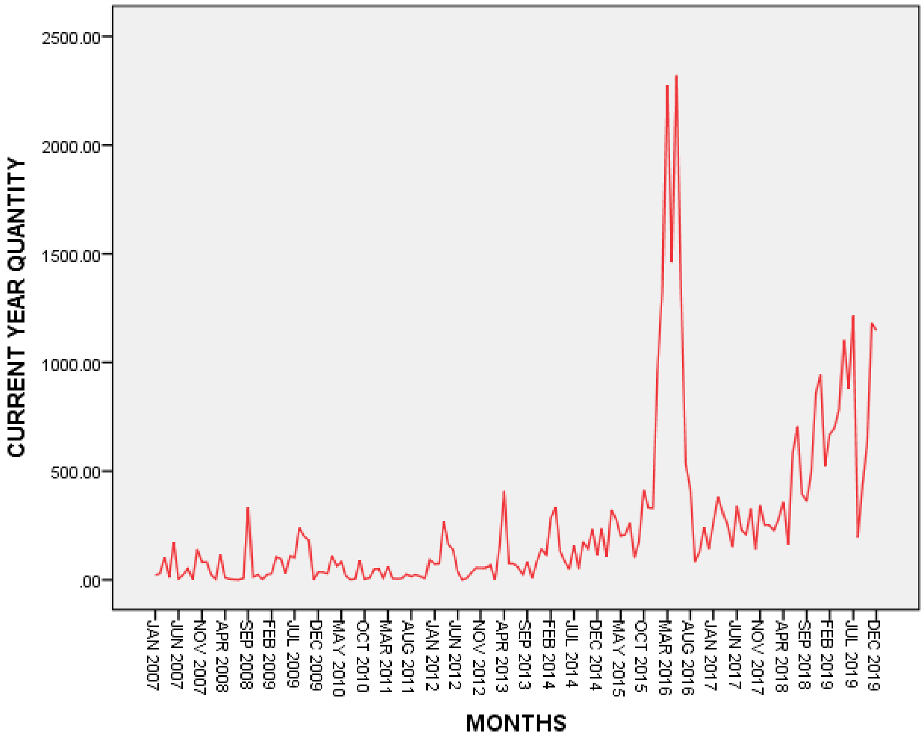


Fig 4.46: Time series plot of commodities in hscode-0303 of import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0303 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (2,1,2) (1,1,1) [12]. The model coefficients are given in table 4.19.

Table 4.19: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0303 of import.

ARIMA (2,1,2) (1,1,1)	
AIC	1984.07
BIC	2004.804

According to Bayesian information criteria ARIMA (2,1,2) (1,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.20.

Table 4.20: SARIMA models along with their corresponding parameters for the commodities in hscode-0303 of import.

ARIMA Model Parameters

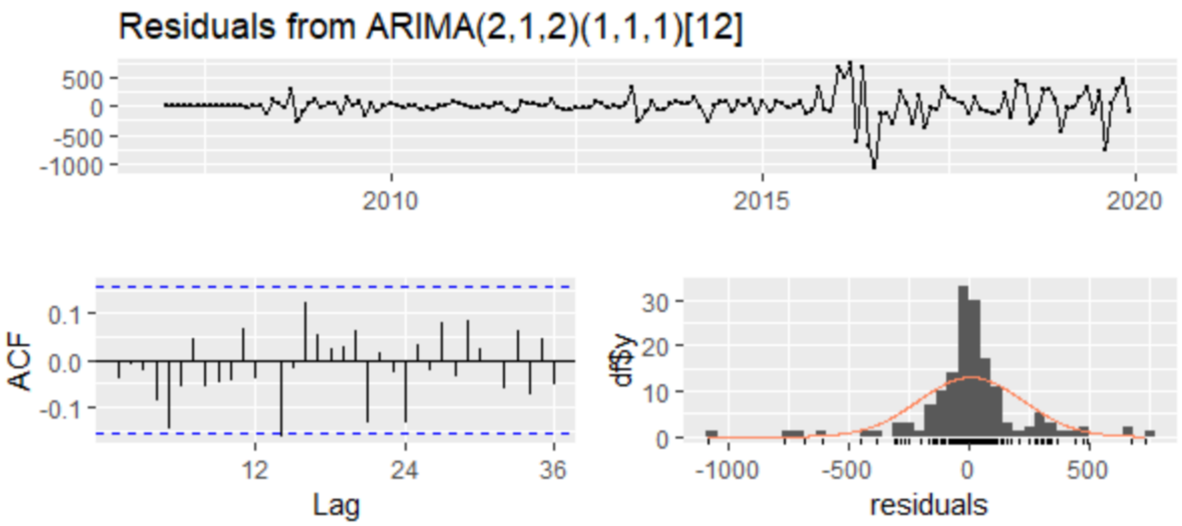
					Estimate	SE	t	Sig.
CURRENTYEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		6.356	12.803	.496	.620
			Difference		1			
			MA	Lag 1	.265	.080	3.293	.001
				Lag 2	-.172	.083	-2.076	.040
				Lag 3	.232	.084	2.763	.006
			AR, Seasonal	Lag 1	.017	1.619	.011	.992
				Lag 2	-.050	.209	-.241	.810
			MA, Seasonal	Lag 1	-.092	1.621	-.057	.955

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-12} + a_t - 0.693(0.563\ a_{t-13} - a_{t-1}) - 0.454(0.563\ a_{t-14} - a_{t-2}) - 0.280(0.563\ a_{t-15} - a_{t-3}) - 0.366(0.563 a_{t-16} - a_{t-4}) \tag{4.3}$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.6266. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 1.768e-11. Therefore, the fitted model satisfies all the required assumptions.



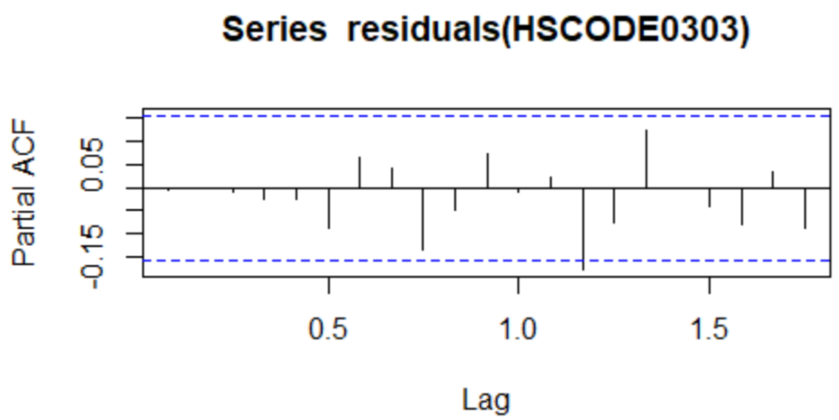


Fig.4.47:ACF,PACF and Histogram plot of residuals of commodities in hscode-0303 of import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

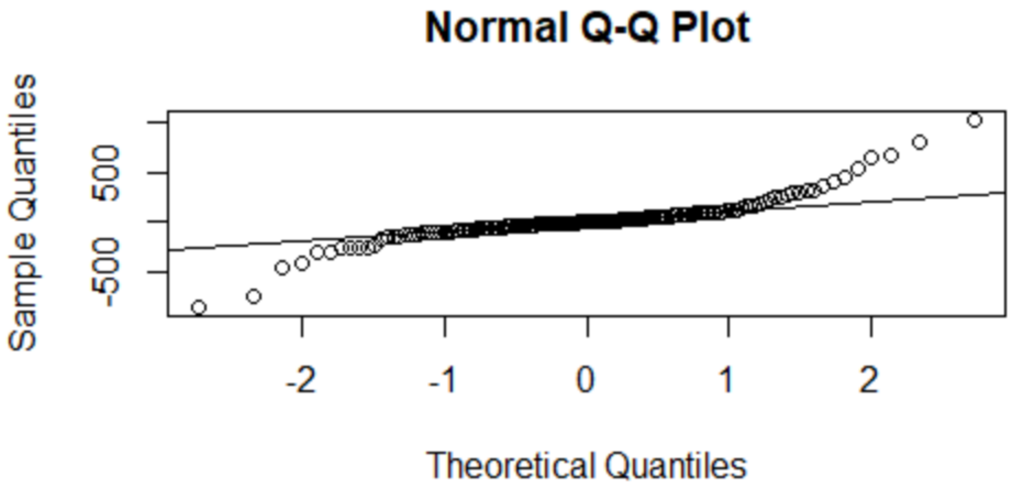


Fig.4.48:Q-Q plot of residuals of commodities in hscode-0303 of import.

Also, from the Normal Q-Q plot we can see that most of the residual values lie on the straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (2, 1, 2) × (1, 1, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0303 of import for the next 24 months is forecasted using the ARIMA (2,1,2) (1,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.49 depicts the forecasted quantity of commodities in hscode-0303 of import.

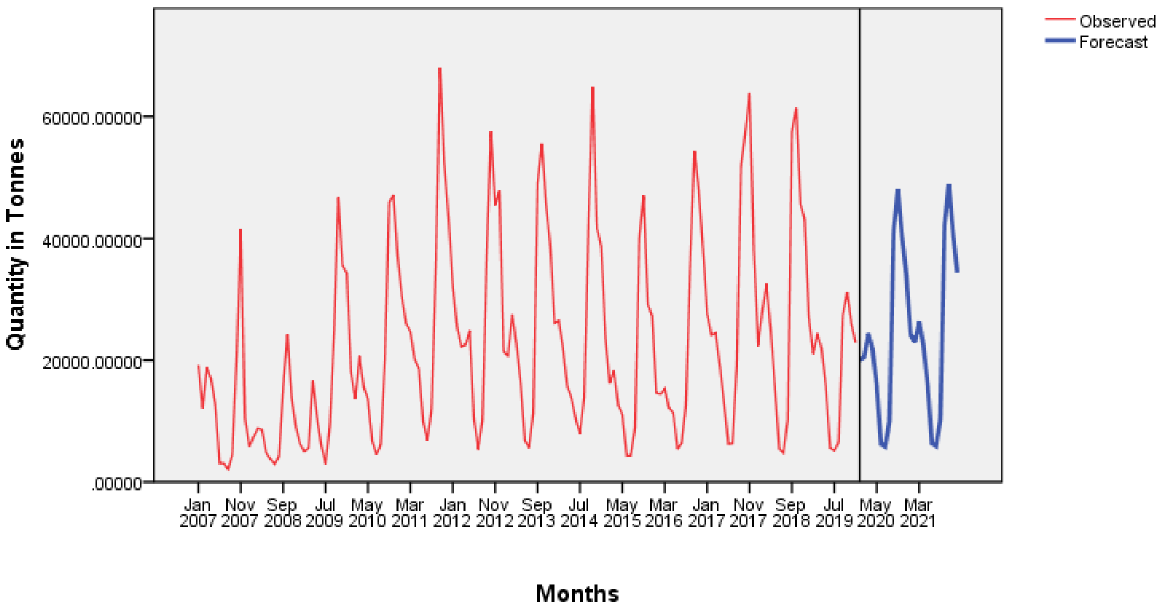


Fig.4.49:forecasted value(quantity) plot of commodities in hscode-0303 of import from 2007 to 2021.

It is clear that there is an upward and downward trend in exports in 2020 and 2021.

Fig 4.50 shows the actual and fitted prices plotted. The blue line shows the actual values and the orange line shows the fitted values.

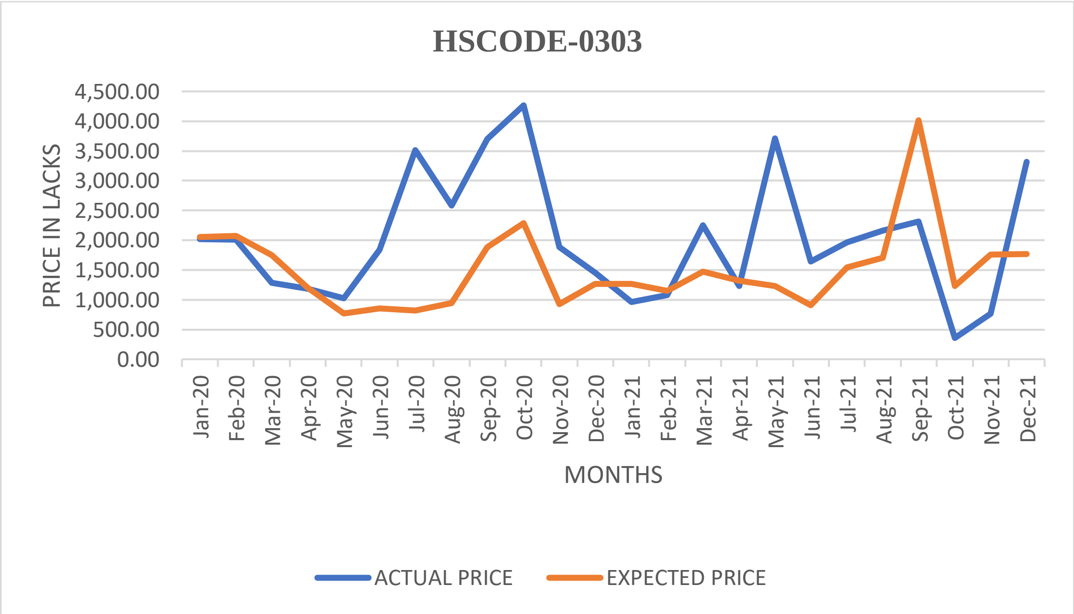


Fig.4.50:actual and expected price(quantity) plot of commodities in hscode-0303 of import from 2007 to 2021.

From the above graph, in all most all month the expected price is lower than actual price in 2020 and 2021.

4.2.4. HSCODE-0304

Fig 4.51 depicts the time series plot of commodities in hscode-0304 import. It is visible that there is a trend. The import of commodities in hscode-0304 was found to be increasing in 2013-19.

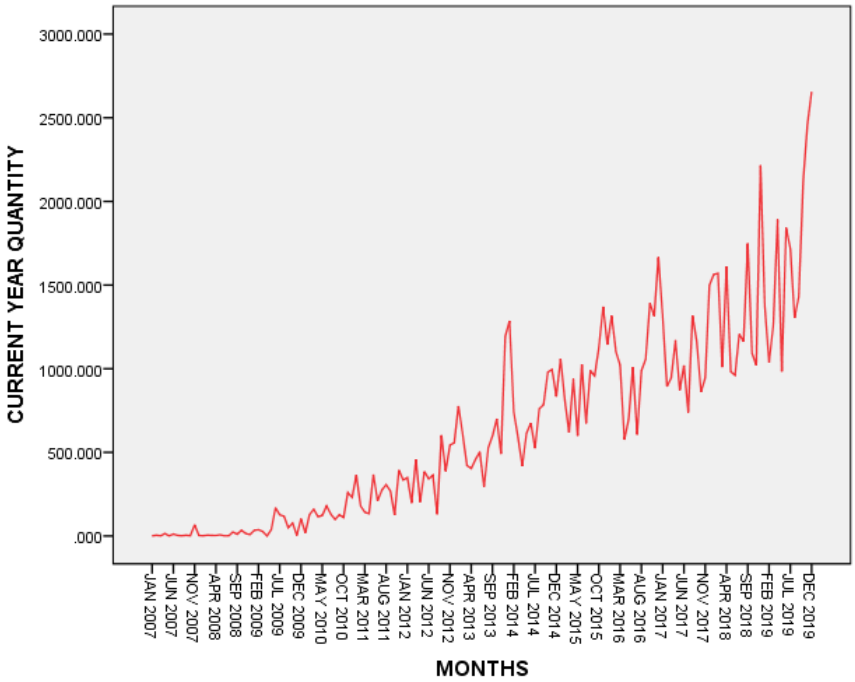


Fig 4.51: Time series plot of commodities in hscode-0304 of import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0304 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented: The model was identified as ARIMA (0,1,2) (0,0,2) [12]. The model coefficients are given in table 4.21.

Table 4.21: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0304 of import.

ARIMA (0,1,2) (0,0,2)	
AIC	2136.33
BIC	2151,547

According to Bayesian information criteria ARIMA (0,1,2) (0,0,2) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.22.

Table 4.22: SARIMA models along with their corresponding parameters for the commodities in hscode-0304 of import.

ARIMA Model Parameters

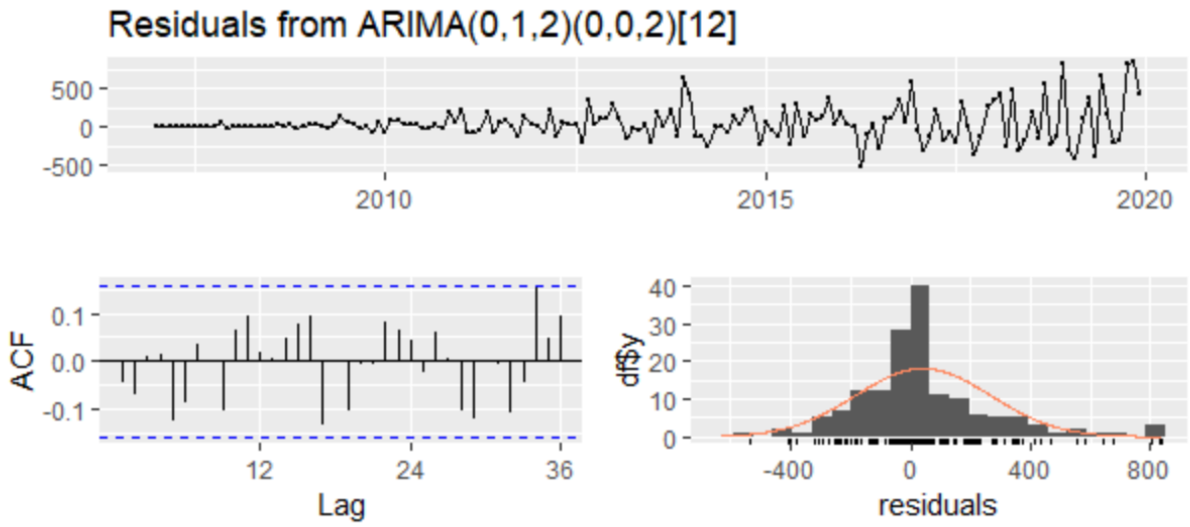
					Estimate	SE	t	Sig.
CURRENTYEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		12.590	3.667	3.434	.001
			Difference		1			
			MA	Lag 1	.696	.083	8.373	.000
				Lag 2	.185	.090	2.057	.041
			MA, Seasonal	Lag 1	-.356	.103	-3.454	.001
				Lag 2	-.153	.122	-1.251	.213

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} + a_t + 0.356a_{t-12} + 0.153a_{t-12} - 0.696a_{t-1} + 0.696a_{t-13}(-0.509) - 0.185a_{t-1} + 0.185a_{t-14}(-0.509) \quad (4.11)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.5868. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 9.136e-08. Therefore, the fitted model satisfies all the required assumptions.



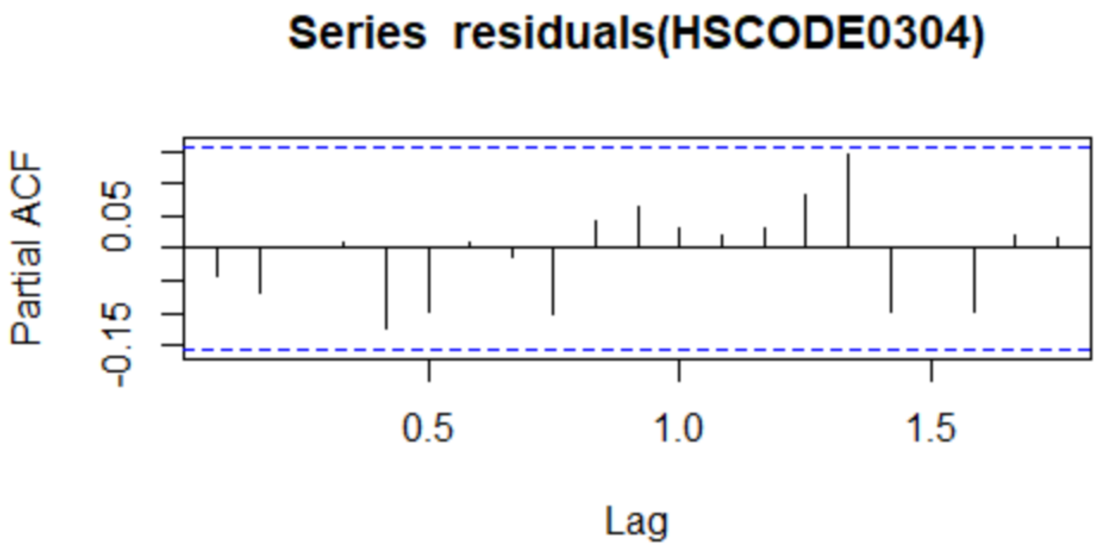


Fig.4.52:ACF,PACF and Histogram plot of residuals of commodities in hscode-0304 of import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

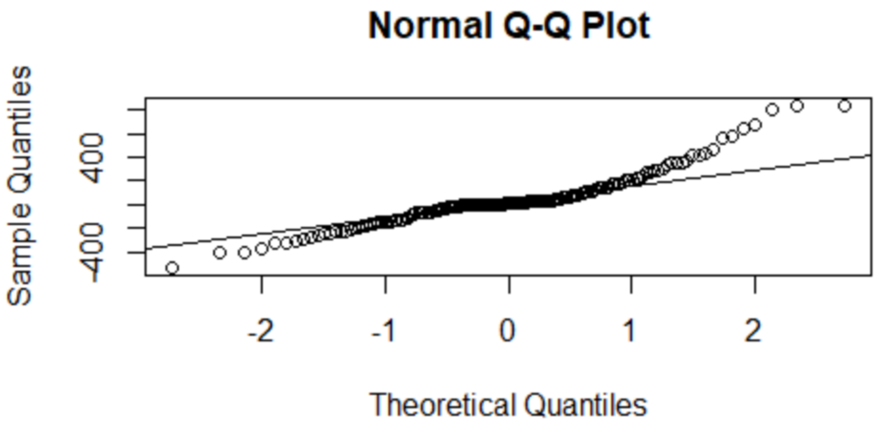


Fig.4.53:Q-Q plot of residuals of commodities in hscode-0304 of import.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie on the straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (0, 1, 2) × (0, 0, 2) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0304 for the next 24 months is forecasted using the ARIMA (0,1,2) (0,0,2) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.54 depicts the forecasted quantity of commodities in hscode-0304 of import. It is clear that there is an upward trend in imports in 2020 and 2021.

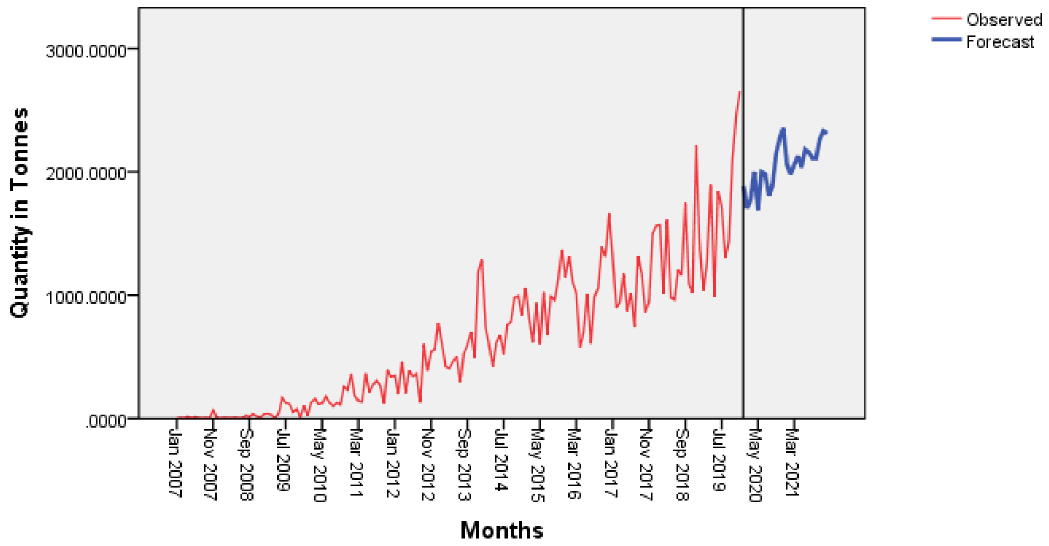


Fig.4.54.:forecasted value(quantity) plot of commodities in hscode-0304 of import from 2007 to 2021

Fig 4.55 shows the actual and fitted prices plot commodities in hscode-0304 of import. The blue line shows the actual values and the orange line shows the fitted values.

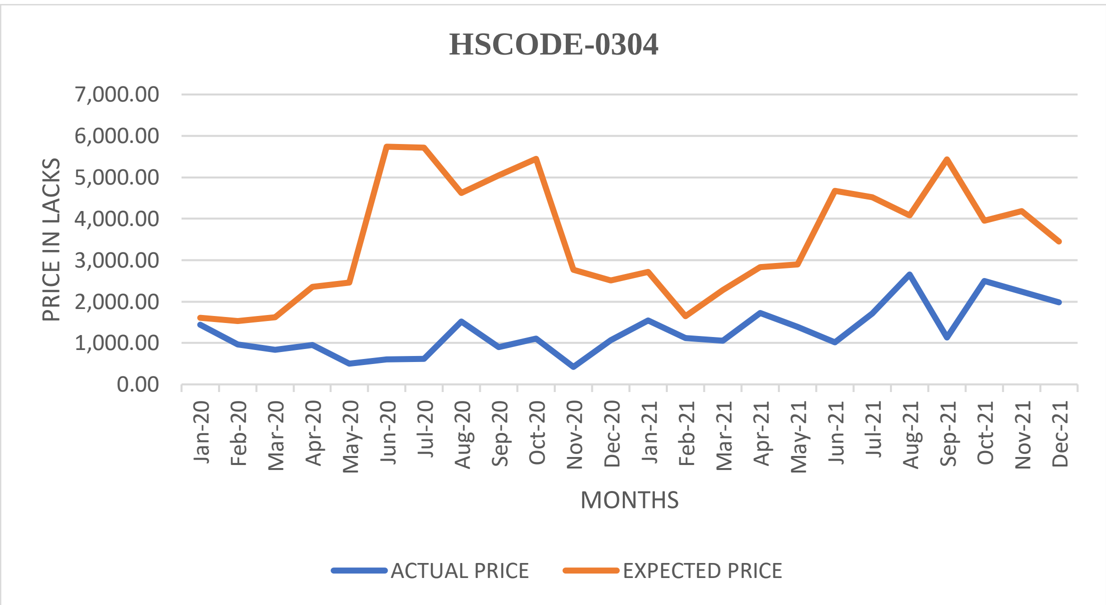


Fig.4.55:actual and expected price(quantity) plot of commodities in hscode-0304 of import from 2020 to 2021

From the above graph, it is clear that the expected price is greater than the actual price. Also, there was a large increase in June 2020 and September 2021.

4.2.5. HSCODE-0305

Fig 4.56 depicts the time series plot of commodities in hscode-0305 imports. It is visible that there is a trend. The import of hscode-0305 was found to be increasing in 2014-19.

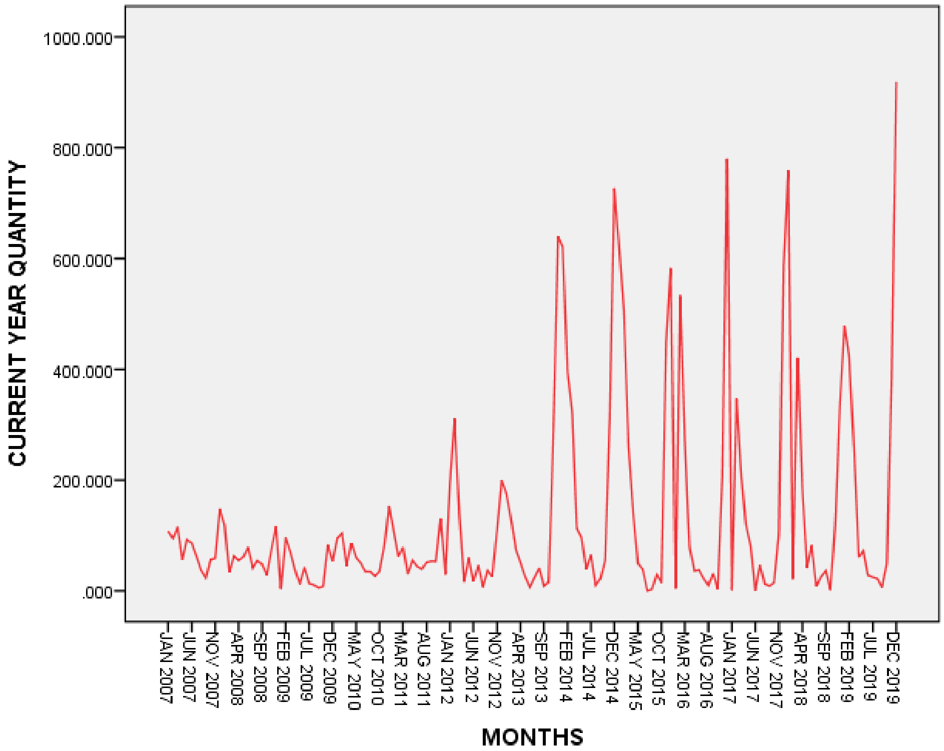


Fig 4.56: Time series plot of commodities in hscode-0305 0f import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0305 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (0,0,1) (1,1,2) [12]. The model coefficients are given in table 4.23.

Table 4.23: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0305 0f import.

ARIMA (0,0,1) (1,1,2) [12]	
AIC	1815.48
BIC	1830.324

According to Bayesian information criteria ARIMA (1,0,1) (0,1,1) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.24.

Table 4.24: SARIMA models along with their corresponding parameters for the commodities in hscode-0305 0f import.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		13.652	5.197	2.627	.010
			MA	Lag 1	-.127	.088	-1.433	.154
			AR, Seasonal	Lag 1	-.333	.320	-1.042	.299
			Seasonal Difference		1			
			MA, Seasonal	Lag 1	.065	.312	.208	.836
				Lag 2	.473	.171	2.774	.006

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-12} - 0.127(Z_{t-1} - Z_{t-13}) + a_t - 0.065a_{t-12} - 0.473a_{t-12} + 0.333a_{t-1} - 0.333a_{t-13}(0.538) \quad (4.12)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.9591. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 3.115e-14. Therefore, the fitted model satisfies all the required assumptions.

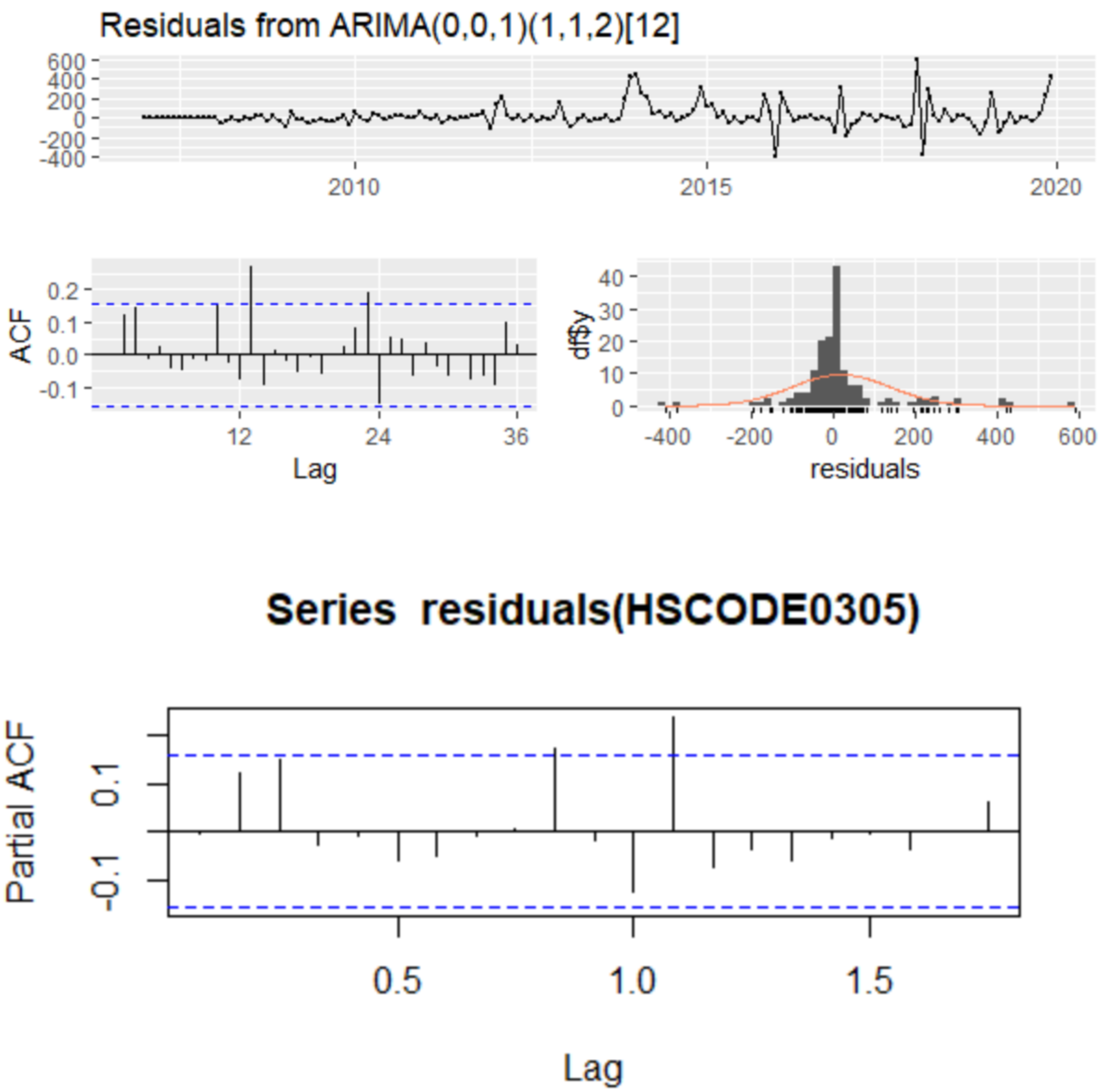


Fig.4.57:ACF,PACF and Histogram plot of residuals of commodities in hscode-0305 0f import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

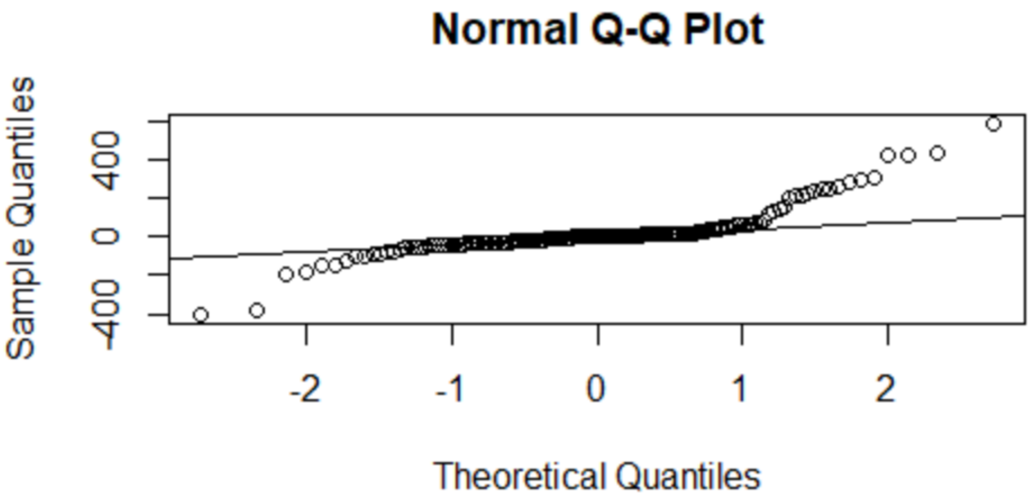


Fig.4.58:Q-Q plot of residuals of commodities in hscode-0305 0f import.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 0, 0) × (1, 0, 1) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0305 for the next 24 months is forecasted using the ARIMA (1,0,0) (1,0,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.59 depicts the forecasted quantity of commodities in hscode-0305 0f import.

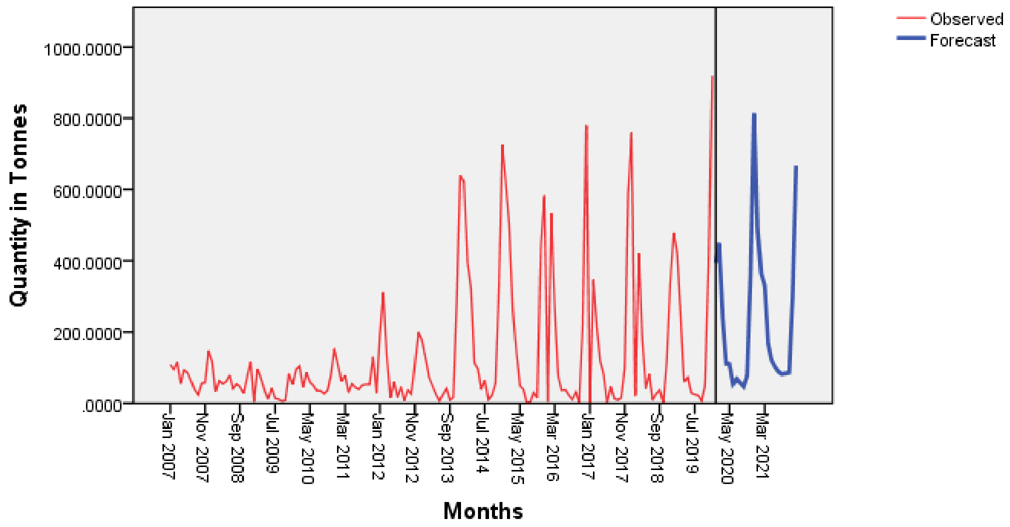


Fig.4.59:forecasted value(quantity) plot of commodities in hscode-0305 0f import from 2007 to 2021.

From the above graph, it is clear that there is trend in 2020 and 2021.

Fig 4.60 shows the actual and fitted prices plot commodities in hscode-0305 0f import. The blue line shows the actual values and the orange line shows the fitted values.

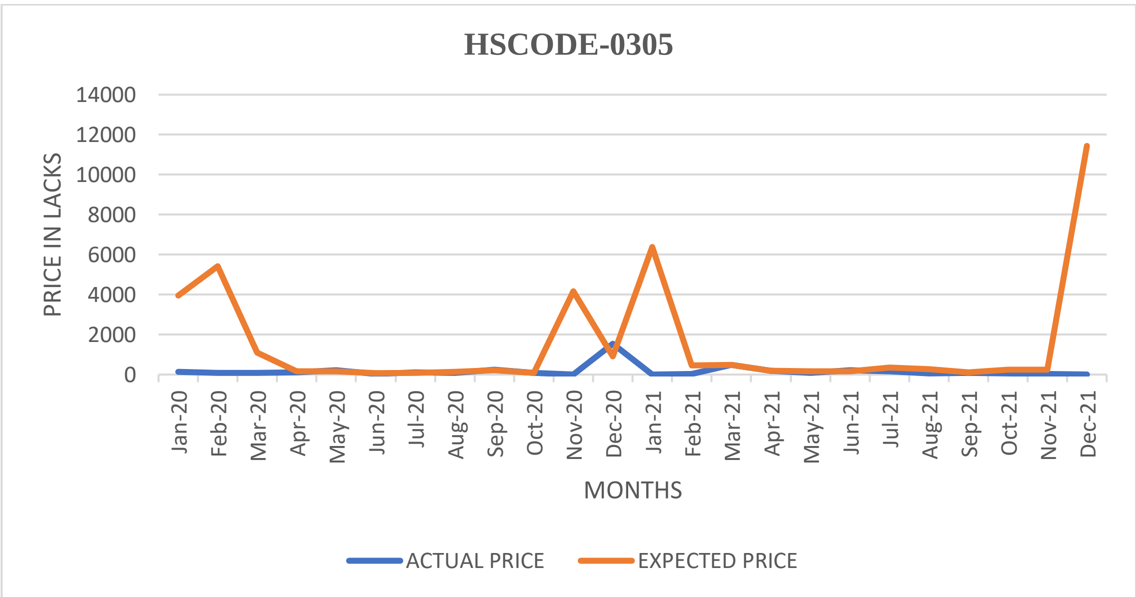


Fig.4.60:actual and expected price(quantity) plot of commodities in hscode-0305 0f import from 2020 to 2021.

From the above graph, it is clear that the expected price is greater than actual price in 2020 and 2021. Also, there was a very large increase in December 2021.

4.2.6. HSCODE-0306

Fig 4.61 depicts the time series plot of commodities in hscode-0306 0f imports. It is visible that there is a trend. The import of hscode-0306 was found to be increasing in 2017-18 but started to decrease in 2019.

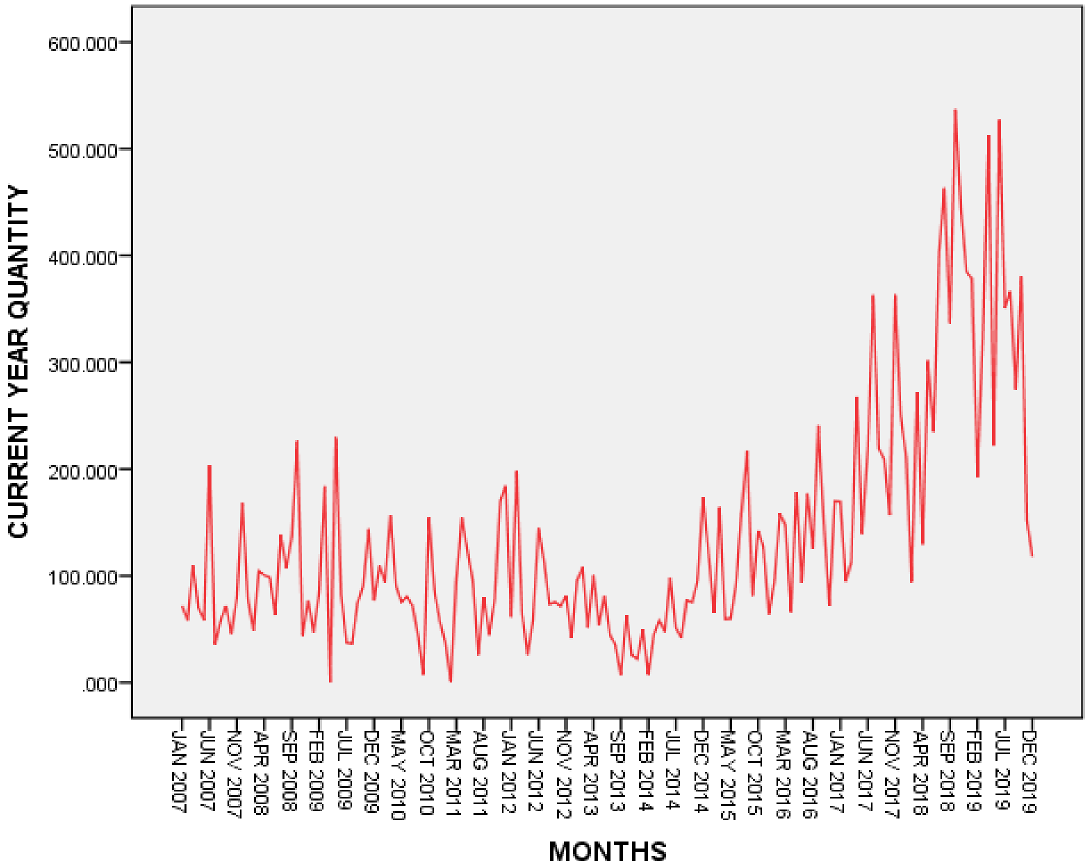


Fig 4.61: Time series plot of commodities in hscode-0306 0f import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0306 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the bet fitted time series model. The results are presented: The model was identified as ARIMA (0,1,1) (1,0,0) [12]. The model coefficients are given in table 4.25.

Table 4.25: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0306 0f import.

ARIMA (0,1,1) (1,0,0) [12]	
AIC	1771.28
BIC	1780.412

According to Bayesian information criteria ARIMA (0,1,1) (1,0,0) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.26.

Table 4.26: SARIMA models along with their corresponding parameters for the commodities in hscode-0306 0f import.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENTYEARQUANTITY-Model_1	CURRENTYEARQUANTITY	No Transformation	Constant		1.340	1.256	1.066	.288
			Difference		1			
			MA	Lag 1	.769	.058	13.342	.000
			AR, Seasonal	Lag 1	-.104	.096	-1.087	.279

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = Z_{t-1} + 0.104(Z_{t-1} - Z_{t-2}) + a_t - 0.769 \quad (4.13)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.5415. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal

Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 0.0001552. Therefore, the fitted model satisfies all the required assumptions.

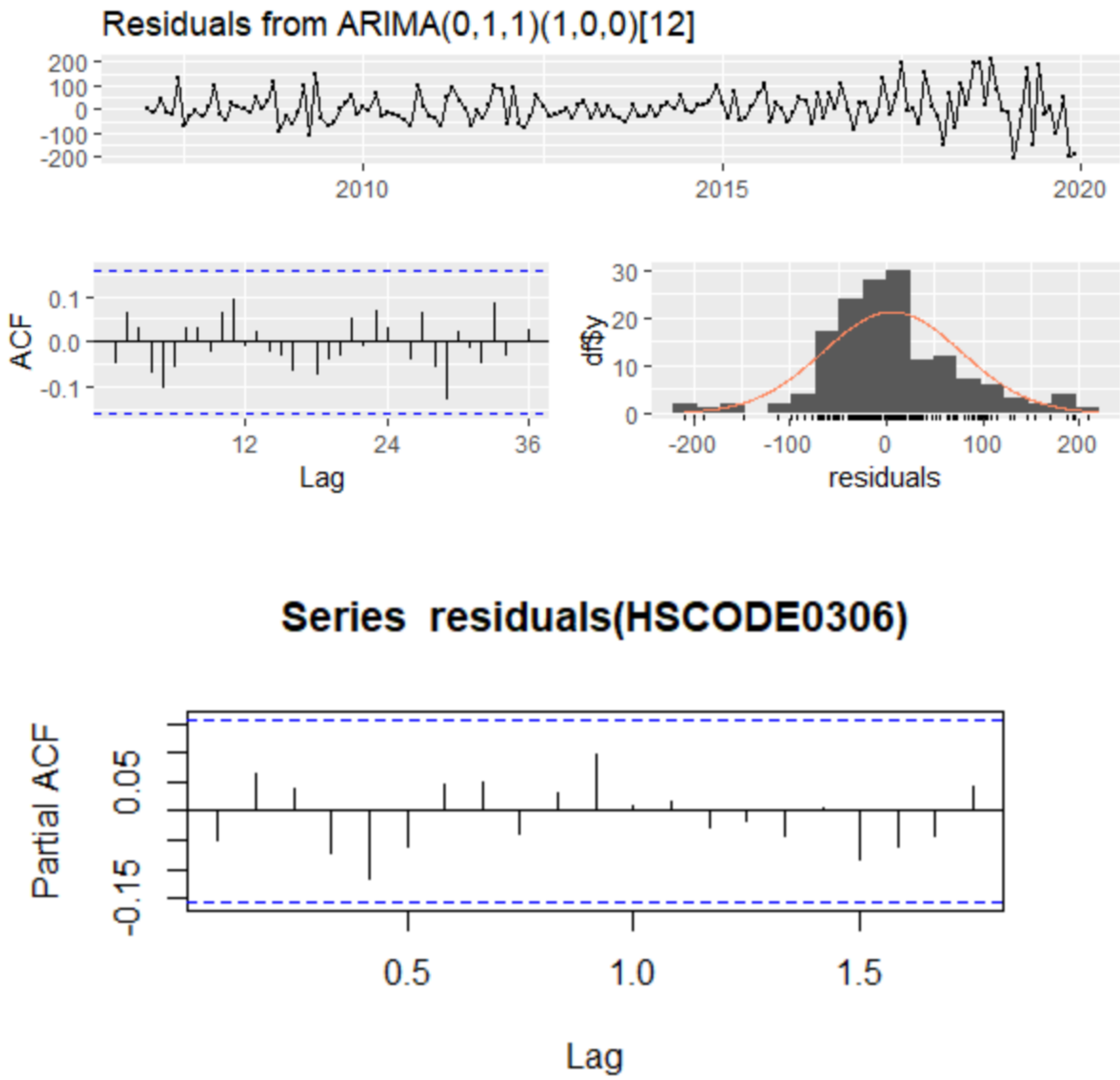


Fig.4.62:ACF,PACF and Histogram plot of residuals of commodities in hscode-0306 0f import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

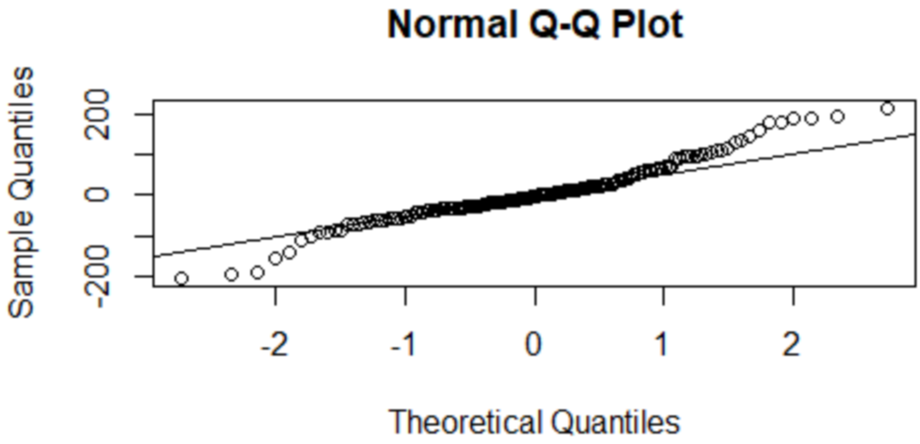


Fig.4.63:Q-Q plot of residuals of commodities in hscode-0306 0f import.

Also, from the above normal Q-Q plot it can be concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (0, 1, 1) × (1, 0, 0) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0306 for the next 24 months is forecasted using the ARIMA (0,1,1) (1,0,0) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.64 depicts the forecasted quantity of commodities in hscode-0306 0f import.

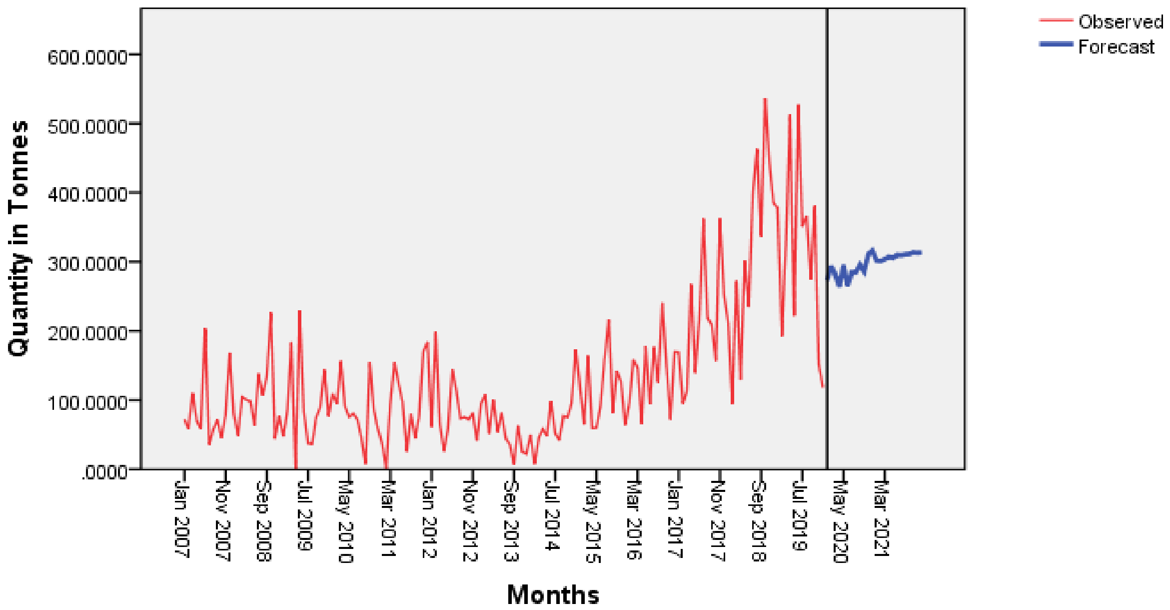


Fig.4.64:forecasted value(quantity) plot of commodities in hscode-0306 0f import from 2007 to 2021.

Fig 4.65 shows the actual and fitted prices plot commodities in hscode-0306 0f import. The blue line shows the actual values and the orange line shows the fitted values.

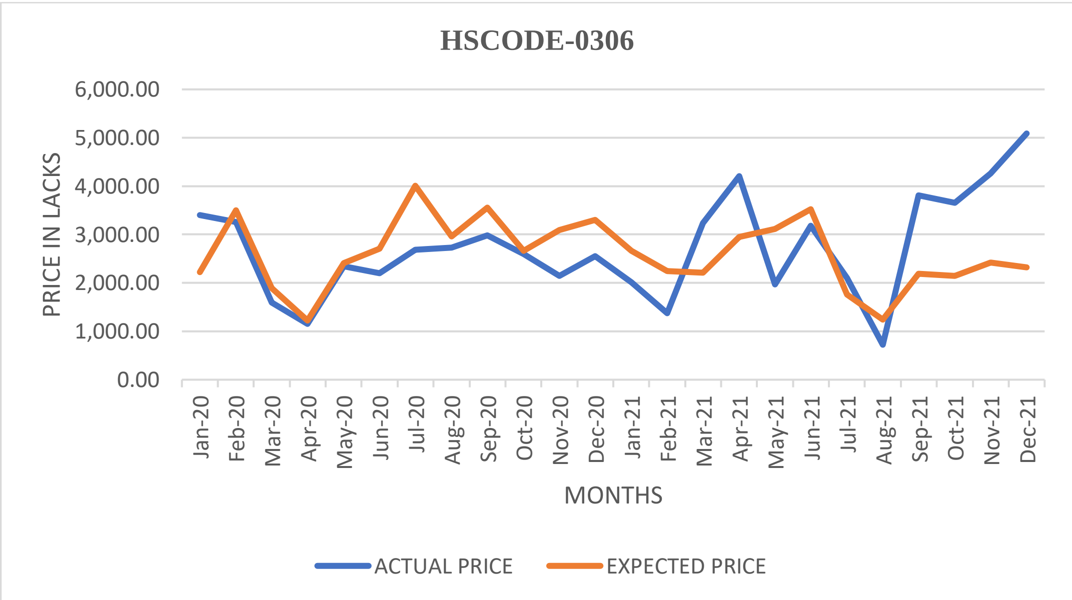


Fig.4.65:actual and expected price(quantity) plot of commodities in hscode-0306 0f import from 2020 to 2021.

From the above graph, in all most all month the expected price is greater than actual price in 2020 and 2021. But in September 2021 the actual price is greater than expected price.

4.2.7. HSCODE-0307

Fig 4.66 depicts the time series plot of commodities in hscode-0307 0f imports. It is visible that there is a trend. The import of hscode-0307 was found to be increasing in 2013-18 but started to decrease in 2019.

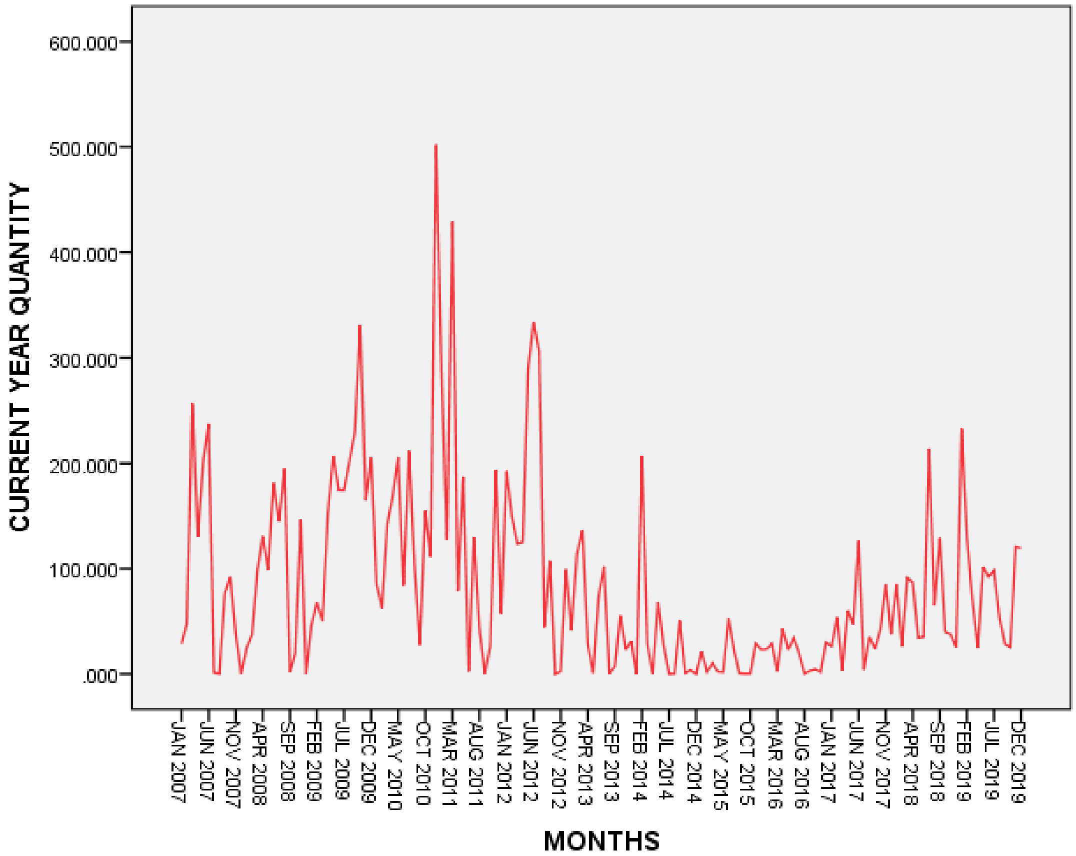


Fig 4.66: Time series plot of commodities in hscode-0307 0f import (quantity in ton) from 2007 to 2019.

Different types of time series models were fitted to the data on hscode-0307 of import from India for the years 2007 to 2019 and the best model was selected. Then the future imports were predicted using the best fitted time series model. The results are presented: The best fitted model was ARIMA (1,1,0) (1,0,0) [12]. The model coefficients are given in table 4.27.

Table 4.27: SARIMA models along with their corresponding BIC statistic for the commodities in hscode-0307 0f import.

ARIMA (1,1,0) (1,0,0) [12]	
AIC	1820.55
BIC	1829.679

According to Bayesian information criteria ARIMA (1,1,0) (1,0,0) [12] model has been chosen as the most appropriate. The parameter estimates for the model are givenin table 4.28.

Table 4.28: SARIMA models along with their corresponding parameters for the commodities in hscode-0307 0f import.

ARIMA Model Parameters

					Estimate	SE	t	Sig.
CURRENT YEAR QUANTITY-Model_1	CURRENT YEAR QUANTITY	No Transformation	Constant		2.614	10.567	.119	.906
			AR	Lag 1	-.465	.072	-6.466	.000
			Difference		1			
			AR, Seasonal	Lag 1	-.043	.084	-.515	.607

The model is adequate and can be used for forecasting future values. The SARIMA model fitted is,

$$Z_t = -0.043\, Z_{t-1} + 0.465\, Z_{t-1} + 0.019995\, Z_{t-2} + a_t \quad (4.14)$$

DIAGNOSTIC CHECKING

The fitted model was subjected to diagnostic checking before forecasting. The ACF plots of residuals are shown in fig. The graph shows that all the lags are within the significant limits thus can be concluded that the residuals are white noise and the fitted model appear to be correct. The Ljung-box test is used to check the residuals of the fitted model for any signs of non-randomness, which produced a p-value of 0.5147. It is concluded that the residuals are independent and the value of the augmented dickey-fuller test is 0.01. Also, from the normal Q-Q plot it can be seen that most of the residual values lie on the straight line. Which shows that residuals are normally distributed. The Shapiro-wilk test yielded a p-value of 4e-06. Therefore, the fitted model satisfies all the required assumptions.

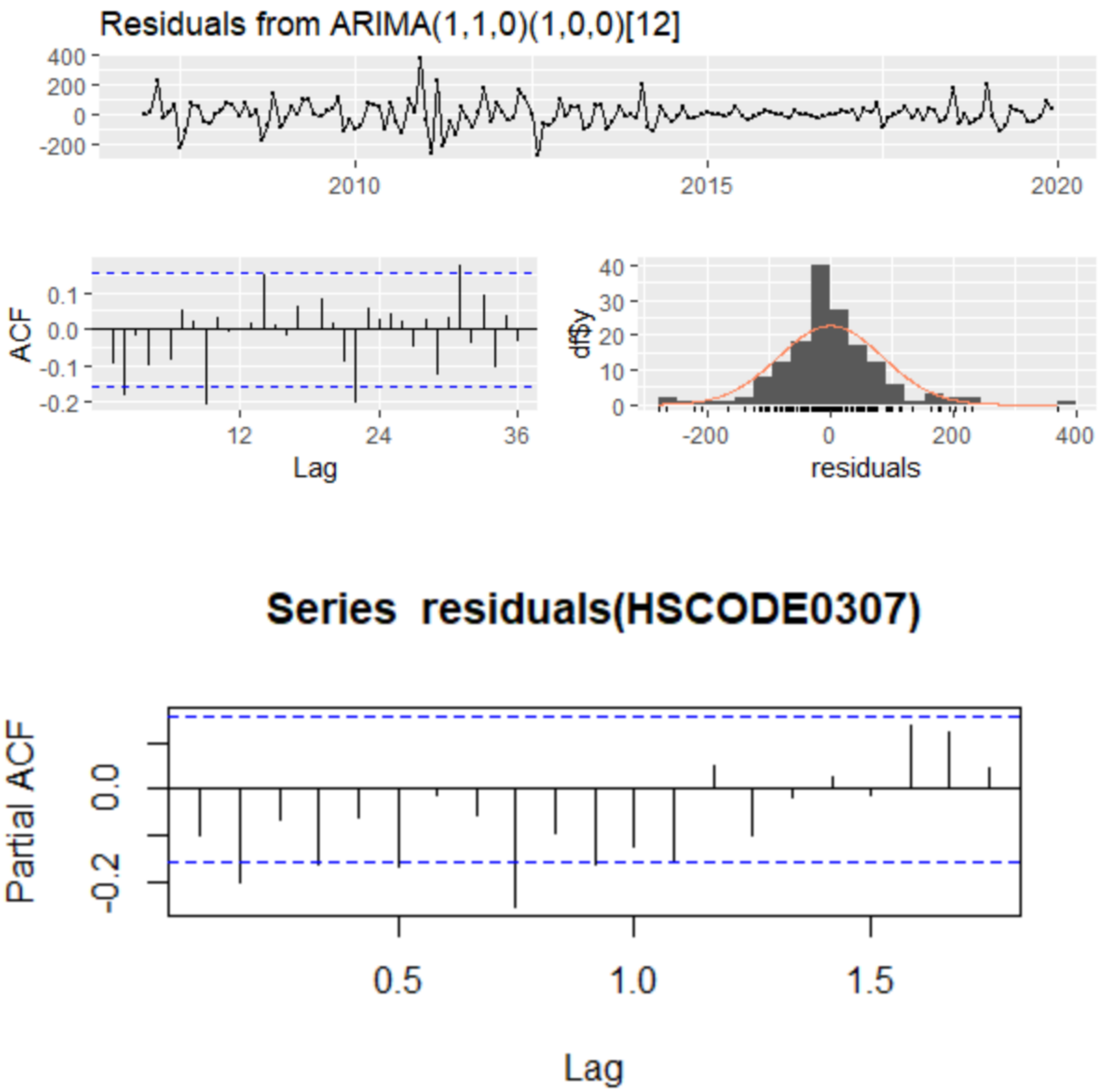


Fig.4.67:ACF,PACF and Histogram plot of residuals of commodities in hscode-0307 0f import.

From the above PACF and histogram plot, it can be concluded that it is normally distributed. Therefore, the distribution of the residuals is normal.

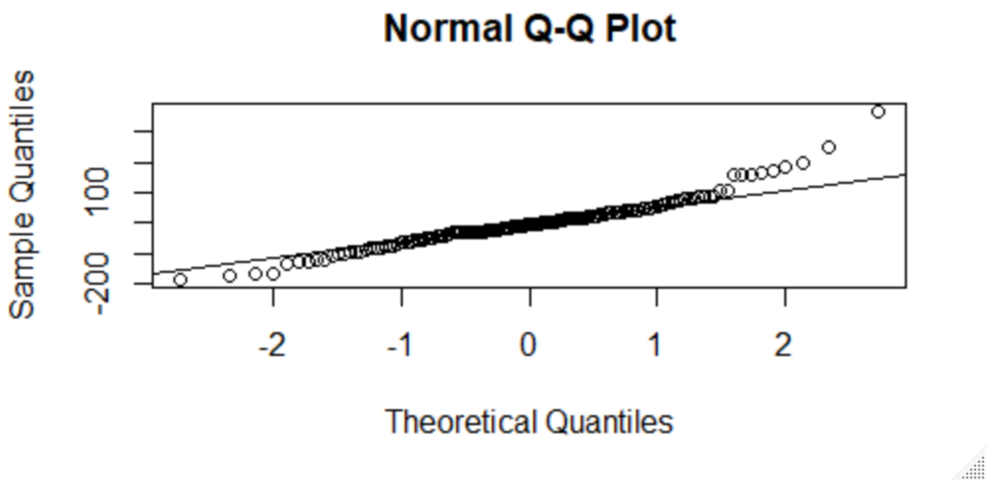


Fig.4.68:Q-Q plot of residuals of commodities in hscode-0307 0f import.

Also, from the above normal Q-Q plot it can concluded that most of the residual values lie onthe straight line. Which shows that residuals are normally distributed.

Thus, the diagnostic checking reveals that the fitted ARIMA (1, 1, 0) × (1, 0, 0) [12] model is statistically adequate. And the model satisfies stationary and invertibility requirements. So, this model can be used to forecast.

FORECASTING

The current model can be used for forecasting. The import of hscode-0307 for the next 24 months is forecasted using the ARIMA (1,0,2) (0,1,1) [12] model fitted. The forecasted values are plotted and it is given below.

Fig 4.69 depicts the forecasted quantity of commodities in hscode-0307 0f import. It is clear that there is an upward trend in exports in 2020 and 2021.

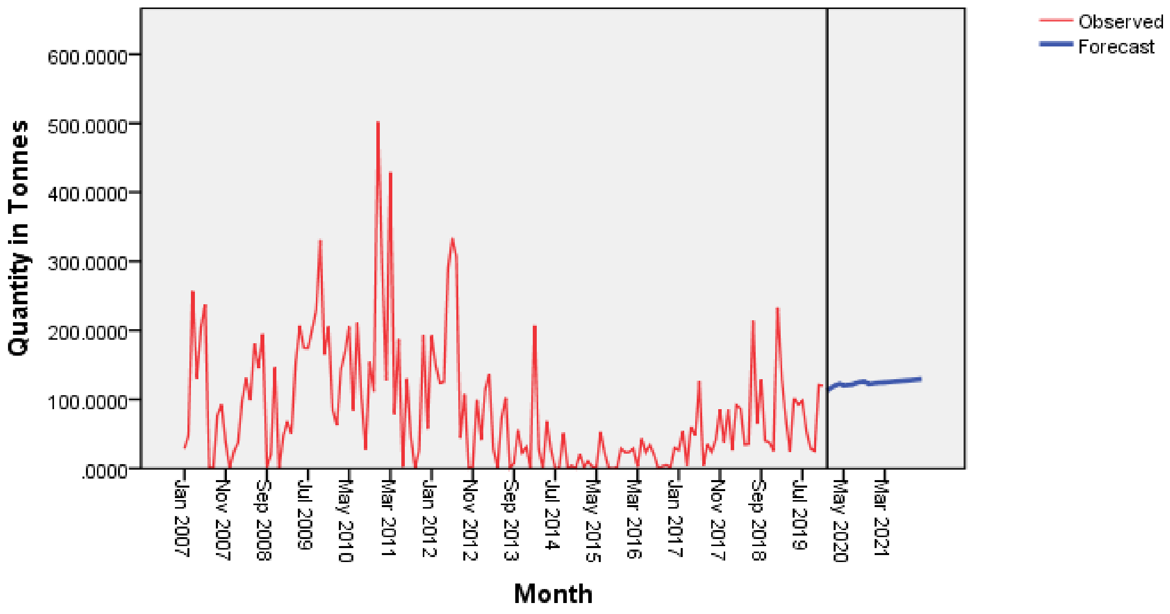


Fig.4.69:forecasted value(quantity) plot of commodities in hscode-0307 0f import from 2007 to 2021.

Fig 4.70 shows the actual and fitted prices plot commodities in hscode-0307 0f import. The blue line shows the actual values and the orange line shows the fitted values.

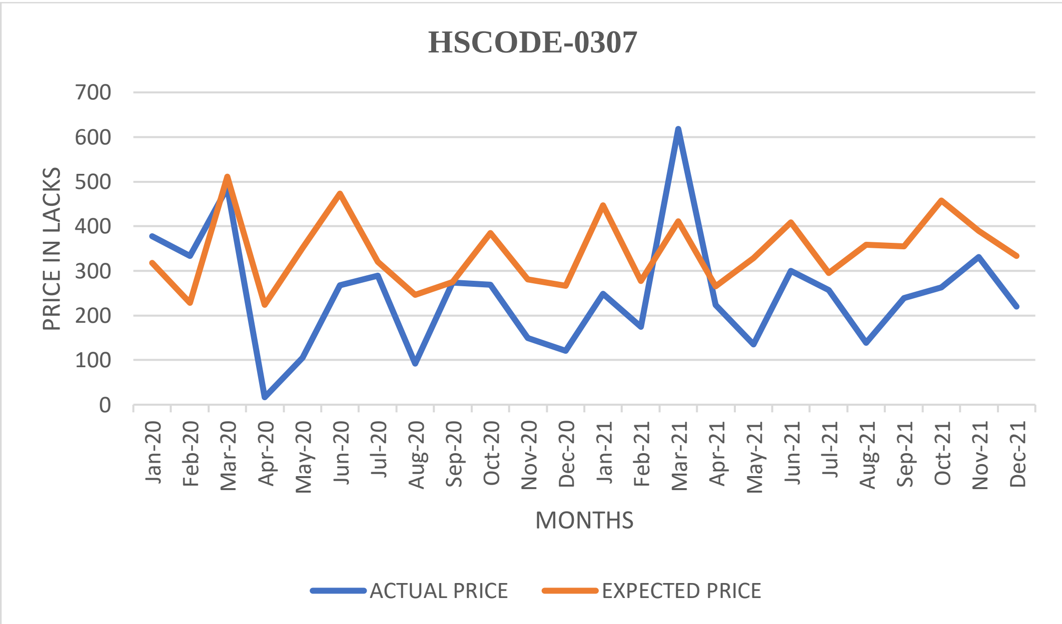


Fig.4.70:actual and expected price(quantity) plot of commodities in hscode-0307 0f import from 2020 to 2021.

From the above graph, in all most all month the expected price is greater than actual price in 2020 and 2021.

4.3. COMPOUND ANNUAL GROWTH RATE OF THE EXPORT OF FISH AND FISHERIES PRODUCTS FROM INDIA

This section discusses the calculation of the effect of covid-19 on the growth rate of export of fish and fisheries products in India. It can be done by calculating CAGR before and after the covid-19 in India. The data is taken from 2007 to 2021, a period of 15 years.

Table 4.29: Compound annual growth rate of India's export of fish and fisheries products of various commodities.

HSCODE	CAGR before covid-19	CAGR after covid- 19
HSCODE-0301	4.7107%	2.746%
HSCODE-0302	2.629%	1.603%
HSCODE-0303	2.321%	0.985%
HSCODE-0304	5.664%	4.3017%
HSCODE-0305	4.297%	2.943%
HSCODE-0306	6.5325%	5.785%
HSCODE-0307	3.306%	2.182%

From the above table, it is clear that the compound annual growth rate of India's export of fish and fisheries products of various commodities has decreased after COVID-19 in 2020 and 2021.

CHAPTER 5
CONCLUSION

5.1. EXPORT OF FISH AND FISHERIES PRODUCTS

India is one of the top 10 exporters of fish and fisheries products. And, with 4.1% of global seafood exports, India is the third largest producer of captured fisheries (5.4 million tonnes) and the fifth largest exporter of fish and fishery products (USD 6.6 billion). The study was conducted to examine the effect of COVID-19 on the export of fish and fisheries products from India. Here, in almost all commodities, the forecasted quantity is greater than the actual quantity. Therefore, it can be concluded that there is an impact. And also, in some months, the expected price is greater than the actual price. This is due to port closures, loss of access to cold storage, cessation of shipping and air freight, lack of fish catch, market, and supply chain due to the COVID-19 lockdown. Therefore, it can be concluded that commodities are affected by COVID-19. And also, in some months, the expected price is lower than the actual price. This was due to the countries' hoarding of particular commodities before the spread of COVID-19 and the lockdown, price drops, international trading agreements, etc. Therefore, it can be concluded there is no impact.

5.2. IMPORT OF FISH AND FISHERIES PRODUCTS

India imports fish and fishery products nearly from 80 countries. The dollar value of Fish import in 2020-2021 (Apr-Nov) stood at 435.43 USD Million and 2505.68 USD Million in 2018, which shows a growth of 132.05% from the previous year's import value which was 1079.82 USD Million in 2017. The study was conducted to examine the effect of COVID-19 on the import of fish and fisheries products from India. Here, in almost all commodities, the forecasted quantity is greater than the actual quantity. Therefore, it can be concluded that there is an impact. And also, in some months, the expected price is greater than the actual price. This is due to port closures, loss of access to cold storage, cessation of shipping and air freight, lack of fish catch, market, and supply chain due to the COVID-19 lockdown. Therefore, it can be concluded that commodities are affected by COVID-19. And also, in some months, the expected price is lower than the actual price. This was due to the countries' hoarding of particular commodities before the spread of COVID-19 and the lockdown, price drops, international trading agreements, etc. Therefore, it can be concluded there is no impact.

5.3. CAGR OF EXPORT OF FISH AND FISHERIES PRODUCTS

The growth rate of the export of fish and fisheries products in India was worked out using CAGR values. Before and after COVID-19, CAGR values for fish and fisheries product exports were calculated. From the values, it can be concluded that CAGR values decreased after COVID-19. This is due to shops, eateries, factories, transport services, and business establishments being shattered. And also, the lockdown had a devastating impact on the slowing down fisheries sector and the economy.

LIMITATIONS OF THE STUDY

1) The forecast values may vary for other reasons as well.
2) The study is based on secondary sources.

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