# **Executive Summary**

In our project, we conducted a thorough analysis for the demand of beer bottles at Titanium Brewery, located in the southern Caribbean Island of Trinidad. To suffice our forecasting values, we collected the monthly historical data from January 1999 to February 2004 (in thousands of cases). Then, we have utilized the application “Forecast Pro” to get actionable insights for any possible trend, seasonal, or cyclical patterns. Per requirement, we withheld 8 months of data and performed the Exponential Smoothing method to produce a forecast. From our analysis, we have narrowed down some possible forecasting methods, and then we ranked each method based on their fit and accuracy measures. By observing MAPE for all the methods, a measure of predicting accuracy of a forecasting method, the Winter’s Exponential Smoothing method has comparatively the lowest value of 10.36%. Also, Hence, Winter’s Exponential Smoothing method with an additive seasonality appeared to be the most accurate and fits the data correctly. As the purchasing managers at Banged-Tail Bikes, **we recommend ……………………………………………….………………………………………………………………………………………………………………………………………………** The following report demonstrates our analysis in a detailed manner, explaining each step of our study and how we reached our conclusion.

# **Objective**

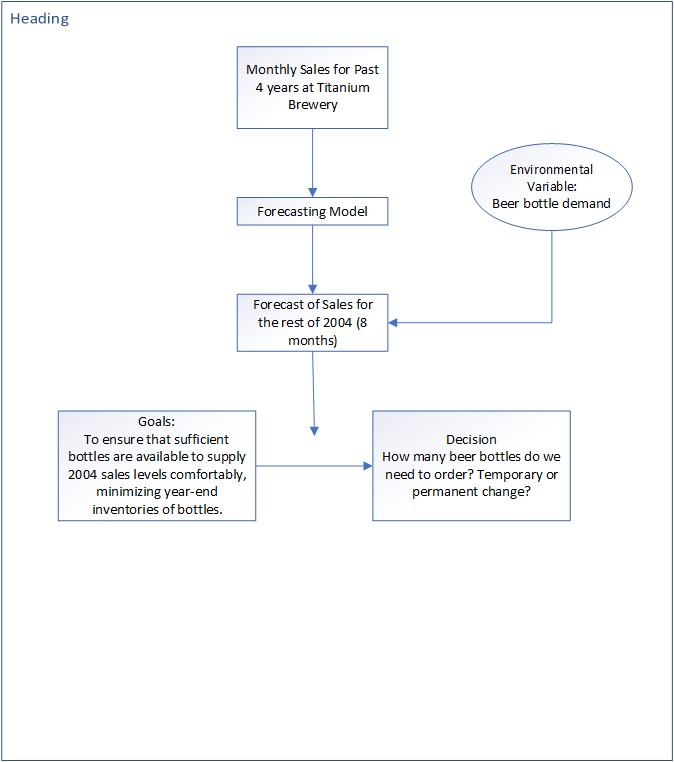
*The forecasting problem for the Titanium Brewery is that the covered storage space for empty bottles is tight and a bottle design change is expected in 2005 and 2006. So, they want to forecast the number of beer bottles to order in the year 2004 which would accommodate the year’s supply comfortably along with minimizing the year end inventories. Both under-forecasting and over-forecasting are going to be expensive situations hence, careful forecast is needed as a strong base before placing the order of beer bottles. The cost of under production and losing sales is much higher than the cost of over stock. If sales exceed, Titanium Brewery must expand their storage space. They must also consider by how much the quarterly sales exceed, for how many quarters the sales will exceed, and finally whether exceeding the sales in a year will be a short-term situation or if it will be a permanent state. They should also record if sales increase in a particular season. For instance, generally beer sales are more in summer than in winter.*

**Issue:** The forecasting problem for the Titanium Brewery is that the covered storage space for empty bottles is tight and a bottle design change is expected in 2005 and 2006.

**Goal:** Titanium Brewery wants to forecast the number of beer bottles to order in the year 2004 which would accommodate the year’s supply comfortably along with minimizing the year end inventories.

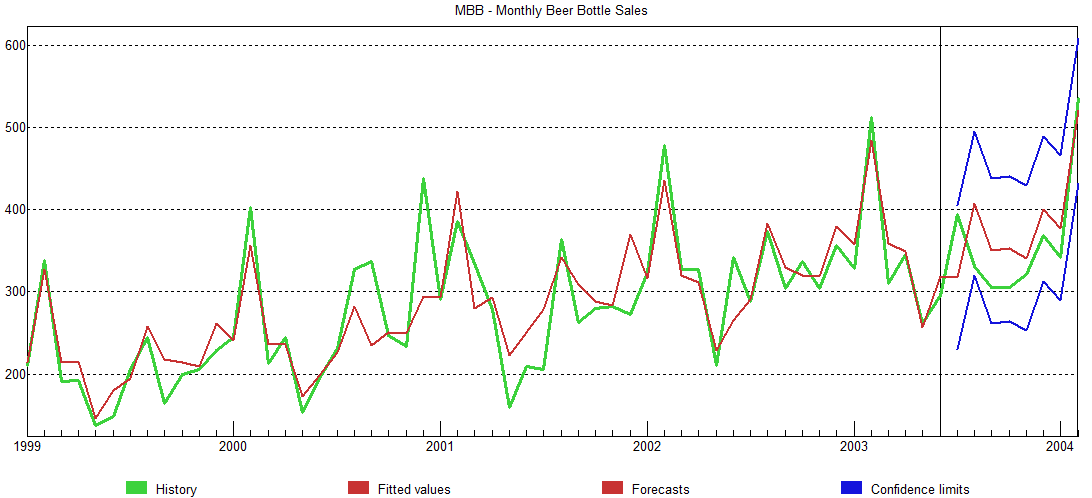
**How will forecasting help in achieving the goal:** Both under-forecasting and over-forecasting are going to be expensive situations hence, careful forecast is needed as a strong base before placing the order of beer bottles. The cost of under production and losing sales is much higher than the cost of over stock. If sales exceed, Titanium Brewery must expand their storage space. They must also consider by how much the quarterly sales exceed, for how many quarters the sales will exceed, and finally whether exceeding the sales in a year will be a short-term situation or if it will be a permanent state. They should also record if sales increase in a particular season. For instance, generally beer sales are more in summer than in winter except during carnivals. These decisions could be taken after proper forecasting of Titanium brewery business.

***Below is a graphical frame work that illustrates how our decision making is related to forecasting.***



# **Data Patterns**

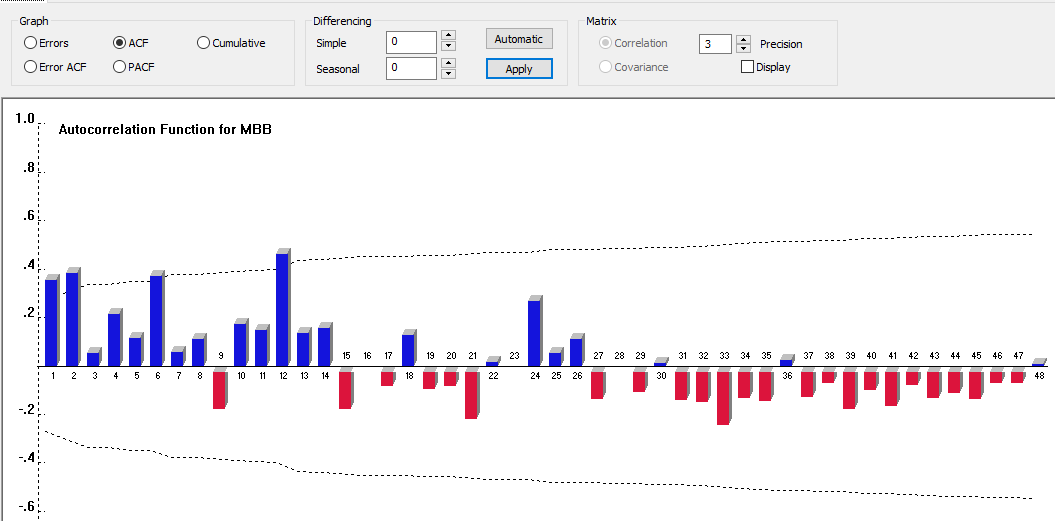
As per time-series, our model shows Linear trend since the



**Determining Patterns in time series using Autocorrelation**

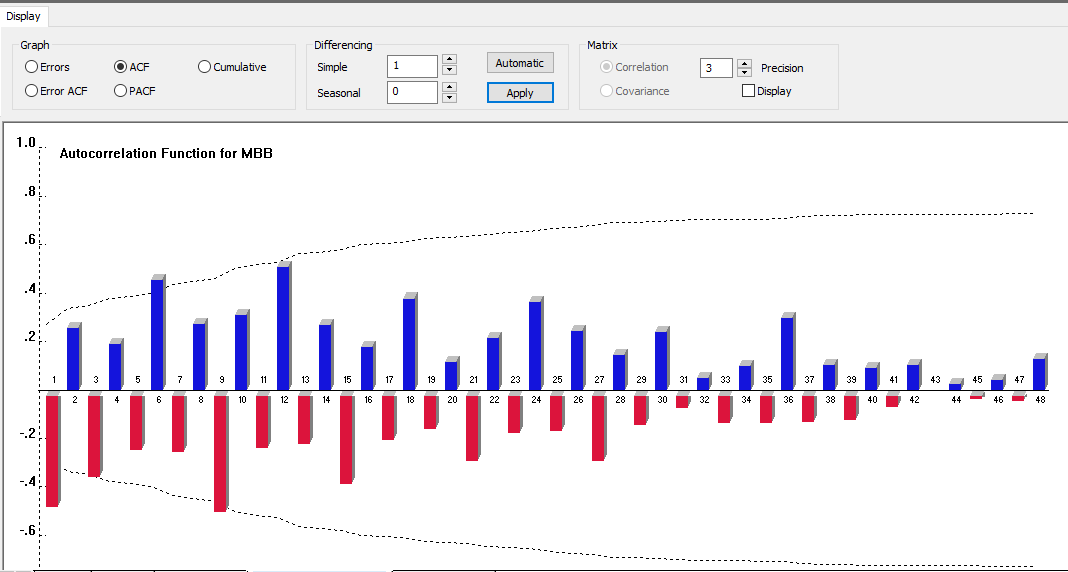
We performed autocorrelation and modified ‘Simple Differencing’ and ‘Seasonal differencing’ to determine the patterns in the data.

* **Patterns observed when no differencing was applied**



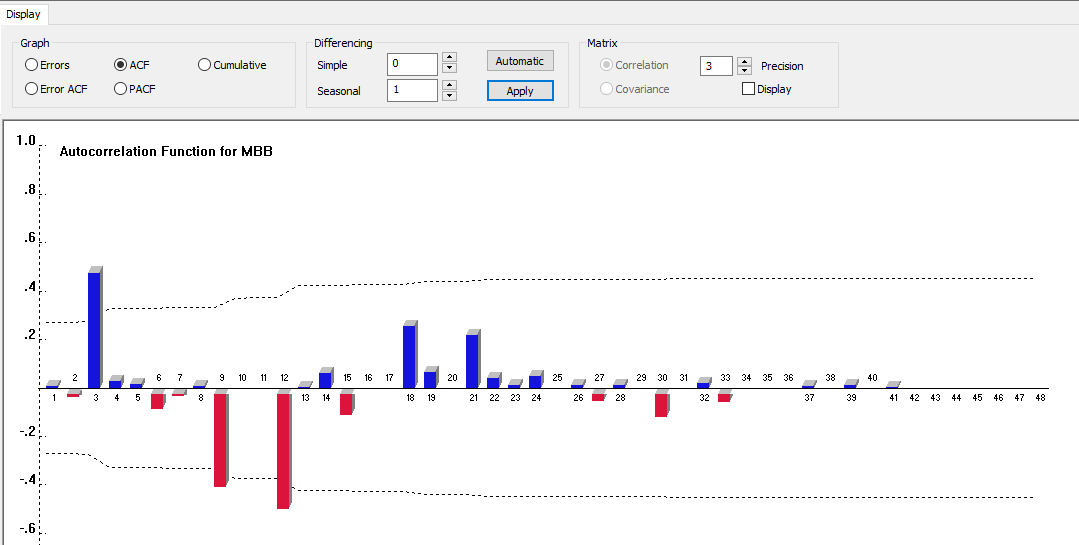
From the figure above, we observe that the autocorrelation function gradually drops to 0. As a result, we can infer that the time series is non-stationary. Also, high correlation can be seen among the observations with initial lags being significantly different from 0 and then gradually dropping to 0 which explains the trend within the series.

* **Patterns observed when first order simple differencing was applied**



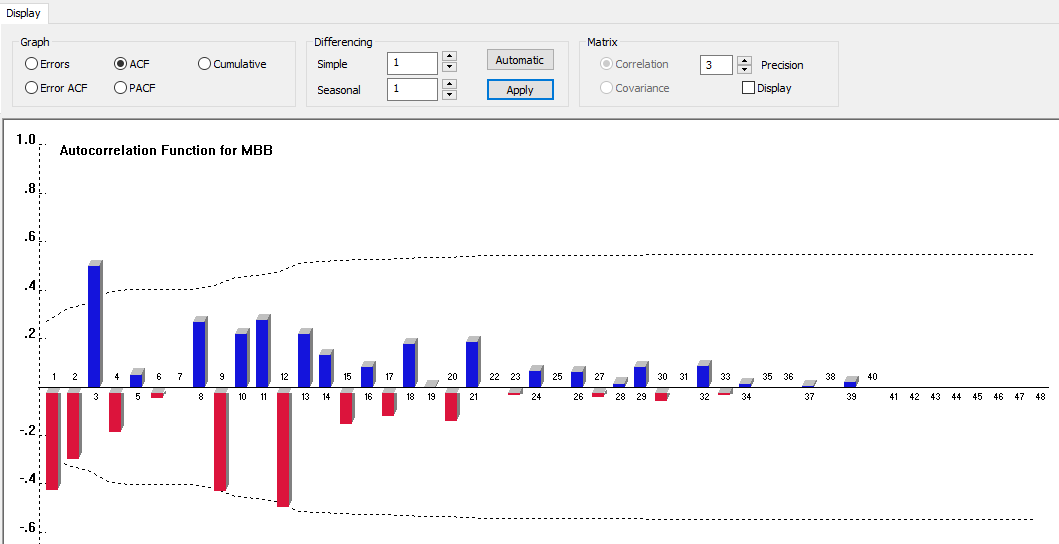
The figure shows that the series has seasonality which can be observed by increase of sales every February and also by a significant autocorrelation coefficient occurring in lags of 12 months.

* **Patterns observed when first order seasonal differencing was applied**



We see that the trend is not repeated after fixed periods. Therefore, the trend within the series is cyclic.

* **Patterns observed when both first order seasonal and simple differencing were applied**



This differencing is applied in order to make the series stationary. We can determine that the series is moving towards stationary with constant mean and variance. Moreover, the autocorrelation immediately drops to 0 which happens when the series is stationary.