MODELLING AND FORECASTING THE SEASONAL VARIATIONS OF APPAREL EXPORTS IN SRI LANKA WITH A SPECIAL REFERENCE TO COVID-19 PANDEMIC

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Abstract

The apparel industry in Sri Lanka contributes predominantly to the country's economy. Therefore, it is crucial for policymakers and other stakeholders to know about the apparel and textile export behavior to make informed decisions. Thus, the main aim of this study was to model and forecast Sri Lankan apparel and textile exports using the data for the period of January 2007 to December 2022 and provide accurate forecasts. ARIMA model was employed for the univariate time series analysis with modeling and forecasting. Among the candidate models, ARIMA (1,1,1) $(2,0,0)_{12}$ was the best-fitted model based on the information criteria: AIC, AICc and BIC. Then, the model adequacy checking of the selected model was done using residual diagnostic graphs, the portmanteau test, the Ljung-Box test, and the characteristic roots of the model, which found that the model was adequate for forecasting. Subsequently, the forecasts were generated for two years ahead, and the forecast accuracy was checked with metrics such as MAPE, RMSE and MAE. The best-fitted model was found to have an average prediction error of 11.77%, while RMSE and MAE were 78.57 and 59.92, respectively. Further, an analysis of the major fluctuations of the time series during the period of study was done, and it was found that despite the inevitable adverse impact of the COVID-19 pandemic in its initial phase, the apparel sector swiftly adapted and showed a significant improvement in export earnings during the post-COVID period.

Keywords: ARIMA, export earnings, textile exports.

1. Introduction

1.1. Sri Lankan Apparel Industry

Apparel manufacturers in Sri Lanka are reputed for their ethical manufacturing of high-quality apparel and have global clientele, including iconic global fashion brands. According to the Sri Lanka Export Development Board (SLEDB), they have successfully tapped into the global market by moving beyond traditional designs and exports, providing reliable, creative, and sophisticated apparel solutions through research and development, innovation centers, and BPO services.

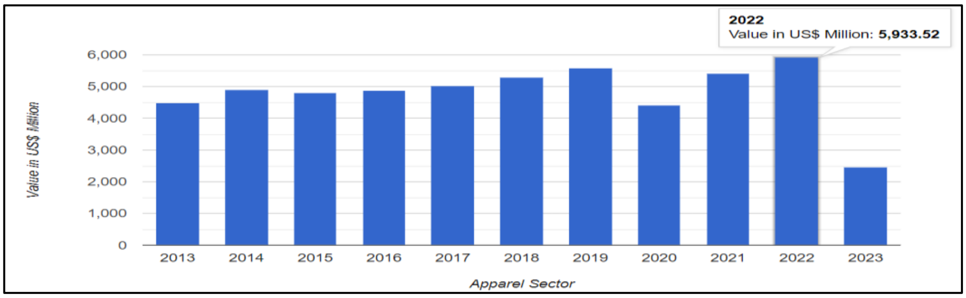
Further, as per the Industry Capability Report published in 2022 by SLEDB, Sri Lankan apparel exports are known for the use of best practices and technology in the apparel sector where they included the world's first eco-friendly "Green Garment Factory" that cut energy and water consumption by 50% and 70% respectively. These factories have adopted lean manufacturing which has helped them lower their overheads and yield faster Return on Investment, leading to sustainable businesses.

In addition to that, according to SLEDB, Sri Lanka has the ability to provide a competitive regional advantage by utilizing regional strengths in the supply chain, which is one of the core competencies of the apparel industry in Sri Lanka. Further, the investment-friendly government policies of the country and strategic location advantage significantly contribute to the success of the Sri Lankan apparel sector.

1.1.1. Impact of Apparel Industry on Sri Lanka's Economy

The Sri Lankan apparel industry is one of the main contributing sectors to the country's economy. As per the SLEDB Statistics, performance in the apparel sector exports in 2022 was recorded as USD 5933.52 Million (Figure 1).

Figure 1: Performance in the Apparel Sector Exports in 2022

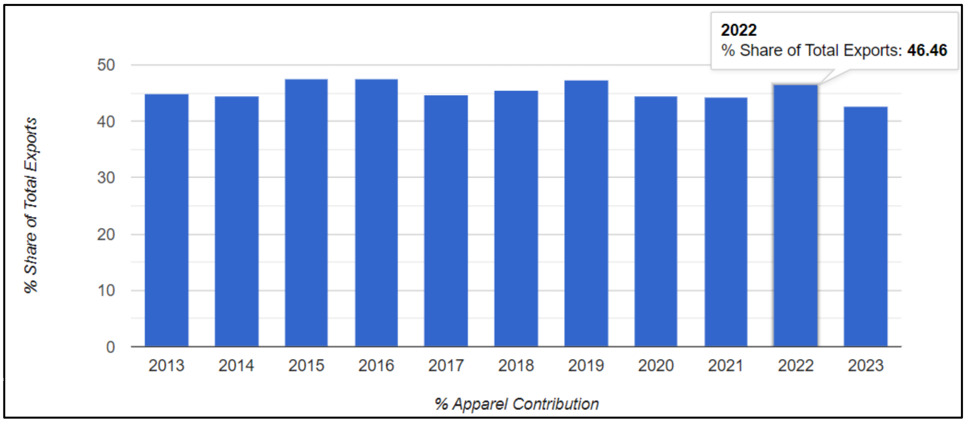


Source: SLEDB Statistics

According to SLEDB Statistics, apparel and textile exports account for approximately 46.46% of the country's total merchandise exports as of December 2022 (Figure 2).

Moreover, as stated in the Central Bank of Sri Lanka (CBSL) Annual Report, earnings from total exports surpassed USD 13 Billion per year for the first time in the year 2022, which marked an increase of 4.9% from the previous highest recorded in the year 2021. The increase was mainly due to the increased earnings from industrial exports, which include apparel and textile exports. Further, in 2022, there was a decline in the cumulative trade deficit, which was mainly due to the increase in apparel and textile exports. However, in the month of December 2022, there was a decline in earnings from industrial exports compared to December 2021, which was mainly due to the high inflation and recession faced by Sri Lanka's major markets, including the European Union (EU), UK, and USA.

Figure 2: Merchandise Exports in Apparel Sector as of December 2022



Source: SLEDB Statistics

Further, as per the national accounts data published by CBSL on Gross Domestic Product (GDP) by industrial origin at current market prices under GDP (Production Approach), for 2022, the Sri Lankan apparel industry contributes approximately 6% to the country's GDP.

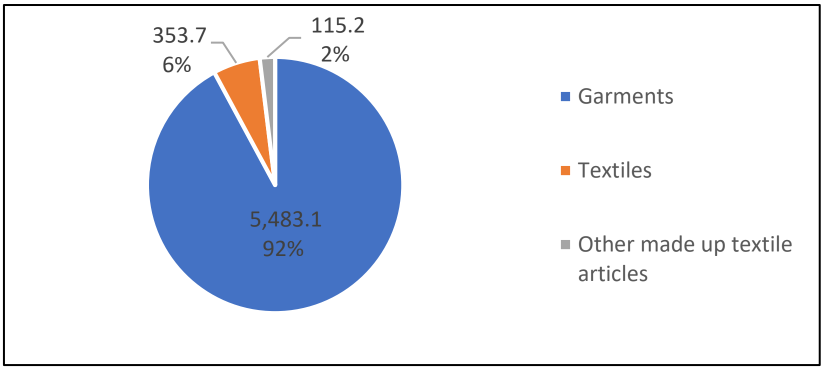
Furthermore, the apparel industry significantly contributes to job creation and employment in the country. Brandix, MAS Holdings and Hirdaramani are prominent multinational apparel organizations with workplaces and garment factories across Asia, Europe, and North America (Roshana et al., 2020). According to SLEDB, the apparel industry provides direct employment for 350,000 individuals, with another 350,000 people (approximately) supporting this workforce. Moreover, female participation in the workforce is noteworthy in this industry, which approximately amounts to 34%. Thus, it is quite apparent that the apparel industry significantly impacts on the country's economy.

1.1.2. Latest Tendencies in Apparel and Textile Exports

With the COVID-19 pandemic, there was a reduction in global demand for Sri Lankan apparel and textile products. Moreover, with the government-imposed restrictions regarding safety in the workplaces, the apparel factories initially could not operate at their full capacity. However, without much time, the apparel industry could identify and exploit some new opportunities even during the pandemic situation. They started producing personal protective equipment (PPE) during that period.

Under the different categories of garments and textiles exports in 2022, the garment category, textiles category and other made-up textile articles account for 92%, 6% and 2% of the total textiles and garment exports, respectively (Figure 3).

Figure 3: Garments and Textiles Exports in 2022



Source: SLEDB Statistics

1.1.3. Apparel and Textile Exports Before and After COVID-19

Prior to the COVID pandemic, during its peak, Sri Lanka's apparel and textile exports significantly declined due to order cancellations and island-wide lockdowns, which adversely affected production. In addition, the majority of the raw materials were imported from China for the Sri Lankan apparel sector, and China's slowdown due to COVID-19 significantly affected production. According to the Joint Apparel Association Forum Sri Lanka (JAAFSL), which is the leading body of the apparel industry in Sri Lanka, export earnings from apparel and textiles declined by 21% in the first 10 months of 2020 as compared to 2019. According to Weerasinghe et al. (2023), this health crisis also contributed to the country's economic crisis, which was initially thought to have no signs of recovery for Sri Lanka as a developing country that heavily relies on industrial exports like apparel and textiles. However, as the situation improved when restrictions were lifted by the government, apparel and textile production started to increase, and the industry as a whole began to bounce back.

1.1.4. Importance of Modelling and Forecasting Apparel and Textile Exports

Modelling and forecasting apparel and textile exports in Sri Lanka is important for several reasons. One of the main reasons is the impact of apparel and textile exports on the Sri Lankan economy. It is one of the primary sources of foreign exchange earnings of the country while creating many employment opportunities and driving employment growth in the labour market. Thus, modelling and forecasting apparel and textile exports would be important to identify the behaviour of the exports and identify the factors affecting fluctuations. Besides, in general, the import payments exceed the export earnings, resulting in a trade deficit in Sri Lanka over the years. To address this trade deficit issue and increase the contribution to the export earnings through apparel and textile exports, it is important to identify the past behaviour of the apparel and textile exports, model it and generate forecasts. (Edirisooriya and Senevirathne, 2020).

Further, if the apparel and textile exports can be modelled with improved accuracy, policymakers can formulate trade and industrial policies to improve the economic impact of the sector. In addition to that, the apparel businesses would also be able to utilize and encourage innovation, attract investments, and grow businesses sustainably by considering the latest dynamics of the industry.

1.2. Significance of the Study

Modelling and forecasting export values of the apparel sector, which is a vital sector that significantly contributes to the Sri Lankan economy, is an important area to study. Though there are previous studies done to model and forecast industrial exports as a whole, there are only a few studies done on modelling and forecasting apparel sector exports specifically. One of the previous studies examined the Sri Lankan apparel and textile exports' behaviour prior to the COVID-19 pandemic. However, no previous literature was found which has modelled and forecasted apparel and textile exports in Sri Lanka with a special reference to the COVID-19 pandemic. This study, using the latest available data, was identified as an area to scrutinize and provide significant implications to different stakeholders.

1.3. Problem Statement

No previous studies have been done to model and forecast Sri Lankan apparel and textile exports with a special reference to the COVID-19 pandemic. However, due to the significant impact of the apparel sector on Sri Lanka's economy, it was identified as an important area to study. Therefore, this study attempts to model and forecast the apparel and textile export figures in Sri Lanka.

1.4. Objectives of the Study

The objectives of this study are:

- to model and forecast future apparel and textile export figures
- to find whether Sri Lankan apparel and textile exports are significantly affected by the COVID-19 pandemic
- to identify major fluctuations in the data over the period of study with relevant reasons

2. Literature Review

2.1. Apparel Industry in Sri Lanka

Embuldeniya (2015) studied the apparel industry's impact on the GDP of Sri Lanka. The apparel industry export figures were taken as the independent variable for the study. The finding was that a positive relationship existed between the apparel exports and the GDP of the country, which implied that the apparel sector had an impact on Sri Lanka's economy.

Abeysinghe (2014) stated that the apparel industry was showing a declining contribution to the country's economy, and it was losing the comparative and competitive advantage it once held in the 1980s. However, with reference to the past decade, it was found that there was no substantial decline in the apparel industry's impact on the country's economy, though it indicated a weak positive relationship.

Further, according to the national accounts data published by CBSL on GDP by industrial origin at current market prices under GDP (Production Approach), for the year 2022, the Sri Lankan apparel industry contributes approximately 6% to the country's GDP.

2.2. Data-Driven Approaches of Modelling and Forecasting Time Series

A significant body of literature on time series modelling, and forecasting has been available in recent times. Hence, it is one of the major research interests of many scholars who are into time series analysis. Different mathematical models are put forward in the literature for improving the accuracy and effectiveness of such modelling and forecasting methods.

2.2.1. Tourist Arrivals

Lin et al. (2011) forecasted tourist arrivals in Taiwan using the data from January 2004 and June 2010. ARIMA, Artificial Neural Network, and Multivariate Adaptive Regression Splines models were employed for the study. The ARIMA model was selected as the best-fitted model based on RMSE, MAPE, and MAD values.

Nagendrakumar et al. (2021) forecasted the tourist arrivals for the period of August 2021 to August 2025, modelling the data using the ARIMA model for the monthly tourist arrivals from January 2000 to July 2021. The best-fitted model was the ARIMA (12,1,3) model, which showed better accuracy in forecasts of tourist arrivals.

2.2.2. Cotton Exports

Ghosh (2017) examined cotton exports in India and utilized the ARIMA model to forecast cotton exports in India in the short run. The study evaluated the ARIMA model with simple exponential smoothing and Holt's two parameters of exponential smoothing to derive the model with higher accuracy. The ARIMA model demonstrated better forecasts than the other models and identified that forecasts are better for the near future. To forecast for a five-month period, the selected model was ARIMA (1,1,0). The predictive power of the model was also tested.

2.2.3. Textile and Garment Exports

Edirisooriya and Senevirathne (2020) modelled and forecasted textiles and garment exports using the export data from 2009 to 2018. The study used Box-Jenkins methodology, and SARIMA modelling was done to model and forecast the exports. The best-fitted model was selected as SARIMA $(2, 1, 0)(1, 0, 2)_{12}$ based on the Akaike criterion, Schwarz Criterion and Hannan-Quinn Criterion. The forecast figures were validated using MSE. However, since the study used the data until 2018, it did not include the shocks resulting from the COVID-19 pandemic and the country's economic downturn.

2.2.4. Oil and Gas Exports

Ahmar et al. (2022) conducted a study to model and forecast oil and gas exports in Indonesia. The study used data retrieved from the Indonesian Central Bureau of Statistics website from January 2010 to March 2022. The analysis was done using R software, and the ARIMA Model was used for modelling and forecasting.

The ARIMA (0,1,1) model was chosen as the best-fitted model using the information criterion, AIC. The study found that the forecasts for oil and gas exports in Indonesia were steady until September 2022.

2.2.5. Agricultural Prices

Wawale et al. (2022) examined the agricultural prices in India to perform forecasting. The period of data used for the modelling was from 2016 to 2021, and forecasts were validated for 2022. The ARIMA model was used, and the forecast accuracy was investigated using MSE and MAPE metrics. The study stated that accurate forecasts were generated with ARIMA modelling.

3. Methodology

3.1. Data Sample

The study is entirely based on the secondary data collected from textile and garment export data published by CBSL under the section of External Sector – Exports, Imports and Trade. Monthly exports of textiles and garments (in USD Million) from January 2007 to December 2022 were considered for this study. The data will be divided into training and test datasets: training set from 2007 January to 2021 December and the test set from 2022 January to 2022 December.

3.2. ARIMA Modelling

Based on the literature, it was found that the ARIMA model generates more accurate forecasts over a short time span than other models. This particular study aims to generate apparel and textile forecasts for the near future; therefore, this model was selected for generating forecasts.

3.2.1. Data Preprocessing

The dataset will be scrutinized first to see if there are any missing values in the series. The ARIMA model does not inherently handle missing data in a time series. Therefore, it is important to address it prior to fitting the model, and Kalman smoother can be used to impute missing values. In addition to this, scrutinizing the outliers will be done. If the outliers have occurred due to a data entry error, they will be removed. However, in this study, there can be outliers due to the COVID-19 pandemic-caused shocks, and they will be retained in the analysis because they contain important information.

3.2.2. SARIMA Model

Based on the literature, the SARIMA Model will be used for the study to find the point forecasts with accuracy.

The general form of seasonal Autoregressive Integrated Moving Average or SARIMA process can be written as follows (Equation 1).

$\phi_p(B)\Phi_p(B^s)W_t = \theta_q(B)\Theta_q(B^s)\varepsilon_t$ ---------------------------------------(1)

B denotes the Backward shift operator, whereas ϕ_p, Φ_p, θ_q, Θ_q are the polynomials of order p, P, q, Qand respectively. ε_t denotes the white noise at period t. $W_t = \nabla_d \nabla_s^d Y_t$ denotes the differenced series (Priyangika et al., 2016). Here, ∇_d and ∇_s are ordinary and seasonal difference components (Chang et al., 2012).

3.2.3. Statistical Techniques Used

For this study, R programming is used due to its user-friendliness. To run different statistical tests and generate data visualizations, several packages were installed: readxl, fpp3, tseries, forecast and sarima. The readxl package helps to load the data from Excel to R. The fpp3 package loads packages such as tibble, dplyr, tidyr, lubridate, ggplot2, tsibble, tsibbledata, feasts and fable for time series analysis. The t-series package allows time series analysis and computational finance, and contains stationarity tests. The Sarima package includes functions, classes and methods in time series modelling for ARIMA and related models. The forecast package allows displaying and analyzing univariate time series forecasts, including automatic ARIMA modelling.

In R, three approaches will be used for modelling the data: the ARIMA function, the ARIMA function with the "Approximation=FALSE" argument and Auto. Arima function.

The best-fitted model will be derived by comparing the Akaike Information Criterion (AIC), Corrected Akaike Information Criterion (AICc) and Bayesian Information Criteria (BIC) values of each approach.

Then, the model adequacy will be checked with residual analysis and the Ljung-Box test. Finally, the accuracy of the forecasts will be checked with metrics such as Mean Absolute Percentage Error (MAPE), Root Mean Squared Error (RMSE) and Mean Absolute Error (MAE). Lewis (1982) mentioned in his study that the model provides good forecasting if the MAPE value is less than 20%.

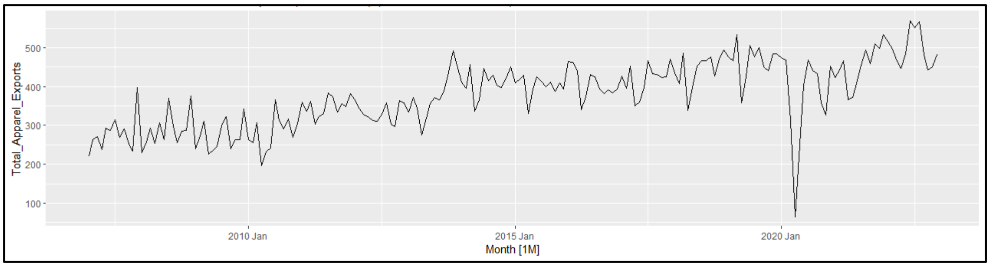
4. Analysis

Data visualizations, modelling and forecasting of the textile and garment exports were done using R Programming Language.

4.1. Visualize the Whole Time Series

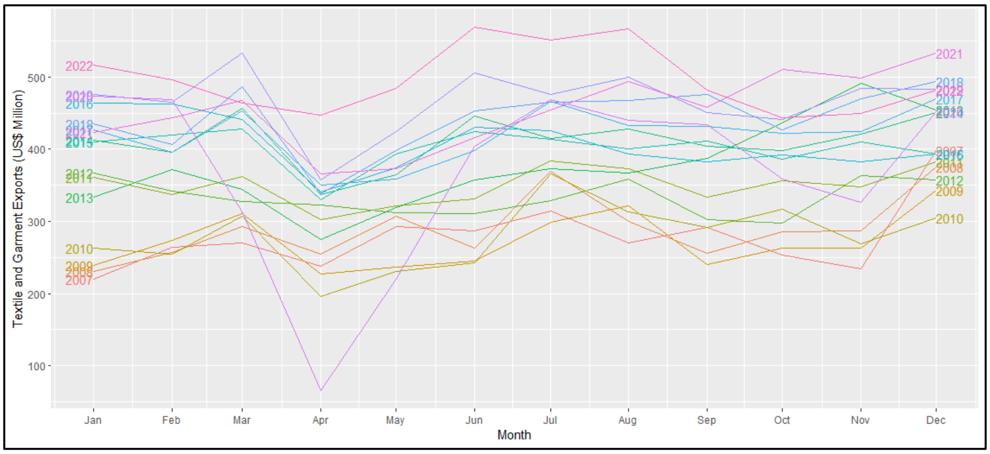
Time series plot, seasonal plot and sub-series plot of the data are used to visualize the time series (Figures 4, 5 and 6).

Figure 4: Time Series Plot (2007 January – 2022 December)



Source: Output of Data Analysis

Figure 5: Seasonal Plot (2007 January – 2022 December)



Source: Output of Data Analysis

Figure 6: Subseries Plot (2007 January – 2022 December)

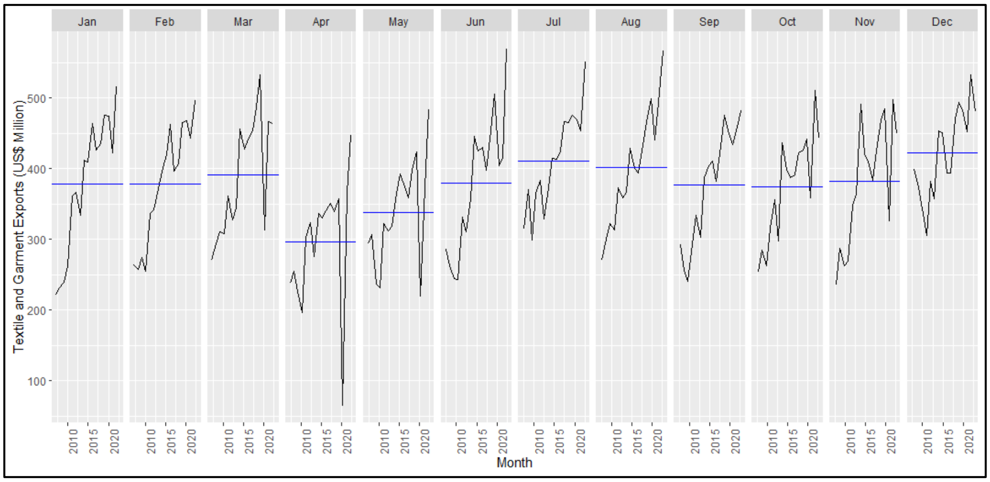


Figure SEQ Figure * ARABIC 6: Subseries Plot: 2007 Jan - 2022 Dec

Source: Output of Data Analysis

When visualizing the time series of the exports from January 2017 to December 2022 using the above plots, some seasonal fluctuations and different irregular shocks can be observed.

As per the seasonal and subseries plots, the seasonal impact on textile and garment exports can be clearly identified. As per the above plots, the months of March and December months show high export earnings. The reason for this is the summer, late summer, and early spring seasons of different regions. (Edirisooriya and Senevirathne,2020). However, March 2020 shows a significant drop in export earningsbecause of the COVID-19 pandemic. Similarly, garments and textiles show high export earnings in the months of June, July, and August in general. This is mainly due to the summer season, which falls from June to August in the countries of major Sri Lankan apparel and textile export markets.

As per the plot, in the time series from 2007 to 2022, the textile and garment export earnings (in USD Million) have generally increased with a few exceptions.

According to JAAFSL, over 30% of Sri Lanka's apparel exports are exported to the EU. During the period spanning from 2007 to 2010, under the GSP+ access, Sri Lanka managed to improve Sri Lankan exports to the EU market by 7.96% on average despite the financial crisis followed by a decline in demand in the Europe from 2009 to 2010 (Weekly Political Review,2017). Moreover, after the civil war in Sri Lanka, the country's economy started to stabilize, which also impacted on textiles and garment exports favourably. (Edirisooriya and Senevirathne,2020). After losing the GSP+ trade concession in 2010, Sri Lankan exports to the EU market increased only by 1.02%. (Weekly Political Review,2017). However, though Sri Lanka regained the GSP+ status in 2017, the EU had entered into trade agreements with many countries, making it competitive and less lucrative for Sri Lanka even under the GSP+ status.

Within the first few months of 2020, when the peak of the COVID-19 outbreak occurred, Sri Lankan apparel and textile exports declined significantly due to lockdowns and high order cancellations. JAAFSL stated that the apparel and textile exports declined by more than 24% to USD 3.93 billion. However, from July onwards, the industry could quickly adapt to the situation and bounce back within a short period, demonstrating an increasing trend, which can also be observed in the above plots.

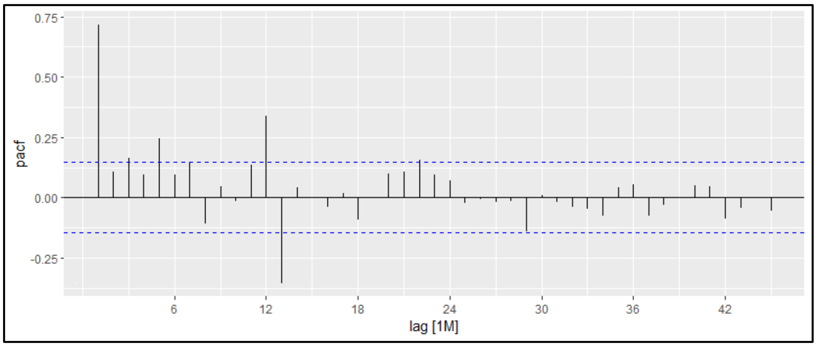
As the plots depict, the apparel industry continued to grow further in 2021. According to JAAFSL, in 2021, Sri Lankan textiles and garments exports surged by 21.5% at the end of September to USD 3.54 billion. According to the statistics for the year 2021, the EU was the largest export market, accounting for approximately 24.1% of the country's total merchandise exports. In 2021, Sri Lankan textiles and garments export earnings for the months of October, November and December recorded the highest sales ever in respective months in the history of apparel and textile exports. When exploring major incidents that happened during the year 2021 regarding the apparel industry, it is noteworthy to mention China entering into a Memorandum of Understanding (MoU) to lift the Sri Lankan apparel sector and Mila Fashion investing in Sri Lanka to establish new apparel manufacturing facilities in the country.

In 2022, it shows high export earnings of textiles and garments exports. However, from October 2022 onwards, the export earnings have declined. According to the CBSL, this is mainly due to the recession and decline in demand for Sri Lankan apparel and textile exports from its major markets. In addition to that, in the latter part of 2022, economic and political chaos prevailed in Sri Lanka, such as excessive inflation, daily power cuts, and fuel shortages affecting the apparel manufacturers adversely. CBSL statistics showed that in December 2022, Sri Lankan apparel & textiles exports fell by 9.56% yearly to USD 480.28 Million.

4.2. Determining the Stationarity of Time Series

Autocorrelation function (ACF) and Partial Autocorrelation (PACF) plots were used to detect the stationarity of the apparel and textile exports time series (Figures 7 and 8).

Figure 7: Partial Autocorrelation Function (PACF)



Source: Output of Data Analysis

Figure 8: Autocorrelation Function (ACF)

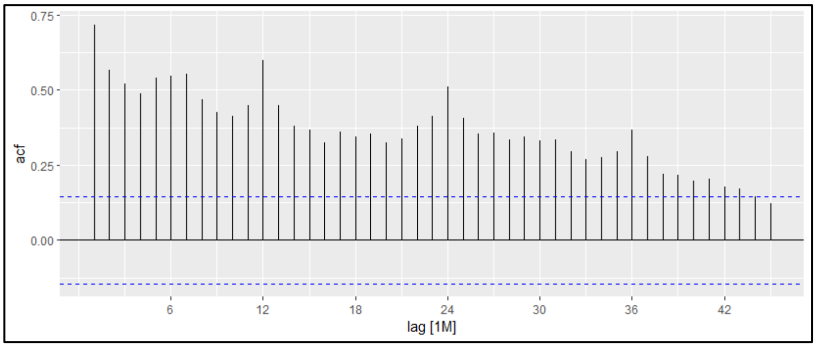


Figure SEQ Figure * ARABIC 8: PACF Plot for Apparel and Textile Series

Source: Output of Data Analysis

As the lags increase, the slowly decaying ACF plot implies that the data is trended. Further, the scalloped shape can be observed with larger autocorrelations for seasonal lags (at multiples of 12 periods) than for other lags, which indicates the seasonality in the data. As per the PACF plot, significant spikes at lags 1, 12, and 13 indicate the presence of a seasonal pattern with cycles of 12 and 13 months. Thus, with both plots, the data shows trend and seasonal behaviour, implying the non-stationarity in the series.

4.3. Fitting ARIMA Model

Since the ARIMA model can handle non-stationarity, the original series (non-stationary) was used for modelling purposes. The best-fitted model was selected after employing three approaches: ARIMA function, ARIMA function with "Approximation=FALSE" argument and auto. Arima function.

The following table (Table 1) summarizes the generated output of each of the above approaches.

Table 1: Evaluating Different Approaches

Approach	ARIMA Model	Coefficient Value		σ^2	log likely--hood	AIC Value	AICc Value	BIC Value
Using ARIMA Function	ARIMA (0,1,2) $(2,0,0)_{12}$	ar1		1871	-929.74	1869.48	1869.83	1885.42
		ma1	-0.3499					
		ma2	-0.3328					
		sar1	0.3801					
		sar2	0.2984					
Using ARIMA Function with Approximation = FALSE Argument	ARIMA (1,1,1) $(2,0,0)_{12}$	ar1	0.5847	1864	-929.49	1868.97	1869.32	1884.91
		ma1	-0.9666					
		ma2						
		sar1	0.4078					
		sar2	0.2818					
Using auto.arima Function	ARIMA (0,1,2) $(2,0,0)_{12}$	ar1		1871	-929.74	1869.48	1869.83	1885.42
		ma1	-0.3499					
		ma2	-0.3328					

sar1	0.3801
sar2	0.2984

Source: Output of Data Analysis

Based on the above AIC, AICc and BIC values, the second approach, which used the ARIMA function with Approximation = FALSE Argument, has the minimum values for each criterion, especially AICc. Therefore, ARIMA (1,1,1) $(2,0,0)_{12}$ is selected as the best-fitted model to forecast apparel and textile exports in Sri Lanka.

The equation for the model can be written as follows (Equations 2 and 3).

$$(1-\phi_1 B)(1-\Phi_1 B^{12})(1-\Phi_2 B^{24})(1-B)Y_t = (1+\theta_1 B)\varepsilon_t \text{ -----------------(2)}$$

$$(1-0.5847B)(1-0.4078B^{12})(1-0.2818B^{24})(1-B)Y_t = (1-0.9666B)\varepsilon_t \text{-- (3)}$$

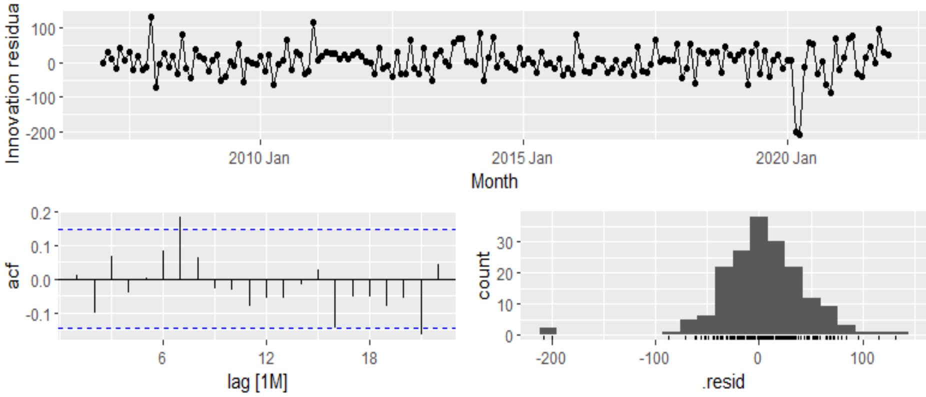
Where Y_t is total Sri Lankan apparel and textile exports at time t and ε_t is residual at time t.

4.4. Checking the Model Adequacy

4.4.1. Residual Diagnostic Graphs

To determine whether the selected model is adequate, the residual diagnostics of the best-fitted model, ARIMA (1,1,1) $(2,0,0)_{12,}$ were examined (Figure 9).

Figure 9: Residual Diagnostics Graph



Source: Output of Data Analysis

The time plot of the residuals of the ARIMA (1,1,1) $(2,0,0)_{12}$ model shows that the mean of the residuals is close to zero and the variance of the residuals stays within a constant band except for two outliers (data points referring to 2020 March and 2020 April). Further, the histogram also seems to be normal if the two outliers are ignored.

Moreover, the ACF plot of the residuals from the fitted model, ARIMA (1,1,1) $(2,0,0)_{12}$ exhibits that all autocorrelations except two small yet significant spikes are within the threshold limits. However, it is still consistent with white noise. To confirm the white noise behaviour of residuals, the portmanteau test Ljung-Box test is employed.

4.4.2. Portmanteau Test Ljung-Box Test

According to Hyndman and Athanasopoulos (2018), the lag value for the test would be taken as twice the period of seasonality, which is 24. The generated output is as follows (Table 2).

Table 2: Ljung-Box Test Output

lb_stat	lb_pvalue
30.4	0.0638

Source: Output of Data Analysis

As per the output, the p-value (0.0638) is greater than the level of significance (0.05), which suggests there is not enough evidence to reject the null hypothesis. Therefore, the residuals of the model are serially uncorrelated.

4.4.3. Plotting the Characteristic Roots of the Model

An invertible model should have all the roots inside the unit circle. For the selected model, all roots have a modulus less than one and lie within the unit circle, therefore, the fitted model, ARIMA (1,1,1) $(2,0,0)_{12,}$ is adequate for forecasting (Figure 10).

Figure 10: Unit Circle

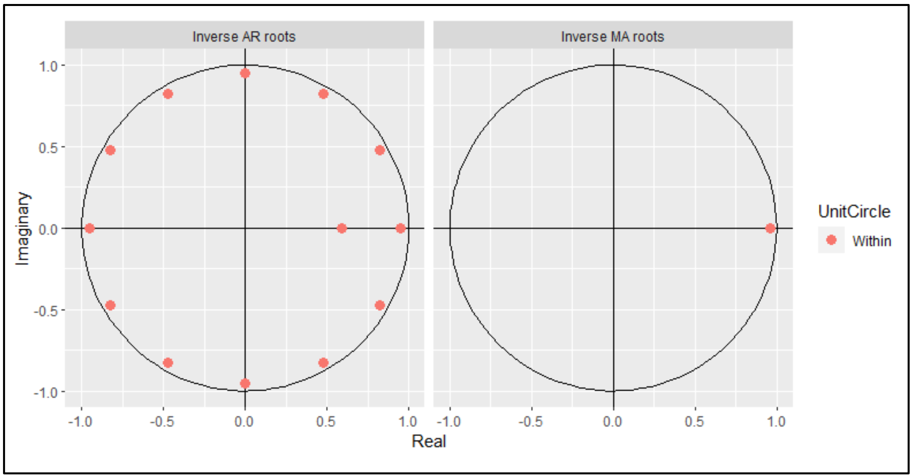


Figure SEQ Figure * ARABIC 10: Inverse Characteristic Roots for the ARIMA (1,1,1) $(2,0,0)_{12}$ Model

Source: Output of Data Analysis

4.5. Forecasting Export Values using the Model

The generated forecasts for the testing period (next 12 months, i.e., from 2022 January to 2022 December) are as follows (Table 3).

Table 3: Point Forecasts for the Testing Period

Data Point	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
181	489.03	433.71	544.35	404.42	573.64
182	478.23	413.19	543.27	378.76	577.70
183	433.97	365.36	502.58	329.04	538.90
184	316.98	246.83	387.12	209.69	424.26
185	359.78	288.87	430.69	251.33	468.23
186	427.03	355.67	498.38	317.90	536.16
187	460.04	388.39	531.69	350.47	569.62
188	467.11	395.24	538.98	357.20	577.03
189	450.74	378.68	522.79	340.54	560.93
190	450.46	378.24	522.67	340.01	560.90

191	436.21	363.84	508.58	325.53	546.89
192	485.83	413.32	558.34	374.93	596.73

Source: Output of Data Analysis

The generated forecasts for future values beyond the testing period are as follows (Table 4).

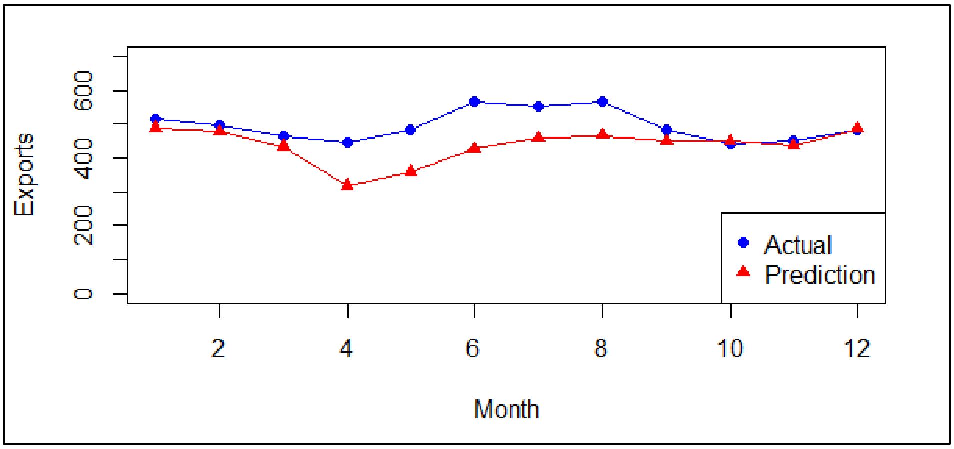
Table 4: Point Forecasts for 2023 January to 2023 December

Data Point	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
193	459.66	382.25	537.07	341.27	578.04
194	460.96	381.39	540.53	339.26	582.66
195	449.62	368.93	530.31	326.22	573.03
196	373.37	292.01	454.73	248.94	497.80
197	392.64	310.82	474.47	267.50	517.78
198	432.20	350.02	514.38	306.51	557.89
199	456.55	374.06	539.04	330.39	582.70
200	470.46	387.70	553.23	343.89	597.04
201	453.98	370.96	537.00	327.01	580.95
202	468.55	385.27	551.82	341.19	595.90
203	459.21	375.70	542.73	331.49	586.94
204	489.34	405.59	573.09	361.25	617.43

Source: Output of Data Analysis

The following plot illustrates the actual values and the forecast values for the testing period, i.e., from January 2022 to December 2022 (Figure 11).

Figure 11: Actual Values and the Forecast Values for the Testing Period,

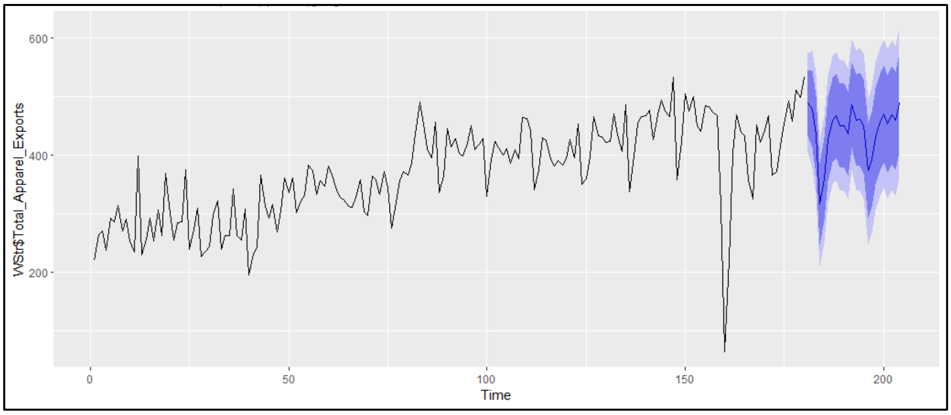


From January 2022 to December 2022

Source: Output of Data Analysis

The plot of the forecasts from January 2022 to December 2023 (24 months) is as follows (Figure 12). According to the plot, it depicts that the forecasts have captured the trend and the seasonal behaviour of the apparel export time series.

Figure 12: The plot of the forecasts from January 2022 to December 2023



Source: Output of Data Analysis

4.6. Checking Accuracy of the Forecasted Values

The accuracy of the forecasts of the best-fitted model, i.e., ARIMA (1,1,1) $(2,0,0)_{12}$, is measured using metrics such as MAPE, RMSE and MAE). The results are as follows (Table 5).

Table 5: Checking Accuracy of Forecasts

Model	MAPE	RMSE	MAE
ARIMA (1,1,1)$(2,0,0)_{12}$	11.77%	78.57	59.92

MAPE of 11.77% implies that the forecasted export figures would differ from the actual values by approximately 11.77%. This indicates that the forecasting model ARIMA (1,1,1)

$(2,0,0)_{12}$ has an average prediction error of 11.77%. Lewis (1982) mentioned in his study that if the MAPE value is less than 20%, the model provides good forecasting; therefore, the generated forecasts can be considered good forecasts. In calculating RMSE, the difference between forecast and corresponding actual values are each squared, then averaged over the sample and the square root of the average is obtained. The output shows RMSE as 78.57. MAE the average over the test sample of the absolute values of the differences between the forecast and the corresponding actual value, which is 59.92.

5. Conclusion

The fitted ARIMA (1,1,1) $(2,0,0)_{12}$ model did a good forecast of textile and garment exports for the year 2022 and is expected to do so for 2023. Since the model has a MAPE of 11.77%, this model can be used for further forecasting under necessary amendments.

Though the COVID-19 pandemic posed considerable challenges to the industry in the initial phase, it could quickly adapt to the situation and bounce back within a short period, showing a significant improvement in export earnings in the post-COVID period. The generated forecasts would provide valuable insights to the government and other stakeholders when making decisions to stimulate the industry dynamics, considering the impact on the country's economy. However, this study is limited to a univariate analysis of textile and garment exports using past data, though many other factors, such as exchange rates and Free Trade Agreement negotiations can significantly influence on the exports (Lu, 2015).

It is recommended that the ARIMA models should be used only for short-span forecasting, even though the models are fitted with a Mean Absolute Percentage

Error of less than 20%. ARIMA models to forecast exports should be updated at least once in two years to predict for another at most two years.

6. Future Research

In this study, the SARIMA Model was used to produce forecasts, however, they are not capable of handling volatility and nonlinearity presented in data series (Dritsaki, 2018). Therefore, future research can be done to explore the existence of volatility behaviour in the data. This can be captured by GARCH models, variations of GARCH models or hybrid ARIMA-GARCH models as appropriate. In addition, Lu (2015) stated in his study that more accurate forecasting can be done through some computing technological methods such as Artificial Neural Networks.

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