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Future outlook of Sri Lankan Textile and Apparel exports: A comparison of Time Series Models

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University of Sri Jayewardenepura
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Ethics Disclaimer Declaration

- Group Name : Standard Deviators
- Module : STA 351 2.0 Research Methodology
- Lecturer in charge : Dr. Neluka Devpura
- Date of submission : 08/10/2021

We declare that this report is an original work of the group members mentioned below and all members have actively participated and contributed to the report.
Any other work of similar nature has been properly referenced in this report.

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CONSENT OF APPROVAL

The work described on this research was carried out by us under the supervision of Dr. Neluka Devpura and a report on this has not been submitted in whole or in part to any University or any other Institution for another Degree/Diploma.

……………………………………………. Date: 08/10/2021

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I certify that above statement made by the candidate is true and that this thesis is suitable for submission to the University for purpose of evaluation.

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Abstract

Exports plays an important role in the economy of a country. Apparel and textile exports is the major export type of Sri Lanka. Several studies have done to find out the factors affecting on apparel exports of Sri Lanka. However, prediction of apparel exports in the future also plays a vital role. This study examines the most suitable time series model for the prediction of future revenues from apparel exports. Statistical software's MINITAB and R were used for the model selection process. Data were taken from Joint Apparel Association Forum website from year 2009 to 2019. Auto Regressive Integrated Moving Average (ARIMA) and Holt Winter models are fitted and compared to get the least error and least deviation in the predictions. Holt Winter model showed the least mean average percentage error of 4.52 and mean absolute deviation of 19.4, hence used to forecast future values. Significant drop due to COVID-19 pandemic is visible in the time series graph of actual and predicted values.

1. Introduction

1.1 Background

Exports represent an important role in advancing a country's economy. In the context of Sri Lanka, exports of Textile and Apparel (T&A) industry plays a crucial part being the most significant and dynamic contributor to the economy of the island nation (Export Development Board of Sri Lanka, 2021). Since the liberalisation of the economy in 1977, T&A industry has been serving the country being a notable destination for a diverse range of multinational clothing brands. As the country which constitutes the highest apparel exports per capita of any exporting nation in the region, Sri Lanka is known as the 'isle of apparel'. Due to the strong reputation the country holds for over three decades for ethical manufacturing and supplying high-quality apparel worldwide, Sri Lanka proudly presents its T&A tagline "Garments without guilt". As a result of this, Sri Lanka was able to be a preferred destination for major global brands such as Patagonia, Lululemon, North Face, Nike, H&M, Victoria's Secrets, Ralph. Countries such as the United States, United Kingdom, the EU, Canada, China and Australia became the leading destinations for Sri Lanka T&A exports which have remained even in the year 2021.

Sri Lankan apparel which started with traditional exports, has now expanded from tailoring designs to providing sophisticated solutions, creativity, and experience in BPO services, Fashion, R&D, and Innovation Centres. Being the largest export merchandise from Sri Lanka, the T&A sector has maintained a 40% or higher share of total merchandise exports from the island nation for over a decade. The highest record in apparel export history of Sri Lanka was recorded in the year 2019 as 5.2 billion U.S. dollars, indicating a 5.1% year on year increase. According to BOI Sri Lanka (2021), the industry contributes to forex earnings by USD 5.2 Billion and plans to expand to USD 10 Billion by the year 2025. In terms of labour force statistics, T&A has created employment opportunities for approximately 15% of the Sri Lankan workforce by the year 2019 and the Institute of Policy Studies Sri Lanka estimates this industry contribution in numbers as 300,000 – 600,000 direct and indirect employment.

The T & A industry experienced severe drawbacks in the face of Covid-19 global pandemic and subsequent economic downturn since the beginning of the major outbreaks. The export of textiles and apparel industry dropped by 18.9 percent due to lower demand from the USA, the EU, and other markets. With the foreign transactions restrictions imposed by the Sri Lankan government, the situation worsened for the T & A industry as the companies were unable to import raw materials from foreign suppliers, hindering the entire manufacturing process. Although many companies reopened soon after the lockdowns in response to COVID-19, overall capacity was reduced due to government-imposed laws and regulations such as workplace curfews, social distance and limited attendance and the workforce attrition rates were reported to be high due to factors such as cutting out benefits, salary cuts, reducing overtime hours and shift basis work hours. With all these negative factors, new product lines and trends have been identified in the T & A industry with the significant rise in garment sales online and hygienic clothing demand.

1.2 Research Problem

Given the importance of Sri Lanka T&A industry and its exports, it is crucial and beneficial at the same time for T&A exporters as well as policymakers to have a foresight of the textile and apparel exports for successful operations in the industry which has not been done yet in the Sri Lankan context. Also, with the current dynamic situation impelled by Covid-19, it enhances this need with the current work challenges and trends experienced by the industry. Thus, it is essential to conduct a forecasting for T&A exports in Sri Lanka while investigating the COVID 19 effect.

1.3 Objectives of the Study

The main objective of this study is to forecast the Sri Lankan T&A exports from August 2021 to July 2022. In order to achieve this objective, this study aims to investigate the accuracy of different time series models. To address a research need identified and outlined in the literature, the study focuses on investigating the effect of COVID 19 on Textile and Apparel exports in Sri Lanka. Moreover, with the results of study, the authors intend to provide recommendations that would enable T&A exporters to plan ahead to increase the bottom line and policymakers for the improvement in trade balance and economic growth.

1.4 Scope of the Study

This study focuses only on the export revenue as the economic indicator to forecast T&A exports and also the forecast was conducted only for one year. The study was limited only to the post war time period as the civil war had a considerable impact on the economic status of the country including garments and textiles export industry depicting several irregular shocks. For the purpose of this study, monthly data were considered which were obtained from January 2009 to July 2021.

1.5 Significance of the Study

There are three primary groups that benefit from this study. The first group would be the T&A exporters in Sri Lanka who will be able to plan ahead and identify ways in which they can maximize export revenues. As forecasting being a tool to drive a company to its success, T&A organizations can optimise business operations such as cash flow, production, staff, and financial management to make informed business decisions which is more beneficial during this dynamic period in time. The second group that may benefit from this study is policymakers. They can utilise this study in terms of balancing Sri Lanka's trade and make plans for economic growth in the future. Finally, investors can use these findings to make good use of the money they invest understanding the fluctuations in the exports.

2. Motivation and Literature Review

2.1 Sri Lankan Textile and Apparel (T&A) Sector

The Textile and apparel industry is a crucial part in Sri Lanka's economy. Export Development Board of Sri Lanka (2021) states that T&A sector is the most significant and dynamic contributor to Sri Lankan Economy. Samanthi (2021) highlights that Sri Lanka has been a notable destination for multinational clothing brands since the liberalisation of the economy in 1977. Embuldeniya (2015) explains that countries such as the United States, United Kingdom, the EU, Canada, China and Australia are amoung leading destinations for Sri Lanka T&A exports which have been remained even in the year 2021 according to the report published by EDB Sri Lanka (2021). For the benefit of the reader, some context of the distinction between Textile and Apparel is that Textile refers to pre-garment produce such as fabrics and yarn and apparel are fully or partially finished garments (Lu, 2015). Nevertheless, Sri Lankan industry consider both under the same umbrella.

Many Corporate and Empirical publications including Dissanayake, et al., (2017) designate the trend amoung Consumers of major clothing brands who are shifting towards ethical production of the garments and the supply chain sustainability. As Ruwanpura (2016) highlight, Sri Lanka was able to position itself as an ethical producer and add value to the supply chain which made Sri Lanka a preferred destination for major brands to manufacture in Sri Lanka. This paved the way to the birth of renown Sri Lankan T&A Tagline; "Garments without Guilt" that brought many brands such as Patagonia, Lululemon, NorthFace, Nike, H&M, Victoria's Secrets amoung many others (Goger, 2013; Samanthi, 2021).

Dilhani (2015) argues that Sri Lankan T&A industry dates back to Before the common era making references to the era of King Wijeya (543-505 BCE) and the cotton industry that has been prominent in Sri Lanka during the time. According to Wijendra (2013), the modern industrialisation was initiated in the 1950s and 1960s saw Sri Lanka venturing into export market. Both Samanthi (2021) and Wijendra (2013) argue that after the liberalisation of the economy in 1977, the industry saw a period of rapid growth. As Alam, et al., (2019) argue, the growth of the industry was stimulated by the quota-based export agreement called Multi-Fibre Arrangement (MFA) that enabled Sri Lankan companies to export to developed economies such as United States, UK and the EU until its abolition in 2005.

Following the abolition of the MFA, a few large companies namely MAS Holdings, Brandix Group, Hirdramani Group and JayJay Mills Group were amoung the dominating players in the industry acquiring significant proportion of the entire T&A exports. According to EDB Sri Lanka (2021), the industry is 100% operated by the private sector. Following the end of War in 2009, companies expanded to all corners of the country improving the overall economy including of women and minority groups.

Scholars have widely recognised the importance of export trade as an established method of getting into international markets (Azar & Ciabuschi, 2017) and generators of forex income which is need for importing of goods to the country (Sultanuzzaman, et al., 2019). Therefore, it is evident that the export trade is vital for economic stability of any country. However, some scholars including Keho & Wang (2017) argue that overdependence on export trade could be detrimental for fiscal sustainability. Sri Lankan exports including T&A experienced this effect during the Covid-19 pandemic outbreak and subsequent order cancellations from major buyers (Wijayasiri, 2021).

According to the Sri Lankan Export Development Board, Textile and Apparel (T&A) is the largest export merchandise from Sri Lanka. The T&M sector has maintained 40% or higher share of total merchandise exports from the island nation for over a decade (EDB Sri Lanka, 2021). According to BOI Sri Lanka (2021), the industry contributes to forex earning by USD 5.2 Billion and planning to expand to USD 10 Billion by the year 2025. In terms of labour force statistics, Institute of Policy Studies Sri Lanka estimates the industry contributes to 300,000 – 600,000 direct and indirect employment (IPSSL, 2020). Above figures indicate how T&A exports are crucial to the Sri Lankan economy which relies on T&A for highest Forex earning.

Apart from the ethical production concepts and accolades that were discussed in Section 1 of the Literature Review, another key factor that attracts major buyers to Sri Lanka is the cost factor. The cost factor is achieved through a time-tested sustainable supply chain. One of the key contributors for this low-cost are Bi-lateral and multi-lateral trade agreements and exports tax concessions (EDB Sri Lanka, 2021). Sri Lanka is located at the heart of the South Asian region which is the fastest growing economic region since 2014 according to Song (2019). As per United States Department of Commerce (2021), Sri Lanka has Bi-lateral agreements with India and Pakistan which are the biggest economies in the region creating a unique position to act as a hub. Moreover, Sri Lanka has agreements with People's Republic of China for importation of raw materials which provide incentives to the cost factor.

Furthermore, Sri Lanka Customs (2021) website indicates that Sri Lanka has multi-lateral agreements with the South Asian Region and Asia Pacific Regions which are the two most vital regions for apparel manufacturing (International Labour Organisation, 2020). This is vital for the aforementioned hub concept to keep low costs in material sourcing and transportation in the global supply chain. Moreover, Sri lanka was able to re-activate the GSP+ the preferential goods tax concession offered by the European Union which is Sri Lanka's second largest export partner (Ada Derana, 2021). As of September 2021, the concession is facing another cancellation following some Human Rights violation allegations leveled against the Sri Lankan Government, which the analysts predict would be detrimental to the already hurt T&A industry which operates within thin margins.

Another key contributor to the cost factor is the low-cost workforce in the island nation (IPSSL, 2020). The cost of living in Sri Lanka is significantly lower than most countries in the world. Therefore, the T&A sector can afford to pay a healthy remuneration to its workers. However, HR practices of T&A sector have come to scrutiny lately, which will be explored next.

2.2 Covid 19 Effects on T&A exports in SL

Being a major export industry that employs a large number of people in Sri Lanka, T&A industry experienced severe drawbacks in the face of the Global pandemic and subsequent economic downturn. Kavindi, et al., (2021) discuss that this situation directly hindered the manufacturing process and availability of new materials from suppliers due to foreign transactions restrictions imposed by the Sri Lankan Government. The author further investigates that manufacturing costs of apparel were increased due to the higher prices of raw materials as the leading raw material suppliers for Sri Lanka are based in China which was highly affected in the wake of the pandemic in 2020. Also, frequent order cancellations were experienced by T&A companies including micro-level apparel companies as well with the shortage of raw materials and transportation issues which led to disruptions in firm activities.

According to Bandara (2020), workers at a factory owned and operated by one of Sri Lanka's largest garment manufacturers, tested positive for COVID 19 on a massive scale which has allegedly led to an outbreak in the whole country. A study conducted by the American Federation of Labor and Congress of Industrial Organizations (2020) claims that this demonstrates the vulnerability of the industry to the spread of Covid 19 and it has been the major reason for the higher attrition rates in T&A industry during 2020. Moreover, Senaratne (2020) explains that the attrition rates are motivated by some additional factors such as cutting out benefits, salary cuts, reducing OT hours and shift basis work hours and some garment factories have already been forced to shut down and management has decided to cut workers' wages in the face of the catastrophic situation. Responding to this situation, Kavindi, et al., (2021) claim that higher attrition rates have become a challenge in workforce management in T&A industry.

With all these negative factors, Berthene (2020) gives an optimistic view to the effect of COVID 19 explaining that primary buyers of apparel in the world whereby 2020 compared to 2019 can be observed switching to online platforms as apparel related products appear to have sold significantly through ecommerce. Also Wright (2021) depicts that new products and trends have been identified with COVID 19 in T&A indutry as most of the companies in Sri Lanka are moving away from producing consumer supplied goods towards hygenic clothing including anti-viral clothing , masks with innovative styles and technologies giving an example to prove Wright's statement by CBI (2020).

2.3 Inspiration for the Study

Given the importance of exports of Sri Lanka T&A industry, it is crucial and beneficial at the same time to predict future events in the industry as it will be beneficial for various personnel in their decision-making process. According to Lui(2016), a sales or revenue forecast is an invaluable tool for any business in predicting future events since it provides insights into potential growth in particular segments over time, reveals new market opportunities and reduces uncertainty and adopts into the changes in the market. This shed the light for the authors of the study on conducting a forecast on Sri Lanka T&A industry where various statistical theories and modeling techniques have been used by many researchers to forecast the export values.

Inspired by the literature, the study compares several time series models in forecasting T&A exports in Sri Lanka. The author's inspiration to use the time series models for the forecasting has roots in empirical evidence as discussed below. According to Chatfield(1995), time series modeling and forecasting is a dynamic research area that aims to carefully collect and rigorously study the past observations of time series to develop an appropriate model that reflects the series' inherent structure. Several time-series forecasting methods are available, such as the Moving Averages method, Linear Regression with Time, Exponential Smoothing, etc.

Keck, et al. (2008) has identified that the trade may be particularly amenable to time series forecasting more than other economic variables. Complementing this statement, Stock & Watson (2003) provide reasons as to what counts in time series models is the explanatory power, the precision of coefficient and in order to make predictions, the reliability of the estimated equation once applied out of the sample of the variable of interest. Adding more to the above reason, the scholars further explain that although the cause cannot be illustrated, timeseries models are still advantageous in producing accurate forecasts than the macroeconomic models. Moreover, Fair (2004) also claims that observing past movements of variables in order to predict their future behaviour can be done simply and accurately with the use of time series models than any other models inspiring the authors to utilize time series models in the study.

In the context of selecting the time series models best fitted for the available data, similar researches were studied to derive the most suitable models for the context of the research. In the literature, ARIMA(p, d, q), SARIMA have been fitted to forecast the export products in Sri Lanka and in many countries. Also, Cranage and Andrew (1992) and Pongdatu and Putra (2018) have used exponential smoothing methods for forecasting sales. It has occurred that effectiveness and forecasting accuracy of the above models may vary on the behavior of the time series data. Therefore, to do a precise forecast, it is important to focus on the recognizable patterns and fluctuations of the specified time series for a sufficient period of time when fitting a model. However, to compare between the fitted models and to select the best model many criterions have been used in the past research such as Mean Absolute Percentage Error (MAPE), Mean Absolute Deviation (MAD), Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) etc.

Concerning Adhikari and Agrawal (2013), the Autoregressive Integrated Moving Average (ARIMA) model is one of the well-known and widely used stochastic time series models based on the basic assumption that the considered time series is linear and follows a specific statistical model which can be used for predicting future events. Box and Jenkins have generalized this model to deal with seasonality known as Seasonal ARIMA (SARIMA). According to Kalekar (2004), the Holt-Winters Exponential Smoothing technique can be applied to forecast time series that exhibit both trend and seasonality. The two primary HW (Holt-Winters) models are the Additive model for time series exhibiting additive seasonality and the multiplicative model for time series exhibiting Multiplicative seasonality.

Ghosh (2017)'s approach for the Indian market on forecasting cotton exports has led ARIMA (1,1,0) as the best fitted time series forecasting model over simple exponential smoothing (SES) and Holt two parameters exponential smoothing (HES) by evaluating the AIC and BIC criteria. As a result of the analysis, a five period ahead export of cotton is predicted in order to fulfill the objective of assessing the volatility of the market structure which is useful for trade organisations.

Pongdatu and Putra (2018) investigate the accuracy of SARIMA and Holt-Winter's Exponential smoothing methods in forecasting sales data with the presence of seasonal component in time series. This study is based on seasonal time series data of clothing retail sales of a certain store in Indonesia. According to these researchers both models can be used to generate satisfactory results effectively. However, they suggest SARIMA model is most preferable when forecasting for short periods. In order to fit a SARIMA model the stationarity of the time series is confirmed by the results obtained from the Box-Cox plot and the Autocorrelation Function (ACF).

Similarly, Regression and ARIMA methods were used by Lu (2015) to forecast US total textile and apparel world exports for the period 2015-2025, where both methods have given almost the same result with an upward trend and no seasonal effect. However, since this is only technical forecasting, he further suggests that the use of computing technology methods such as ANN (Artificial Neural Network) might lead to more accurate forecasting.

Pakistan cotton exports, Indian cotton exports, and US total textile and apparel exports show a trend with non-seasonal effect according to Anwar, et al. (1997), Ghosh (2013), and Lu (2015), which lead to use non-seasonal time series models such as ARIMA, HES, SES, etc. Even though Sri Lankan textile and apparel exports show monthly seasonality compared to Pakistan, India, and the US, the seasonality effect must be taken into consideration when creating a model and conducting a model evaluation. The study Edirisooriya & Senevirathne (2020) conducted, examine a suitable SARIMA model to fit monthly garments and textiles exports in Sri Lanka and the best model was selected according to Akaike criterion, Schwarz

Criterion and Hannan-Quinn Criterion. Box-Jenkins methods were used to build time series models and the model is validated by mean squared error (MSE).

In the literature, countries such as the United States and India have done studies on forecasting T&A within their contexts which points to the need of conducting such a study for Sri Lanka. A similar study was done by Edirisooriya & Senevirathne (2020), however the researchers had limited their study only to compare SARIMA models and the COVID 19 effect was not evaluated as it was an explanatory study done until 2018. Furthermore, Kavindi, et al. (2021) study on the effect of COVID 19 on Sri Lankan T&A industry where they examine only the firms' internal performance due to COVID 19 where further research should be done towards the effect of COVID 19 in revenue generated by exports.

Therefore, this study intends to fulfil the gap of conducting a forecasting for T&A exports in Sri Lanka while investigating the COVID 19 effect. With the consideration to previous literature, the authors of this paper are motivated to select time series models given diverse methods. Also, we observe that the methods used for several analyses are strongly influenced by the characteristics of the series. Therefore, possible models are intended to investigate that can be used to model exports by considering the popularity and the context. For linear time-series observations with seasonal effects, above discussions establish that the SARIMA model and Holt-Winters exponential smoothing techniques are more popular which provide satisfactory results.

3. Data

For this study, we have used secondary data, monthly data on exports of textile and apparel industry from 2004(January) to 2021(July) which were collected from Joint Apparel Association Forum Sri Lanka (JAAFSL).

Initially we have obtained the time series plot for the data on exports of textile and apparel industry, which is for the period 2004(January) - 2021(July).

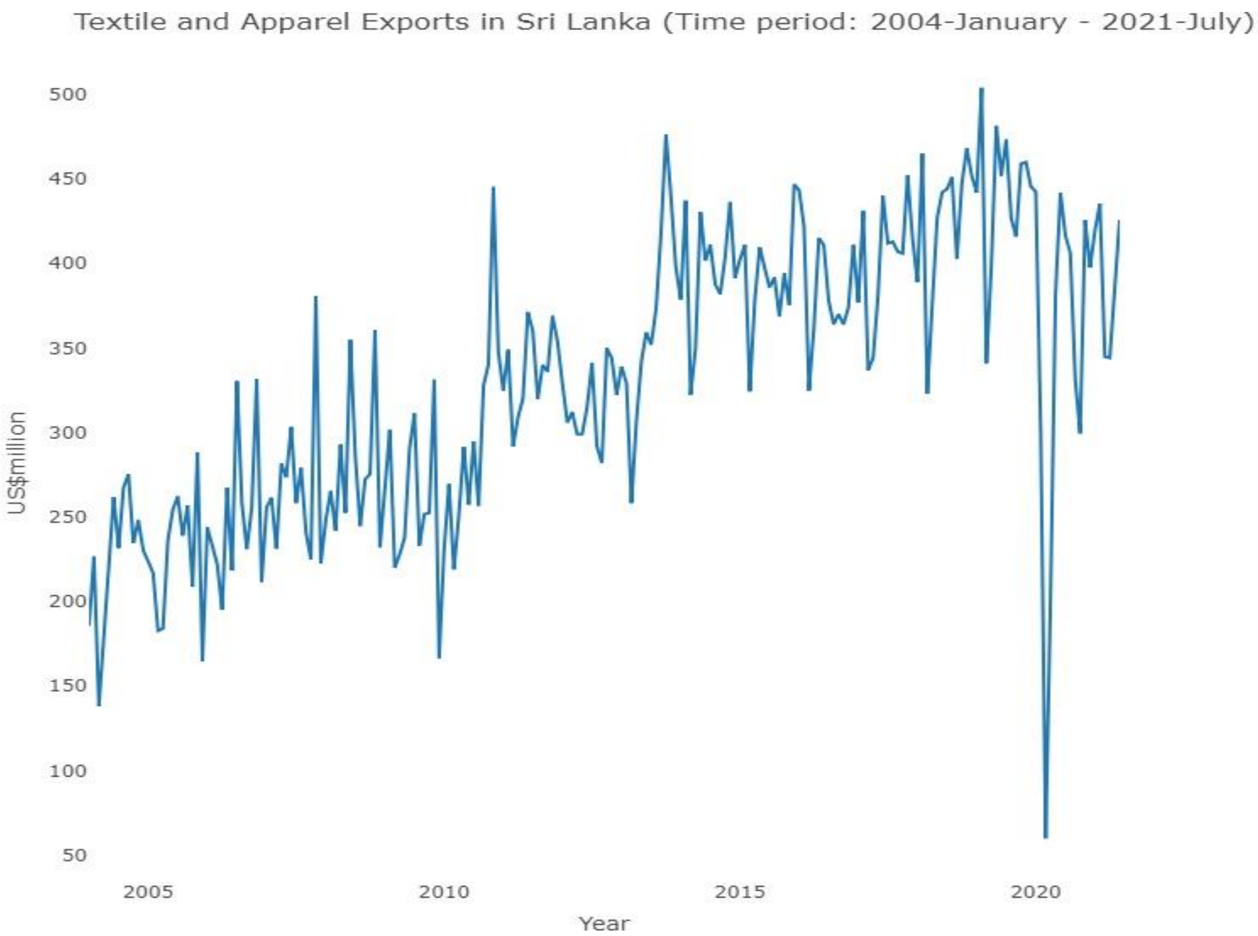

Figure 1: Time Series Plot of Textile and Apparel Exports, Sri Lanka (2004(January) – 2021(July))

According to the Figure 01, we can observe that there are some irregular fluctuations in the time series plot. The time series plot shows some devastating irregular fluctuations in exports during the recent years. Moreover, we can observe that there were some irregular shocks during the war period of Sri Lanka, which was ended in 2009.

Sri Lankan economy has been stabilized after the end of thirty- year war in 2009, textile and apparel industry also ushered stabilized development in the export earnings after the civil war. Moreover, the COVID-19 pandemic caused a significant impact on the textile and apparel industry. Since global brands and retailers cancelled their orders from their suppliers and due to the government-imposed restrictions during the pandemic time, certain months the impact was devastating on the exports, which has caused some irregular shocks occurred during certain months of the recent years.

Therefore, we have considered the post war time period and the pre COVID-19 time period for the analysis, which is 2009(January) - 2019(December).

4. Methodology

We have obtained the time series plot for the monthly data on exports of textile and apparel industry from 2009(January) - 2019(December).

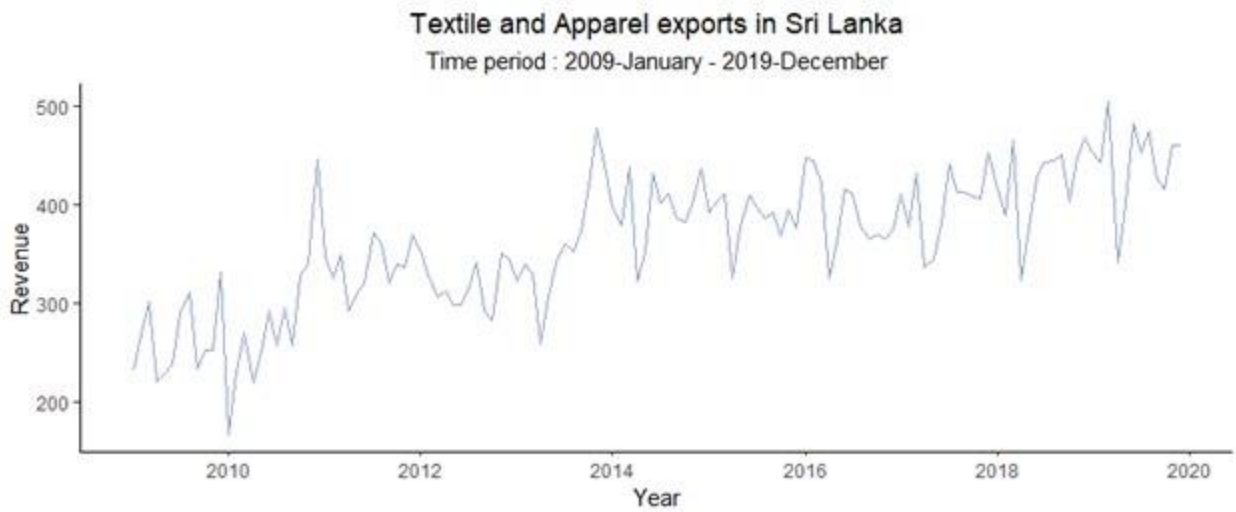

Figure 2: Time series plot of Textile and Apparel Exports, Sri Lanka (2009(January) – 2019(December))

As per the Figure 02, we can observe an upward trend in the exports of textile and apparels within the considered period of time. Furthermore, we can consider seasonal fluctuations throughout the period.

In order to forecast and test the accuracy of the forecasting, the data were split into a training set from 2009 January to 2017 December to train the models and a testing set from 2018 January to 2019 December to test the accuracy of the model. In general, the size of the test set should be around 15% of the whole data set which approximately satisfies the count of data points we have considered.

4.1 Time Series Models

The monthly textile and apparel exports data has been modelled using Seasonal Method Autoregressive Integrated Moving Average (SARIMA) and Holt-Winters' models and implemented using R programming language.

4.1.1 SARIMA Model

Seasonal Method Autoregressive Integrated Moving Average (SARIMA) method can be used for stochastic model data with seasonality.

General SARIMA notation is:

ARIMA *(p, d, q) (P, D, Q) s*

Where,

p, d, q : The non-seasonal part of the model

(P, D, Q) s : The seasonal part of the model

s : Number of periods per season

The general formula of ARIMA (p, d, q) (P, D, Q) s is as follows:

$$\Phi_p B^s \varphi_p(B)(1-B)^d\,(1-B^s)^D Y_t \;=\; \theta_q(B)\;\;\Theta_q(B^s)a_t$$

Where,

p^B : AR Non Seasonal

$\Phi_p B^s$: AR Seasonal

$(1-B)^d$: differencing non seasonal

$(1-B^s)^D$: differencing seasonal

$\theta_q(B)$: MA non seasonal

$\Theta_q(B^s)$: MA seasonal

Box – Ljung test is performed on the fitted ARIMA models to validate the assumptions of the residuals However, the most suitable Seasonal Method Autoregressive Integrated Moving Average (SARIMA) model has been selected among several possible models with respect to AIC or BIC values.

4.1.2 Holt-Winters' Model

The Holt-Winters' method is based on the smoothing equations – for the level, for trend and for seasonality. The seasonal component in Holt-Winters' method may be treated with additively or multiplicatively depending on how the seasonality should be modelled.

The basic equation for Holt-Winters' additive method are as follows:

Level: $L_t = \alpha \frac{Y_t}{S_{t-s}} + (1-\alpha)(L_{t-1} - b_{t-1})$

Trend: $b_t = \beta(L_{t-1} - L_{t-1}) + (1-\beta)b_{t-1}$

Seasonal: $S_t = \gamma(Y_t - L_t) + (1-\gamma)S_{t-s}$

Forecast: $F_{t+m} = L_t + b_t m + S_{t-s+m}$

Where,

s : length of seasonality (number of months)

L_t : the level of the series

b_t : the trend

S_t : the seasonal component

F_{t+m} : forecast for m periods ahead

The basic equations for Holt-Winters' multiplicative method are as follows:

Level: $L_t = \alpha \frac{Y_t}{S_{t-s}} + (1-\alpha)(L_{t-1} - b_{t-1})$

Trend: $b_t = \beta(L_{t-1} - L_{t-1}) + (1-\beta) b_{t-1}$

Seasonal: $S_t = \gamma \frac{Y_t}{L_t} + (1-\gamma) S_{t-s}$

Forecast: $F_{t+m} = (L_t + b_t m) S_{t-s+m}$

Where,

s : length of seasonality (number of months)

L_t : the Level of the series

b_t : the trend

S_t : the seasonal component

F_{t+m} : forecast for m periods ahead

Next, Box – Ljung test is performed to validate the assumptions of the residuals on the fitted Holt-Winters Model.

4.1.3 Measures of Accuracy

It is essential to evaluate the performance of time series models obtained in terms of the accuracy of forecasts. The most accurate forecasting method can be examined using Mean Absolute Deviation (MAD) and Mean Absolute Percentage Error (MAPE) values.

4.1.3.1 Mean Absolute Deviation (MAD)

MAD is the value of the overall forecasting error for a model. The MAD value can be calculated by taking the sum of the absolute values of the forecasting error divided by the number of data periods. MAD expresses accuracy in the same units as the data, which helps conceptualize the amount of error occurred when forecasting.

$$MAD = \frac{\sum_{i=1}^{n} |Actual_i - Forecast_i|}{n}$$

Where,

n: number of data periods

4.1.3.2 Mean Absolute Percentage Error (MAPE)

MAPE also can be used to evaluate how well the model is accurate when forecasting. MAPE expresses the accuracy as a percentage.

$$MAPE = \frac{100}{n} \sum_{i=1}^{n} \left| \frac{Actual_i - Forecast_i}{Actual_i} \right|$$

Where,

n: number of data periods

These measures describe how well the model fits to the actual data and comparatively lower MAD and MAPE values represent a better fit to the model.

5. Data Analysis

5.1 Time series Analysis

All the data are analyzed using the R Programming Language. Time series analysis is conducted briefly on Sri Lankan Textile and Apparel exports from 2009 to 2019. Even though data have been available since 2004, data before 2009 are eliminated to enhance the model's accuracy. Sri Lanka was suffered from 30 years of civil war, which ended in 2009, and had a significant impact on the textile and apparel industry. Moreover, literature found that Edirisooriya & Senevirathne (2020) also eliminated the Textile and Apparel data before 2009 to avoid this effect from 30 years of civil war, following them export revenue before 2009 are eliminated from the data set. Data after 2019 December are eliminated from model creation since the COVID-19 epidemic has a considerable impact. The dataset considered in the analysis is shown in Figure 3.

Figure 3

As the model's accuracy needs to be tested, the Sri Lankan Textile and Apparel exports from 2009 to 2019 are split into two parts: training and testing. Export revenue from 2009-2017 is included in the training test, and export revenue from 2018-2019 is included in the testing test. The upcoming analysis is conducted using the training test, and accuracy is calculated using the testing test. The training set of the analysis is shown in Figure 4.

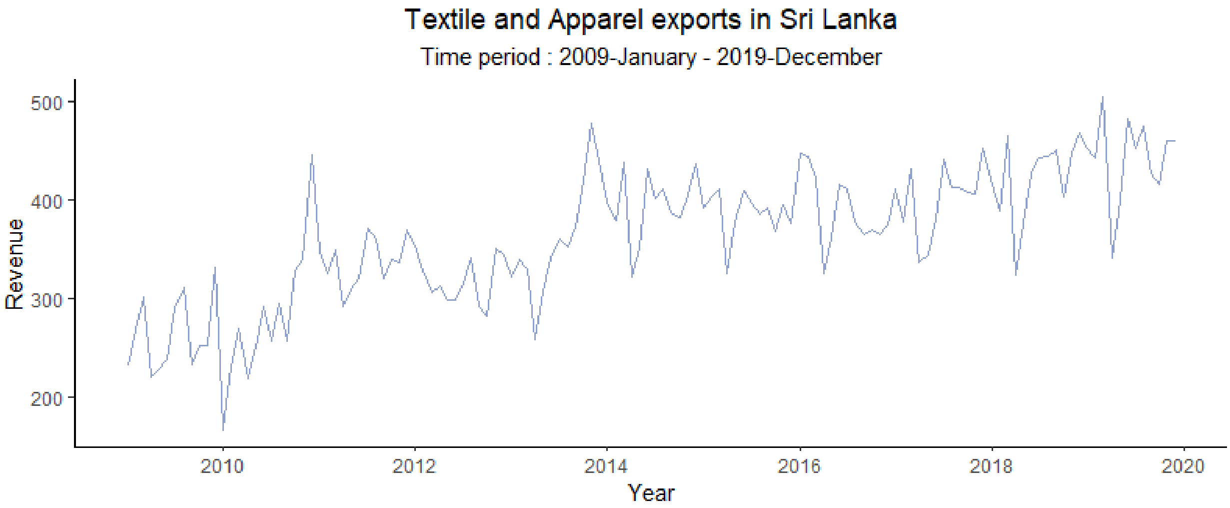

Figure 4

5.2 SARIMA Analysis

Seasonal Autoregressive Integrated Moving Average(SARIMA) model is projected only for stationary series. The stationary series implies that the observations vary with time with a constant mean and a constant variance. First, it determines whether the series of observations of the training test data is stationary or not; observing from Figure 4, it is evident that the series is not stationary. It can be identified that the textile and apparel exports time series is not stationary concerning Autocorrelation Function (ACF) and Partial Autocorrelation Function(PACF), which is shown by Figures 5 and 6, respectively.

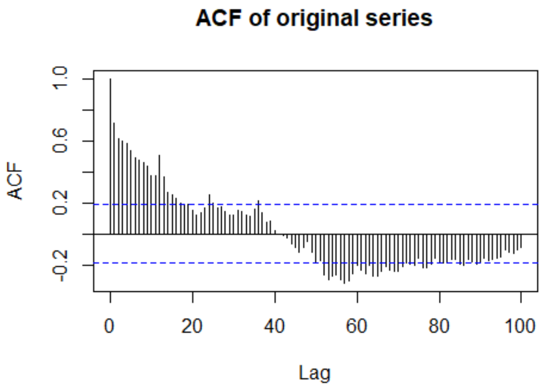

Figure 5

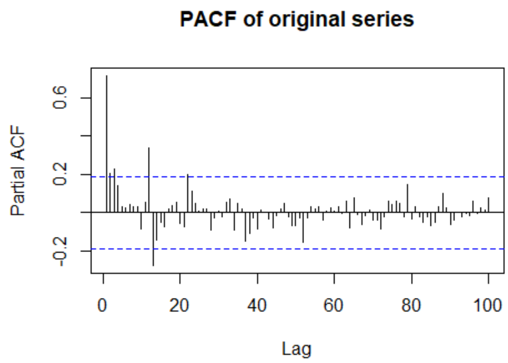

Figure 6

Furthermore, the variance of textile and apparel exports time series increases over time with respect to Figure 4. To make the variance constant, a log transformation has been conducted, shown in Figure 7.

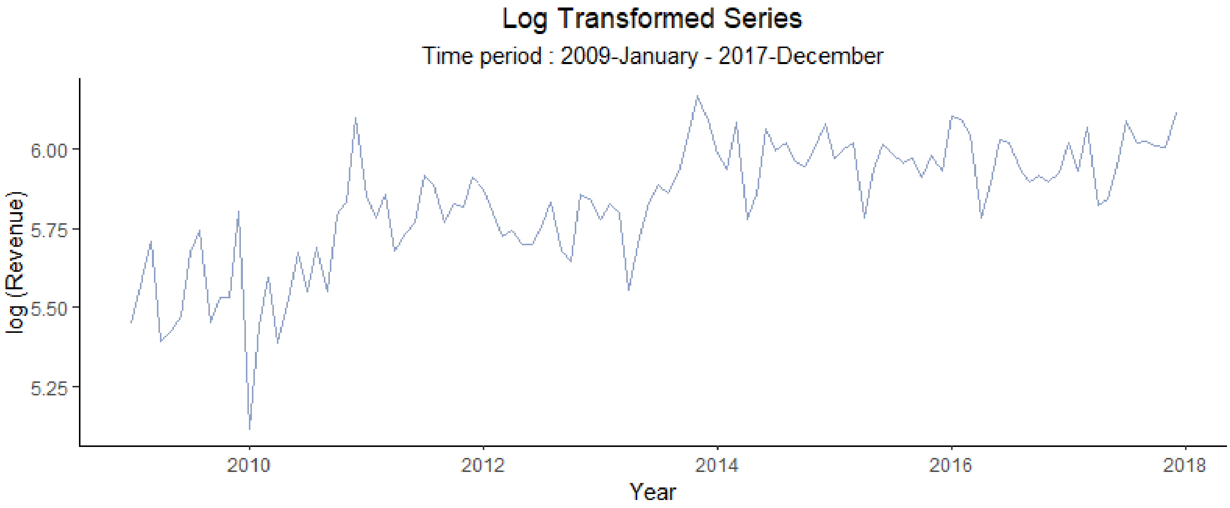

Figure 7

Even after log transformation, time-series show an increasing trend with seasonality, implying time-series is not stationary. It can be identified that the series shows monthly seasonal variation by Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) for Log Transformed Series, which is shown in Figures 8 and 9, respectively.

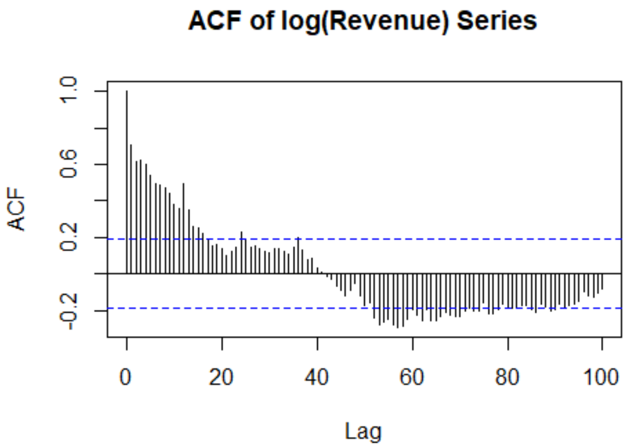

Figure 8

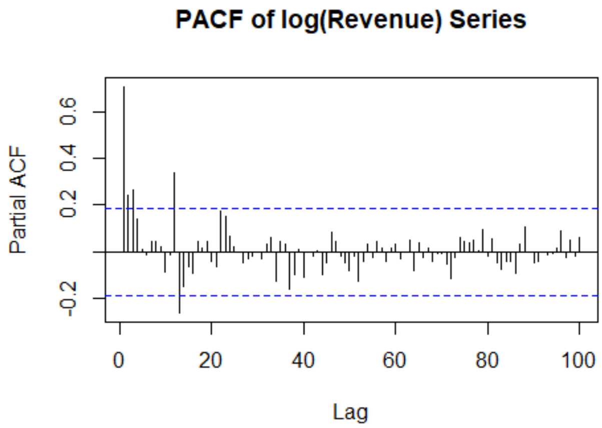

Figure 9

Seasonal differencing is done to make log(Revenue) series stationary, and Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) for the resulting series are shown in Figures 10 and 11, respectively.

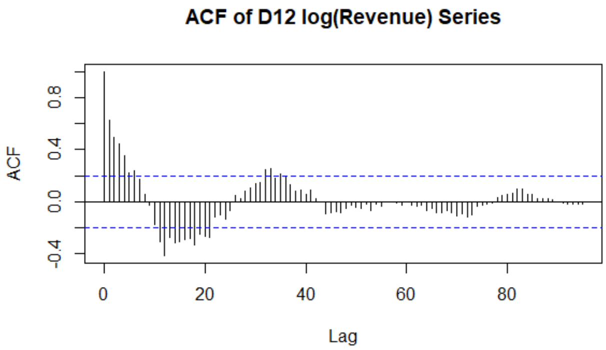

Figure 11

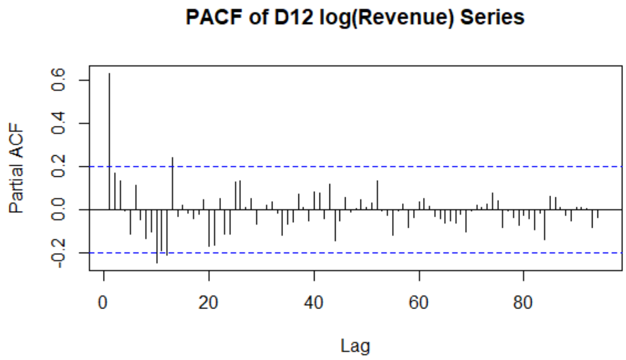

Figure 10

Lag 1 differencing is taken into consideration since D12 log (Revenue) series does not show a stationary series and Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) for the resulting series is shown in Figure 12 and 13 respectively.

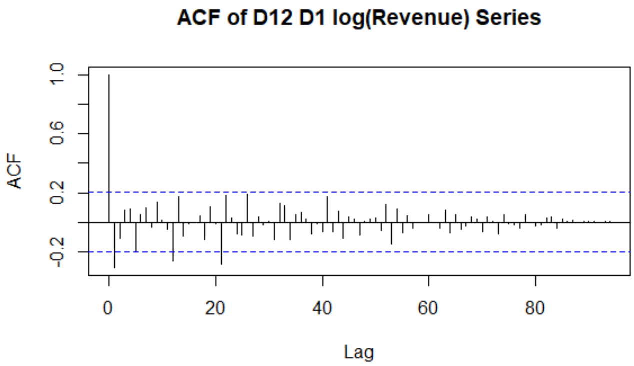

Figure 12

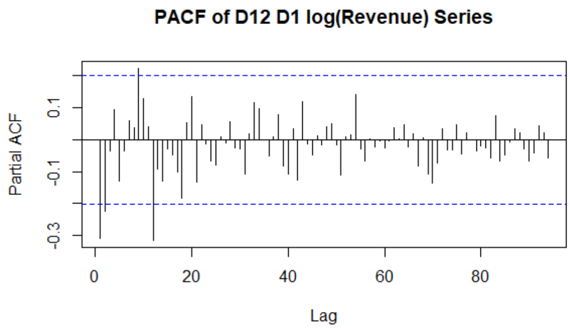

Figure 13

Autocorrelation Function (ACF) shown in Figure 12 shows a stationary series, and based on the ACF and PACF shown in Figure 12 and 13, respectively, the following SARIMA models have been modelled.

Model	AIC	AIC(adj)	BIC	**Box – Ljung Test**
ARIMA(1,1,0)(0,1,2)$_{12}$	-134.17	-133.72	-123.95	0.05443
ARIMA(1,1,0)(3,1,0)$_{12}$	-134.67	-134	-121.9	0.06797
ARIMA(1,1,0)(3,1,2)$_{12}$	-132.51	-131.22	-114.63	0.1452
ARIMA(0,1,2)(0,1,2)$_{12}$	-141.04	-140.37	-128.27	0.2489
ARIMA(0,1,2)(3,1,0)$_{12}$	-140.93	-139.98	-125.61	0.2633
ARIMA(0,1,2)(3,1,2)$_{12}$	-138.26	-136.58	-117.83	0.3771
ARIMA(1,1,2)(0,1,2)$_{12}$	-138.97	-138.01	-123.64	0.2905
ARIMA(1,1,2)(3,1,2)$_{12}$	-136.24	-134.12	-113.26	0.3916

Table 1: Fitted ARIMA Models

Box – Ljung test is performed on the fitted SARIMA models to validate the assumptions of the residuals. According to the Box – Ljung test, the residuals of the fitted SARIMA models given in Table 1 are uncorrelated and independently distributed. Therefore, residuals of the fitted model are considered as white noise.

Regarding AIC and BIC values in Table 1 for fitted SARIMA models, ARIMA (0,1,2) (0,1,2)$_{12}$ is considered the best model with less AIC and BIC value.

The estimated parameters and the p – values for the fitted ARIMA (0,1,2) (0,1,2)$_{12}$ are shown in Table 2.

Parameter	**Estimate**	**P - value**
ma1	-0.5459	2.686e-06
ma2	-0.0330	0.7689
sma1	-0.5990	9.252e-06
sma2	0.0453	0.7733

Table 2: Fitted ARIMA Models

According to the p – values shown in Table 2, two parameters, namely ma2 and ma2, are considered insignificant. However, all the models in Table 1 had at least one insignificant parameter. Therefore, ARIMA(0,1,2)(0,1,2)$_{12}$ is selected for the forecasting of exports revenue.

The model equation for the ARIMA(0,1,2)(0,1,2)$_{12}$ is given by Equation 1.

$$(1 - B)(1 - B^{12})y_t = (1 - 0.5459B - 0.033B^2)(1 - 0.599B^{12} + 0.0453B^{24}) \quad \text{Equation 1}$$

5.3 Holt-Winters Exponential Smoothing

With respect to Figure 4, Sri Lankan Textile and Apparel Exports time series shows an increasing trend with monthly seasonality. The triple exponential method, known as the Holt-Winters method, has been used to handle seasonality. Refer to Figure 4; it can be identified that the variance of the time-series varies over time. Since Holt Winter's exponential smoothing method with multiplicative seasonality, provides a model with large AIC and BIC value, stabilizing the variance is done by log transformation. The log-transformed series is shown in figure 7. After that, log-transformed series is used to fit Holt Winter's exponential smoothing method with additive seasonality since the variance of the log-transformed series is constant over time.

The estimated α, β, and γ values and statistics are shown in Tables 3 and 4, respectively.

Parameter	Estimated values
α	0. 3466
β	0.0004
γ	0.0001

Table 3: Estimate α, β and γ values

AIC	AIC adjusted	BIC
27.26088	34.06088	72.85712

Table 4: AIC and BIC values for training test

The fitted Holt-Winters equations for Textile and Apparel exports in Sri Lanka as follows;

$$\alpha_t = \frac{y_t}{s_{t-12}} + 0.6534 \times \left(\alpha_{t-1} - g_{t-1}\right) \quad \text{Equation 2}$$

$$g_t = 0.0004 \times \left(\alpha_t - \alpha_{t-1}\right) + 0.9996 \times g_{t-1} \quad \text{Equation 3}$$

$$s_t = 0.0001 \times \frac{y_t}{\alpha_t} + 0.9999 \times s_{t-4} \quad \text{Equation 4}$$

The prediction formula for k period ahead at period T is given by Equation 5;

$$\hat{y}_{T+k} = (\alpha_t + k \times g_t) \times s_{t-4+k} \quad \textit{Equation 5}$$

Where

αt is the base signal also called the permanent component

gt is a linear trend component

st is an additive seasonal factor

Furthermore, equation 2 is used for overall smoothing, equation 3 is used for trend smoothing, and equation 4 is used for seasonal smoothing. Equation 5 is the fitted equation for the log-transformed time series, and it can be used to obtain log-transformed forecasted revenue.

Box – Ljung test is performed to validate the assumptions of the residuals on the fitted Holt-Winters Model, and it is identified that the residuals are white noise with a 0.4487 p-value.

ARIMA(0,1,2)$(0,1,2)_{12}$ model is considered as best fitted model from SARIMA analysis, and it is compared with the best exponential model with α=0. 3466, β=0.0004 and γ=0.0001. Training test is used to compare the best fitted SARIMA and Holt-Winters models. Figure 14 shows the actual export revenue time-series for both training and testing sets along with fitted SARIMA and Holt-Winters Models for the testing set.

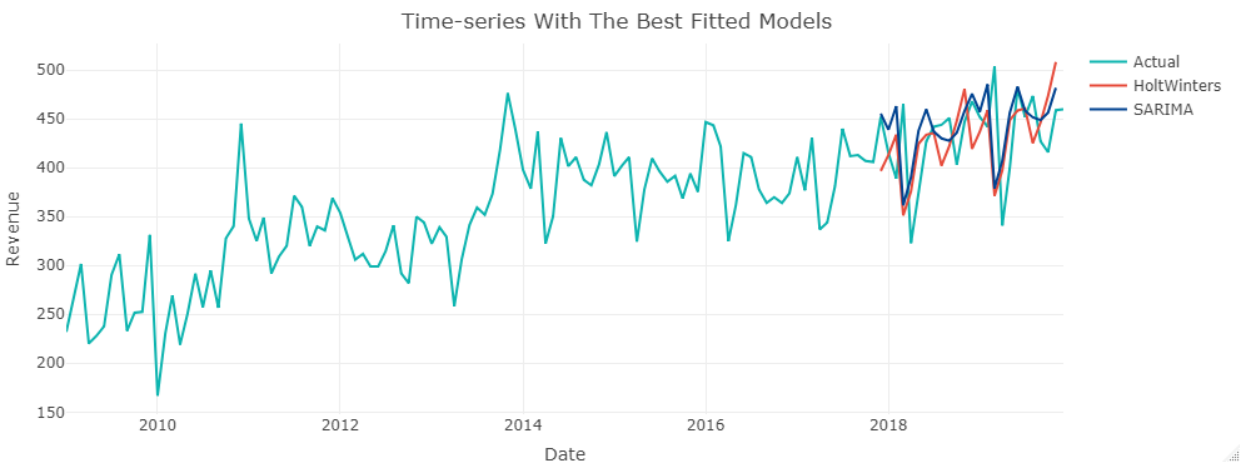

Figure 14

Which model is fitting best for the actual testing set is in detail explained by Figure 15.

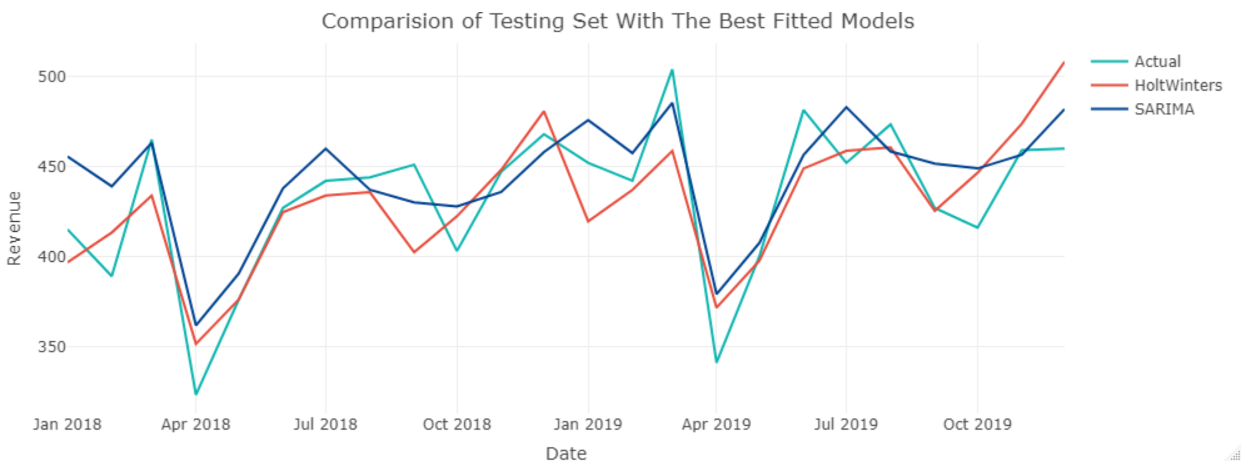

Figure 15

It can be clearly identified that the Holt-Winters method fixed well for actual textile and apparel export revenue compared to the SARIMA model. It is further confirmed by MAPE values for both SARIMA and Holt-Winters models, shown in table 5.

Model	MAD	MAPE
ARIMA$(0,1,2)(0,1,2)_{12}$	21.00993	4.814466
Holt Winters Exponential smoothing with α=0. 3466, β=0.0004 and γ=0.0001	19.39997	4.522666

Table 5

As shown in table 5, Holt-Winters Exponential Smoothing Model with α=0. 3466, β=0.0004, and γ=0.0001 show the lowest MAD and MAPE values and can be considered the best-fitted model to the forecast Sri Lankan Textile and Apparel Exports. Log transformed forecasted values for Holt-Winters Exponential smoothing method can be calculated by equation 5, and forecasted revenue can be obtained by taking the antilog of that values.

5.4 Forecasting Sri Lankan Textile and Apparel Export Revenue for the August 2021 – July 2022.

Forecasted textile and apparel exports revenue for the August 2021 – July 2022 by the Holt-Winters Exponential Smoothing Model with α=0. 3466, β=0.0004, and γ=0.0001 are given in Table 6.

Month	Forecasted Revenue
2021 Aug	729.165
2021 Sept	678.185
2021 Oct	713.284
2021 Nov	757.778
2021 Dec	825.319
2022 Jan	732.000
2022 Feb	759.135
2022 Mar	807.893
2022 Apr	653.851
2022 May	713.541
2022 Jun	791.120
2022 Jul	829.456
2022 Aug	729.165
2022 Sep	678.185
2022 Oct	713.284
2022 Nov	757.778
2022 Dec	825.319

Table 6: Forecast T&A Exports Revenue

5.5 COVID-19 effect on Sri Lankan Textile and Apparel Exports

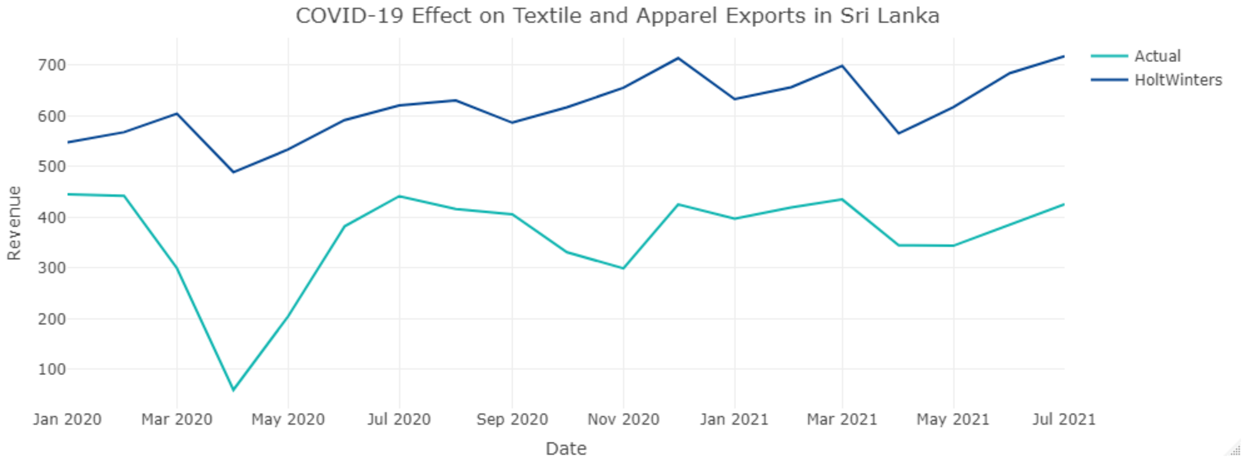

Figure 16

As shown in Figure 16, it can be identified that the COVID-19 epidemic has a significant impact on Sri Lankan Textile and Apparel Exports. It is noticeable that export revenue has decreased more than half of that amount during this period. Furthermore, it is identified that there is a massive drop in April 2020 compared to other months.

6. Discussion and Conclusion

6.1 Conclusion

Textile and Apparel industry in Sri Lanka is a fast growing and one of the major contributors to Sri Lanka export revenue. This research was carried out to find an adequate time series model to analyse the textile and apparel exports in Sri Lanka. Based on the previous studies which was carried out to derive time series forecasting models in Sri Lanka and in other countries we came up with the conclusion that the behaviour of the times series data strongly effects the accuracy of the model and forecasting efficiency. In this study we evaluated the adequacy of time series models namely Holt Winter's exponential smoothing method and SARIMA in modelling and forecasting apparel exports in Sri Lanka. For the period 2009 – 2019 textiles and apparel exports in Sri Lanka shows a linear upward trend with an increasing variance. Further, we observed that there is a monthly seasonal variation. Initially data set was split into two sets as Training set and Testing set. Several SARIMA models were fitted by the Box Jenkins methodology for the period 2009 to 2017. Among them ARIMA(0,1,2)$(0,1,2)_{12}$ was selected as the best model that adequately fit the data in the Training set. The fitted ARIMA(0,1,2)$(0,1,2)_{12}$ model was used to derive the exports forecasts for the period August 2021 to December 2022.

It was suggested by the previous literature that classical time series models may provide accurate results in time series forecasting as well. Therefore, we used Holt Winters Exponential method to fit a model for the Apparel Exports for the given period. Using the Holt Winters model with parameters $\alpha = 0.3466$, $\beta = 0.0004$ and $\gamma=0.0001$ forecasts were derived for the period August to December 2022. The forecasted values from ARIMA(0,1,2)$(0,1,2)_{12}$ and Holt Winters were compared by the MAPE value to select the best model to forecast the exports in Sri Lanka. Since Holt Winters model had the lower MAPE, it was selected as the best model.

Generally, SARIMA models are more accurate than other time series forecasting methods since they can capture the various behavioural patterns of the time series. However, this study suggested that Holt Winter's Exponential Smoothing model can be used to provide more accurate forecasts than the ARIMA model. Further, Holt Winters Exponential Smoothing models are more feasible and less time consuming than ARIMA models. Therefore, Holt Winters model were suggested as the adequate and efficient model to forecast apparel exports in Sri Lanka.

6.2 Suggestions for T& A Exporters

Many International buyers especially from Europe and US have imposed quality parameters for the merchandise that they are purchasing from Sri Lanka. Stringent quality and inspection standards are implemented at the exporters end. In order to supply final products to buyers the processors have to be updated with latest techniques, machineries and chemicals.

Furthermore, during Covid 19 situation, with the identified higher attrition rates, it is recommended to make sure that fair going wage should be paid for the employees for their work (or better) and offer them competitive benefits.

6.3 Suggestions for policy makers

The desired forecast for the covid-19 period from January 2020 clearly indicated that there was a significant impact on the apparel industry from the pandemic situation. It was determined that this could be due to unavailability of the raw materials caused by transportation limitations within countries. China is the major cotton supplier for Sri Lanka. China was affected critically by the pandemic and during this period there were frequent disruptions in the imports as well due to restrictions imposed by the government. Therefore, to ensure stable manufacturing process it is required to facilitate the processing of raw materials in Sri Lanka.

6.4 Suggestions for further research

This study was mainly focused on modelling the apparel exports in Sri Lanka using different time series analysis methods. There are various factors that has the potential to affect the variability of the apparel exports in Sri Lanka. Therefore, further research should be carried out to investigate the relationship among those factors and provide alternative methods to assess the impact on the exports.

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