Sama Circular Model on Forecasting Foreign Guest Nights in Anuradhapura of Sri Lanka

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ABSTRACT

The Sama Circular Model (SCM) is a modern development in univariate time series. It is a powerful technique to capture wave-like patterns with the trend of a data series. Forecasting occupancy is very useful for the tourism industry in Sri Lanka. Anuradhapura is one of the leading ancient cities of Sri Lanka which is highly occupied by a foreign guest. Therefore, the study was a focus on forecasting occupancy guest nights. Monthly data of foreign guest nights for the period of January 2008 to December 2017 were obtained from the Sri Lanka Tourism Development Authority (SLTDA). The SCM and Seasonal Autoregressive Integrated Moving Average (SARIMA) models were tested for forecasting. The Anderson–Darling test, Auto-Correlation Function (ACF), and Ljung-Box Q (LBQ)-test were used as the goodness of fit tests in model validation. The best-fitting model was selected by comparing by absolute measurements of errors. The study concluded that Sama Circular Model performed better than SARIMA. Therefore, it is recommended to test the Sama Circular Model for other business activities in the tourism industry of Sri Lanka.

Keywords: Occupancy, Sama Circular Model, SARIMA

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1. INTRODUCTION

Sri Lanka is flooded with opportunities for experiencing ancient history. There is strong evidence left by a proud civilization stretching back more than two thousand years (Konarasinghe, 2018) [9]. It is home to eight UNESCO world heritage sites (SLTDA, 2017). Anuradhapura city is one of the major city and capital of North Central Province and the capital of Anuradhapura District in Sri Lanka. This city located approximately 200 km north of Colombo. Anuradhapura is one of the ancient capitals of Sri Lanka which consist of well-preserved ruins of an ancient civilization of the country. Anuradhapura is the home of a right-wing branch of the sacred fig tree which the Lord Buddha himself found enlightenment. Anuradhapura City is a valuable stop for international tourist today. In addition to the sacred fig tree, The Brazen Palace, Ruwanweli Dagaba, Thuparama Dagaba, Jetavana Dagaba, Abhayagiri Vihāra, Monastery and Dagaba, Samadhi Buddha, Kuttam Pokuna – The Twin Ponds and Mirisavati Dagaba are the main attractions of Anuradhapura City. There is a growth of occupying Anuradhapura City by international tourist (SLTDA, 2017).

1.1 PROBLEM STATEMENT

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The high occupancy of Anuradhapura will increase the demand for various products and services of the tourism-related business. It enhances the competition of business and it causes the risk for their business and stakeholders (Konarasinghe, 2017) **[4]** and (Konarasinghe, 2018) **[9]**. To minimize the risk, the businesses and other stakeholders should adopt various management practices. Forecasting occupancy guest night is one of the components to minimize the risk in the tourism business in the Anuradhapura area. It is a well-known fact that accurate forecasting is a critical component of efficient business operations (Schwartz and Hiemstra 1997). Occupancy series follows the trend with a wave-like pattern. It may contain both seasonal and cyclical variation. The Cyclical variations are long term wave-like patterns, while the seasonal variations are short term wave-like patterns. Seasonal patterns are observed within a year, but the cyclical patterns are observed in the longer period; at least more than a year. In general, wave-like patterns are modeled by; Seasonal Auto-Regressive Integrated Moving Average model (SARIMA) or Decomposition techniques. Yet SARIMA is not capable of capturing cyclical variation. In Decomposition models; a time series is described as a function of four components; Trend (T), Cyclical influence (C), Seasonal influence (S) and the random error (e). In order to capture the cyclical pattern, Decomposition technique follows several steps; firstly, fit the trend model and then obtain the de-trend series; secondly, find the seasonal indices for de-trended data and deseasonalize them; finally, model the deseasonalized series by trigonometric functions. However, this method is time-consuming and cumbersome. In contrast, the Sama Circular Model (SCM) is easy to use and less time-consuming. Therefore, it is worth testing the SCM to forecasting occupancy guest nights in Anuradhapura of Sri Lanka.

1.2 OBJECTIVE OF THE STUDY

The objectives of the study are as follows;

1.2.1 Primary Objective:

To forecast foreign guest nights in Anuradhapura of Sri Lanka

1.2.2 Secondary Objectives:

1. To test SARIMA on forecasting foreign guest nights in Anuradhapura of Sri Lanka
2. To test Sama Circular Model (SCM) on forecasting foreign guest nights in Anuradhapura of Sri Lanka
3. To compare the forecasting ability of SARIMA and SCM

1.3 SIGNIFICANCE OF THE STUDY

The results of this study can be used to forecast the number of occupancy guest nights in Anuradhapura of Sri Lanka. This is useful for strategy development, policy making and other decision making for tourism-related business and other governing authorities in the Anuradhapura area. The occupancy behavior provides a guideline to increasing or decreasing their production volume and various product developments

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in tourism-related business. At the same time, manufacturers can improve their product and process layout to ensure a smooth and rapid flow of large volumes of goods or customers through a system and handle varied processing requirements of tourist who occupied these areas. An occupancy behavior leads to carry out long-range, intermediate and short-range plans to ensure effective and efficient delivery of their products. In addition, businesses will be able to control physical, human and financial resources in their business by observing the results of this study. Further, they can plan for various promotional offers, pricing of accommodation and other products and services based on the results of this study. Hoteliers at Anuradhapura can work out their requirements of food and beverages, purchasing decisions of perishable and non- perishable items, hiring employees, and maintenance decisions can be decided by accurate forecasting of occupancy guest nights. Accommodation, food and beverages and transport are some of the business avenues for host communities. Therefore, the local government can provide guidance, facilities, and employment opportunities and for business avenues to host communities based on forecasting occupancy guest nights.

Anuradhapura area is flooded with ancient sites and sacred places. Tourist occupancy may cause both positive and negative consequences to the ancient sites. During high or low occupancy periods the visitors could show little respect for the sanctity of spiritual places, practices, and traditions. Occupancy may cause negative impacts on the environment including water and noise pollution, garbage production. Governing authorities can be minimized negative consequences by a dedicated environmental impact assessment and monitoring, qualified guides with an enhanced responsibility to enforce regulations and precautionary actions based on the results of this study. They can improve the standards of formal waste collection services in the aforesaid areas. Various forms of threats could be aroused parallel to high occupancy in the areas. Therefore, it is mandatory to implement security services, practice and monitor them in order to make sure the protection of tourists and the host community.

2. LITERATURE REVIEW

The studies based on forecasting guest nights are very limited. Multivariate and univariate statistical techniques have been used for the purpose.

2.1 Studies based on forecasting guest nights
2.2 Studies based on Circular Model and Sama Circular Model

2.1 STUDIES BASED ON FORECASTING GUEST NIGHTS

Brannas, and Nordstrom (2000) model the number of Norwegian guest nights in Swedish hotels and cottages and did the demand analysis. They used the integer-valued autoregressive model for the study. Lim and Chang (2009) focus on Autoregressive Moving Average (ARMA) and Seasonal Autoregressive Integrated Moving Average (SARIMA) approach to examine and forecast tourist accommodation demand in New Zealand using hotel-motel room nights. SARIMA performed better. Zhang, Wu, Pan, Li, Ma, and Wang, (2017) forecast daily occupancy for hotels in China. They combined Ensemble Empirical Mode

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Decomposition (EEMD) with Autoregressive Integrated Moving Average (ARIMA) model to forecast. This hybrid approach performed better than ARIMA in short term forecasting. The same approach used to forecast weekly hotel occupancy in Charleston, South Carolina, the USA by Zhang, Li, Pan, and Zhang (2018). The results of the study revealed that the EEMD – ARIMA performed better than ARIMA on forecasting weekly occupancy. In Sri Lankan context; Konarasinghe, (2017) [9] used SARIMA to forecast foreign guest nights in ancient cities of Sri Lanka, Konarasinghe (2017) [5] used SARIMA and decomposition techniques for forecasting foreign guest nights in Colombo and Greater Colombo of Sri Lanka. Konarasinghe (2018) [10] used SARIMA, decomposition techniques and Holts Winters three parameter techniques for forecasting foreign guest nights in Hill Country of Sri Lanka. Konarasinghe (2018)[11 used SARIMA, decomposition techniques and Holts Winters three parameter techniques for forecasting foreign guest nights in Southern Coast of Sri Lanka. Univariate time series techniques are heavily used in forecasting occupancy guest nights. The results of these studies revealed that the SARIMA is the most suitable model in forecasting guest nights in the Sri Lankan tourism industry.

2.2 STUDIES BASED ON CIRCULAR MODEL AND SAMA CIRCULAR MODEL

The Circular Model (CM) was developed in the year 2016 and improved in the year 2018 to overcome the limitations of the CM. The improved model is named as the Sama Circular Model (SCM). The CM was mostly applied on forecasting share returns, yet some of the studies were focused on tourism. However, studies based on CM and SCM are limited, as they are new developments. Konarasinghe (2016) [2] has tested the CM for forecasting per share returns of listed companies of Colombo Stock Exchange (CSE). The CSE had 249 companies in twenty business sectors. A stratified random sample of fifty companies was used for the study; results revealed that the CM is successful in 82% of them. Also, it has shown that the forecasting ability of the CM is higher than that of the ARIMA in that light. Konarasinghe, Abeynayake, and Gunaratne (2016) [3] have shown that the CM is successful in forecasting returns of Hotel and Travel sector of the Sri Lankan share market. Konarasinghe (2018) [6] has tested the "Improved Circular Model" on forecasting arrivals from Western European countries to Sri Lanka. Monthly arrival data for the period of April 2008 to December 2016 were used for the analysis. The forecasting ability of Sama Circular Model (SCM) was compared with the Decomposition techniques and Seasonal Auto-Regressive Moving Average (SARIMA). It was concluded that the SCM is capable in forecasting arrivals from Western European countries and the SCM is superior to the other tested models. Konarasinghe (2018; 2018) [7] [8] have applied the SCM on forecasting tourist arrivals to Sri Lanka. Monthly total arrival data and arrivals from the leading contributors for the period of April 2009 to December 2016 were utilized in the studies. Results revealed that the SCM is suitable in forecasting tourist arrivals to Sri Lanka and the SCM is superior to SARIMA and Decomposition Techniques for the purpose.

3. METHODOLOGY

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Monthly data of foreign guest nights for the period of January 2008 to December 2017 were obtained from annual reports of 2008 -2017 published by SLTDA. Time series plots used for pattern identification. The Seasonal Autoregressive Integrated Moving Average (SARIMA) model and the Sama Circular Model (SCM) were tested for forecasting. The Anderson–Darling test, Auto-Correlation Function (ACF), and Ljung-Box Q (LBQ)-test were used to test the validation criterion and fit the model. The forecasting ability of the models was assessed by two measurements of errors; Mean Square Error (MSE) and Mean Absolute Deviation (MAD) in both model fitting and verification process.

3.1 SEASONAL AUTOREGRESSIVE INTEGRATED MOVING AVERAGE (SARIMA)

ARIMA modeling can be used to model many different time series, with or without trend or seasonal components, and to provide forecasts. The model as follows;
An ARIMA model is given by:

$$\phi(B)(1-B)^d y_t = \theta(B)\varepsilon_t$$

Where; $\phi(B) = 1-\phi_1 B-\phi_2 B^2 ....\phi_p B^p$

$$\theta(B) - 1-\theta_1 B-\theta_2 B^2 ......\theta_P B^q \quad (1)$$

ε_t = Error term

D = Differencing term

B = Backshift operator ($B^a Y_t = Y_{t-a}$)

Analogous to the simple SARIMA parameters, these are:
Seasonal autoregressive - (Ps)
Seasonal differencing - (Ds)
Seasonal moving average parameters - (Qs)
Seasonal models are summarized as ARIMA (p, d, q) (P, D, Q)$_s$
Number of periods per season - S

$$(1-\phi_1 B)(1-\varphi_1 B^s)(1-B)(1-B^s)Y_t = (1-\theta_1 B)(1-\theta_1 B^s)\varepsilon_t \quad (2)$$

3.2 CIRCULAR MODEL (CM) AND SAMA CIRCULAR MODEL (SCM)

The development of the CM was based on; Fourier Transformation, the theory of Uniform Circular motion and Multiple Regression Analysis. The SCM is the improved version of the CM.

3.2.1 CIRCULAR MODEL

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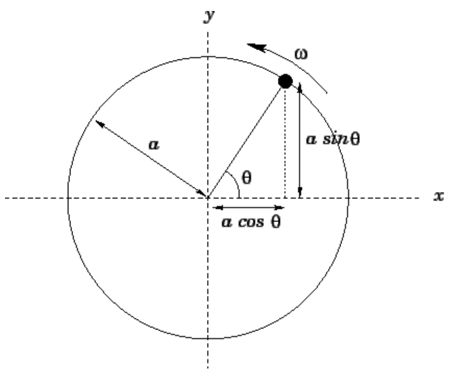
As explained in Konarasinghe (2016)[2], a discrete version of the Fourier transformation for a function *f(x)* is written as:

$$f_x = \sum_{k=1}^{n} a_k \cos k\theta + b_k \sin k\theta \qquad (3)$$

Where a_k and b_k are amplitudes, k is the harmonic of oscillation.

The Fourier transformation is incorporated into a uniform circular motion of a particle in a horizontal circle and basic trigonometric ratios. A particle *P*, which is moving in a horizontal circle of center O and radius a is given in Figure 1. The ω is the angular speed of the particle;

Figure 1: Motion of a particle in a horizontal circle



Angular speed is defined as the rate of change of the angle with respect to time. Then;

$$\omega = \frac{d\theta}{dt}$$

$$\int_0^{\theta} d\theta = \int_0^{t} \omega \, \mathrm{dt}$$

Hence, $\theta = \omega t$ (4)

Substitute (4) in (3); $f_x = \sum_{k=1}^{n} a_k \cos k\omega t + b_k \sin k\omega t$ (5)

At one complete circle θ=2π radians. Therefore, the time taken for one complete circle (*T*) is given by: $T = 2\pi / \omega$

Figure 2 and Figure 3 clearly show how to incorporate a particle in a horizontal circular motion to trigonometric functions;

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Figure 2: sine function and reference circle

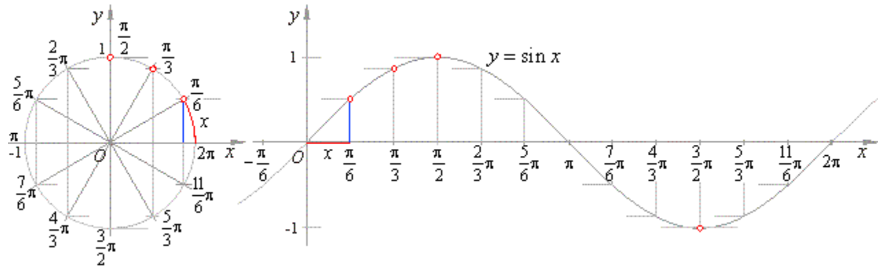
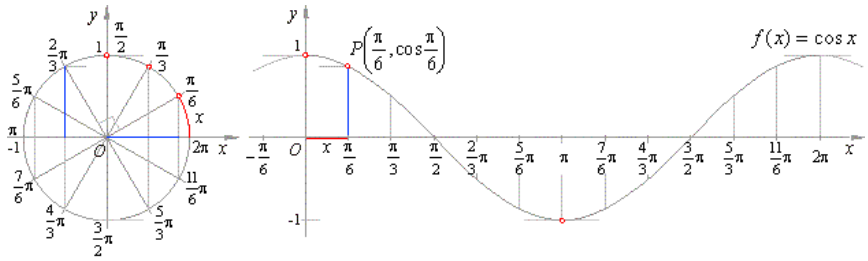


Figure 3: cosine function and reference circle



Reference to Figure (1); $\overrightarrow{op} = a(\cos\theta\,\mathbf{i} + \sin\theta\,\mathbf{j})$, where, a is the amplitude or wave height. A wave with constant amplitude is defined as a regular wave and a wave with variable amplitude is known as an irregular wave. In a circular motion, the time taken for one complete circle is known as the period of oscillation. In other words, the period of oscillation is equal to the time between two peaks or troughs of sine or cosine function. If a time series follows a wave with f peaks in N observations, its period of oscillation can be given as;

$$T = \frac{\textit{total}\text{ number of periods}}{\text{total number of peaks}} = \frac{N}{f} \tag{6}$$

Hence, $\omega = 2\pi \dfrac{f}{N}$ (7)

Therefore, a variable Y_t, with an irregular wave pattern was modeled as;

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$$Y_t = \sum_{k=1}^{n} (a_k \sin k\omega t + b_k \cos k\omega t) + \varepsilon_t \qquad (8)$$

The model (8) was named as "Circular Model".

Model assumptions of the CM are; the series Y_t is trend-free; trigonometric series, $\sin k\omega t$ and $\cos k\omega t$ are independent; residuals are Normally distributed and independent.

3.2.2. SAMA CIRCULAR MODEL (SCM)

A limitation of the CM is that it is not applicable for a series with a trend. Konarasinghe (2018; 2018)**[7] [8]** suggests the method of differencing to mitigate the limitation of the CM. In usual notation, differencing series of Y_t are as follows;

First differenced series: $Y_t^{'} = Y_t - Y_{t-1} = (1-B)Y_t$ (9)

Second differenced series:

$$Y_t^{''} = Y_t^{'} - Y_{t-1}^{'} = (Y_t - Y_{t-1}) - (Y_{t-1} - Y_{t-2)}) = Y_t - 2Y_{t-1} + Y_{t-2} = (1-B)^2 Y_t \qquad (10)$$

Similarly, d th order difference is, $Y_t^d = (1-B)^d Y_t$

(11) Where, B is the Back Shift operator; $BY_t = Y_{t-1}$.

Assume Y_t^d is trend-free. Let, $Y_t^d = X_t$ Then X_t could be modeled as;

$$X_t = \sum_{k=1}^{n} (a_k \sin k\omega t + b_k \cos k\omega t) + \varepsilon_t \qquad (12)$$

Hence; $(1-B)^d Y_t = \sum_{k=1}^{n} (a_k \sin k\omega t + b_k \cos k\omega t) + \varepsilon_t$ (13)

the model (13); improved Circular Model, is named as "Sama Circular Model (SCM)".

3.3 Measurements of errors

The study considered two measurements of errors to measure the forecasting ability of the model. They are:

3.3.1 Mean Absolute Deviation (MAD)

$$MAD = \frac{1}{n} \sum \left| \left(Y_t - F_t\right) \right|$$

(14)

3.3.2 Mean Square Error (MSE)

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$$MSE = \frac{1}{n}\sum\left(Y_t - F_t\right)^{2}$$

(15)

Where; Y_t = Observed value of time t, F_t= Forecasted value of time t

4. RESULTS

Data analysis is organized as follows;

4.1 Testing SARIMA on forecasting foreign guest nights
4.2 Testing Sama Circular Model on forecasting foreign guest nights

At first, outliers were checked and found that the data set is outlier free. Time series plot and Auto-Correlation Function (ACF) were used for pattern recognition. Time series plot of an occupancy guest nights by foreign guest (Figure 4), shows that there is an increasing trend with a wave-like pattern. The ACF (Figure 5) shows that the series is not stationary and suggests a seasonal pattern with the trend. Hence, it was assumed that both SARIMA and SCM would be suitable for forecasting foreign guest nights.

Figure 4: Time Series Plot of occupancy in Anuradhapura

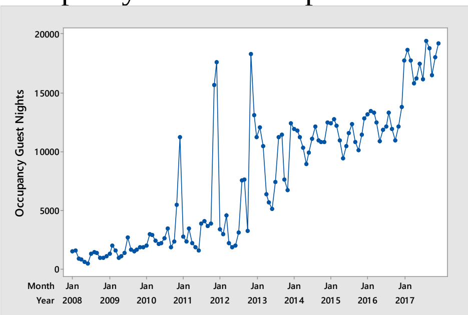
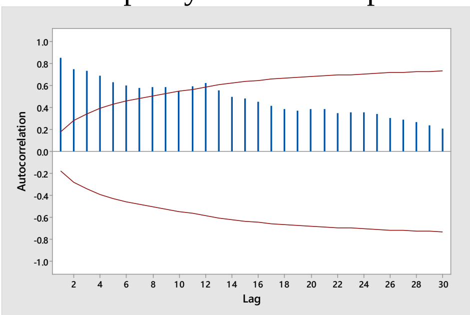


Figure 5: Autocorrelation function of occupancy in Anuradhapura



4.1 TESTING SARIMA ON FORECASTING FOREIGN GUEST NIGHTS

Log-transformed data were used in the analysis. The SARIMA model was tested for the original series and differenced series, but the model was not significant.

4.2 TESTING SAMA CIRCULAR MODEL ON FORECASTING FOREIGN GUESTNIGHTS

The differencing technique was used to obtain the trend-free series. First difference series (X_t) in Figure 6 is trend-free; therefore Circular Model was tested on it.

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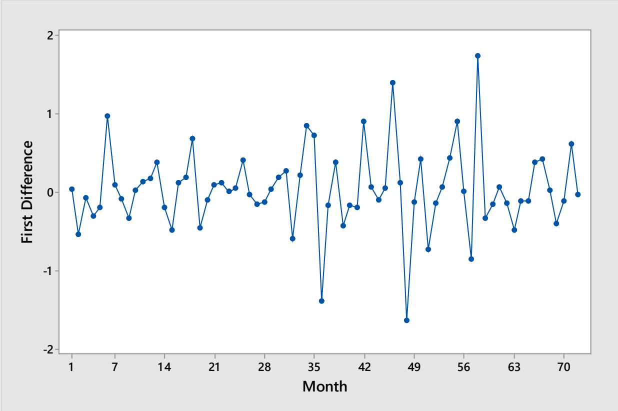
Figure 6: Time Series Plot of First Differences



The fitted model is;

$$X_t = 0.0286 - 0.3357\, sin 6\omega t \qquad (16)$$

Where ω= 1.3089 ^{c}.

Normal probability plot (Figure 7) and the Anderson Darling test confirmed the normality of residuals; the ACF of residuals (Figure 8) and the LBQ test confirmed the independence of residuals.

Figure 7: Probability plot of residuals

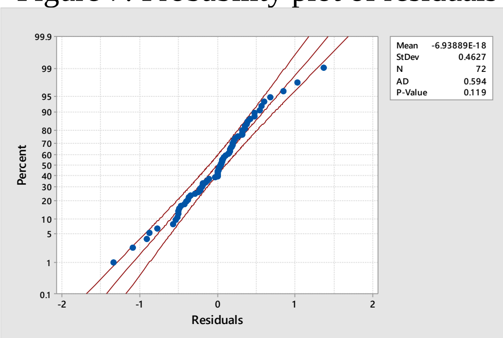


Figure 8: ACF of residuals

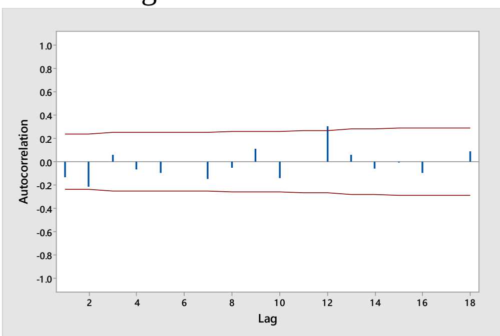


Table 1: Model Summary

Model	Model Fitting		Model Verification	
$X_t = 0.0286 - 0.3357\, sin 6\omega t$	MAD	0.3445	MAD	0.1861
	MSE	0.2111	MSE	0.0537
	Normality	P= 0.119		
	Independence	Yes		

Measurement of errors is satisfactorily small, the MSE in model fitting is 0.2111, while 0.0537 in model verification; the MAD in model fitting is 0.3445, while 0.1861 in model verification. Time series plot of Actual Vs Fits shows that the pattern of fits follows the pattern of actual (Figure 9).

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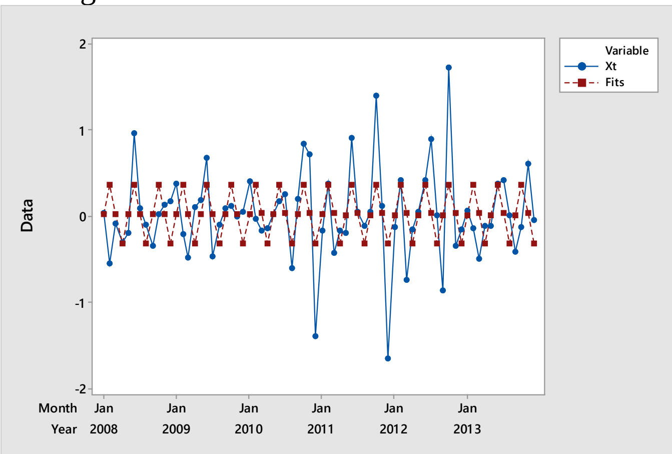
Figure 9: Time Series Plot of Actual Vs Fits



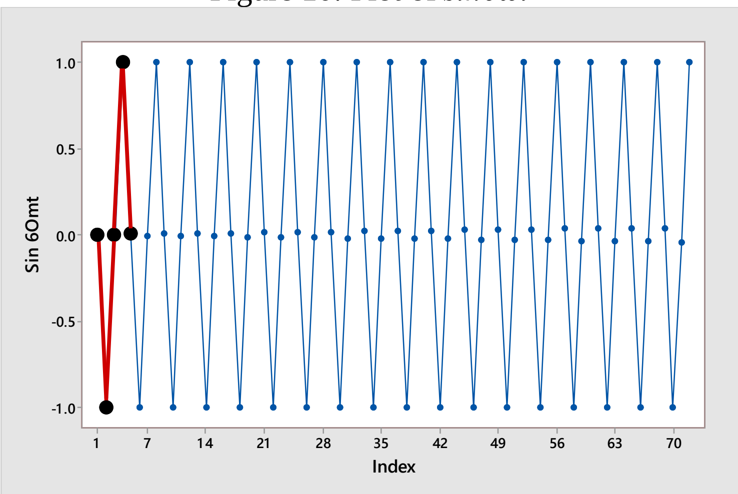
$$X_t = Y_t' = (1-B)\ Y_t = Y_t - Y_{t-1};$$

Hence the SCM is;

$$Y_t = Y_{t-1} + 0.0286 - 0.3357\,sin6\omega t \quad (17)$$

The fitted SCM contains only one trigonometric function (*sin6ωt*). According to Figure 10, the period of oscillation is 5 months. It means occupancy guest nights follow a seasonal pattern. The seasonal length is 5 months.

Figure 10: Plot of *sin6ωt*



Hence the fitted SCM $Y_t = Y_{t-1} + 0.0286 - 0.3357\,sin6\omega t$ can be recommended for forecasting occupancy guest nights in Anuradhapura of Sri Lanka.

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Table 2: Estimated Night Occupancy

Year	Month	Estimated Guests Nights (Anuradhapura)
2020	January	28178
	February	28182
	March	40517
	April	42914
	May	31608
	June	31589
	July	45411
	August	48134
	September	35452
	October	35400
	November	50891
	December	53983
2021	January	39763
	February	39676
	March	57032
	April	60548
	May	44604
	June	44472
	July	63920
	August	67912
	September	50033
	October	49843
	November	71633
	December	76164

Table 2 is the estimated night occupancy by the foreign guest for the period of 2020 and 2021.

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Figure 11: Time series plot of forecasting occupancy in Anuradhapura

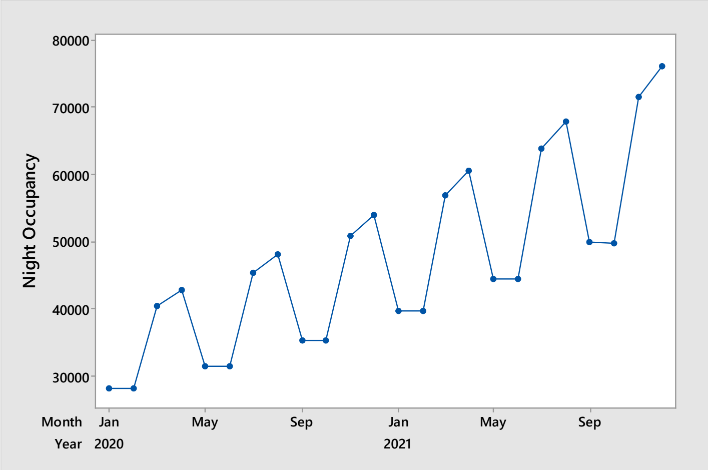

Figure 11 is the time series plot of forecasting occupancy for the period of 2020 and 2021. It shows the increasing trend of occupancy. This is a favorable situation for tourism-related businesses in the Anuradhapura area of Sri Lanka.

5. CONCLUSION AND RECOMMENDATION

The study concluded that the SCM outperformed SARIMA in forecasting occupancy in Anuradhapura of Sri Lanka. SARIMA models were not significant during the model fitting. The series shows the wave-like pattern with the trend. SCM confirmed the seasonal behavior in the data series. The results of the study agree with other applications of SCM in the literature review of the study.

The literature revealed that the SARIMA is a suitable technique in forecasting occupancy guest nights in Sri Lanka. The series of occupancy guest nights of Anuradhapura follows a wave-like pattern with the trend. In general, time series with wave-like patterns are modeled by either Decomposition techniques or SARIMA. However, a wave-like pattern with the trend may contain both seasonal and cyclical variation, but the SARIMA is unable to separate them. Decomposition techniques are suitable to separate them. But the literature revealed that Decomposition techniques are not successful in forecasting occupancy for most of the regions in Sri Lanka. The SCM is the latest development in univariate time series which is a more powerful tool to capture seasonal and cyclical behavior (Konarasinghe, 2018; 2018) [7] [8]. The results of the study showed that SCM is successful than SARIMA in this study. SCM is more comfortable than Decomposition by reducing time and fatigue. On the other hand, the results of this model could explain the seasonal behavior of occupancy. It will be a critical component for strategy development in marketing, operations, HRM and many more business-related activities related to the tourism industry. Forecasting occupancy for the period of 2020 and 2021 shows the increasing trend. It is favorable for businesses related to the tourism industry in the Anuradhapura area. But the business practices in operations, marketing, financial matters, HR and administration should be focused on the seasonal behavior of the occupancy as well. It will be useful to minimize the wastage of resources. It is recommended to test the SCM, in forecasting occupancy in other regions and other activities such as forecasting income, employment, arrivals, tourism price index etc.

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