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Report for Assignment-1

Pizza Sales Demand Report

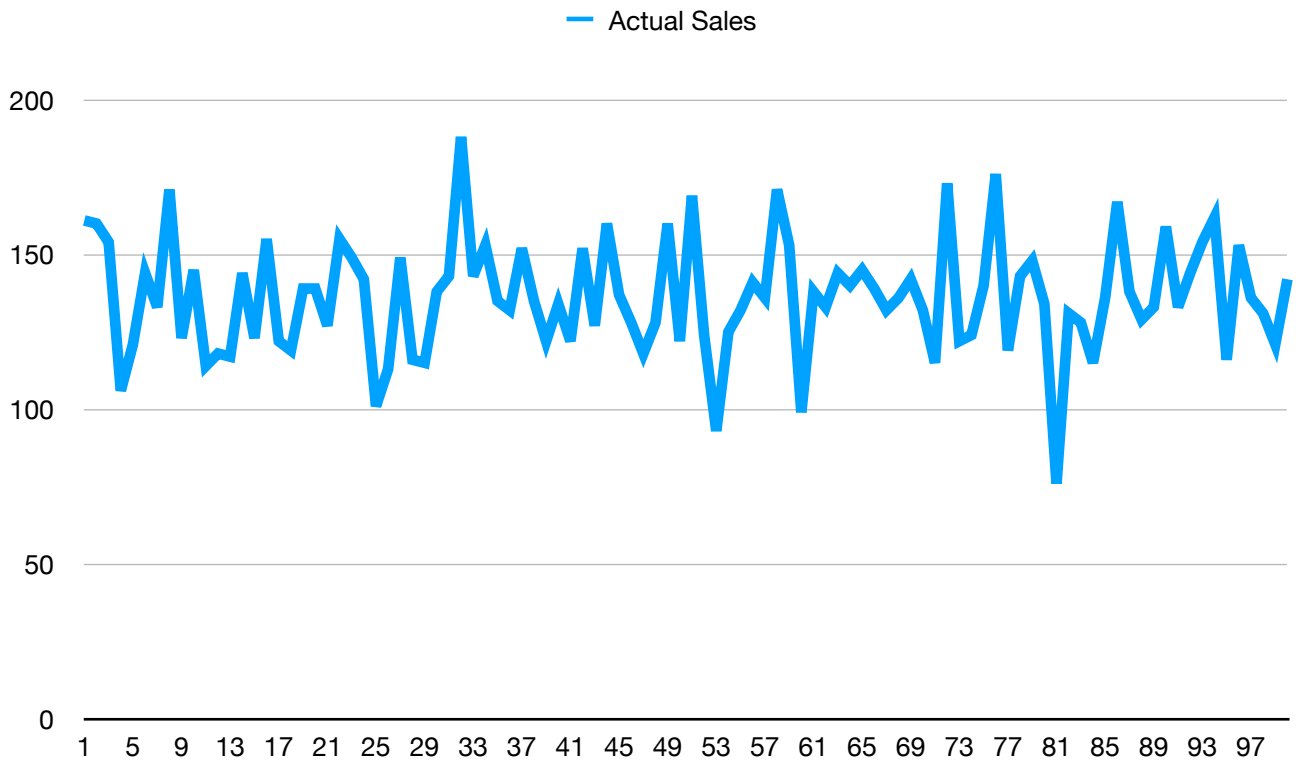
This report analyses the provided pizza sales dataset spanning 100 days. The dataset contains the day number and the corresponding pizza sales demand. The analysis includes key statistics and trends to provide insights into the sales patterns.

1. **Overview**:
- The dataset consists of pizza sales demand for 100 days.
- The daily demand varies between 76 and 188 units, with an average demand of approximately 135 units.

2. **Sales Trends:**
- The highest demand recorded during the period was 188 units on day 32.
- The lowest demand recorded during the period was 76 units on day 81.
- The demand appears to fluctuate throughout the 100 days, indicating variability in customer preferences or external factors influencing sales.

3. **Average Demand:**
- The average daily demand for pizza sales during the analysed period is approximately 136 units.

4.**Stationarity:**
- From the plot below, we can see that the data is stationary.



Sales Forecasting:

Techniques Used:

1. Naive Method:

The naive forecasting method, also known as the "last observation" method, predicts future values based solely on the most recent observed value. In other words, it assumes that the future will be the same as the most recent period. While simple to apply, the naive method might not capture more complex patterns or variations in the data.

2. ARMA Method (AutoRegressive Moving Average):

The AutoRegressive Moving Average (ARMA) method is a time-series forecasting technique that combines both autoregressive (AR) and moving average (MA) components to predict future values. The ARMA model assumes that a future value is a combination of a linear relationship with its past values (AR component) and a linear relationship with past forecast errors (MA component). ARMA models are suitable for stationary time-series data with temporal dependencies.

3. Exponential Smoothing:

Exponential smoothing is a forecasting method that assigns different weights to past observations based on their recency. The more recent observations are given higher weights, reflecting the idea that recent data might be more relevant for predicting future values. Exponential smoothing methods include Simple Exponential Smoothing, Double Exponential Smoothing (Holt's method), and Triple Exponential Smoothing (Holt-Winters method), which also considers seasonality.

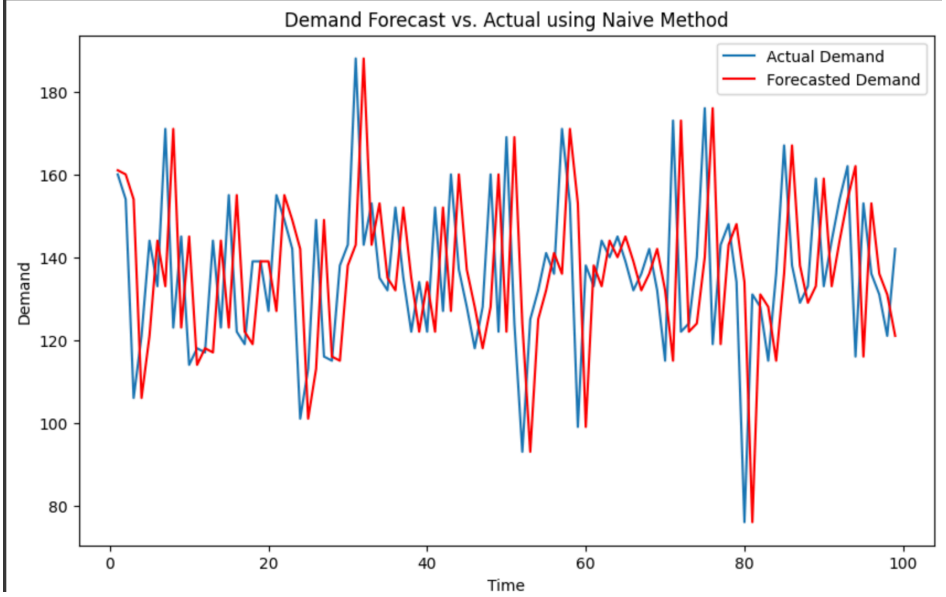
4. Moving Average:

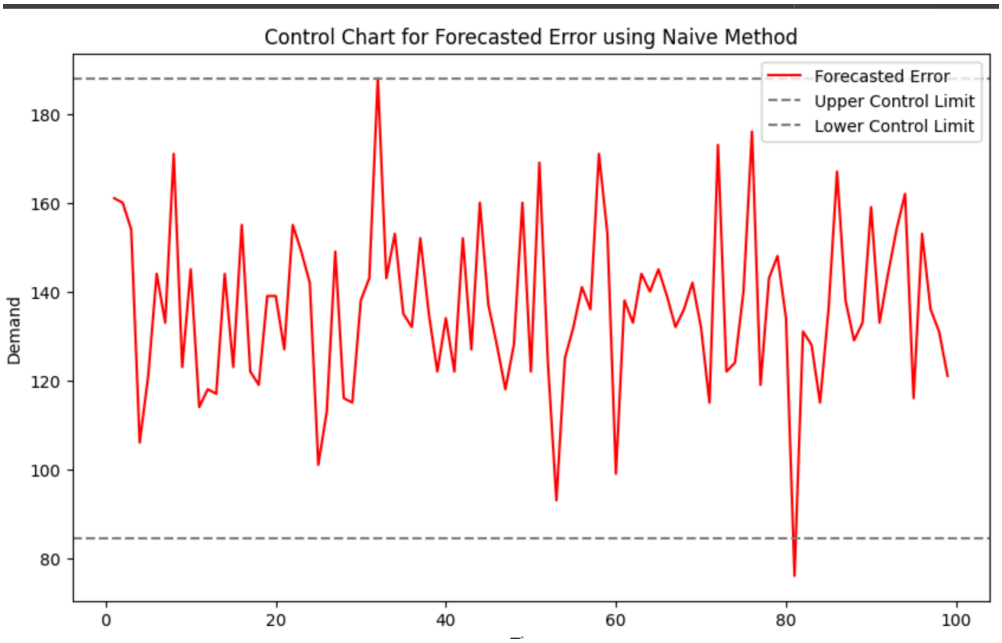
The Moving Average (MA) forecasting method calculates the average of a specific number of most recent observations to predict the future value. It smooths out short-term fluctuations and noise in the data. The method involves taking the average of the last "n" observations, where "n" is the order of the moving

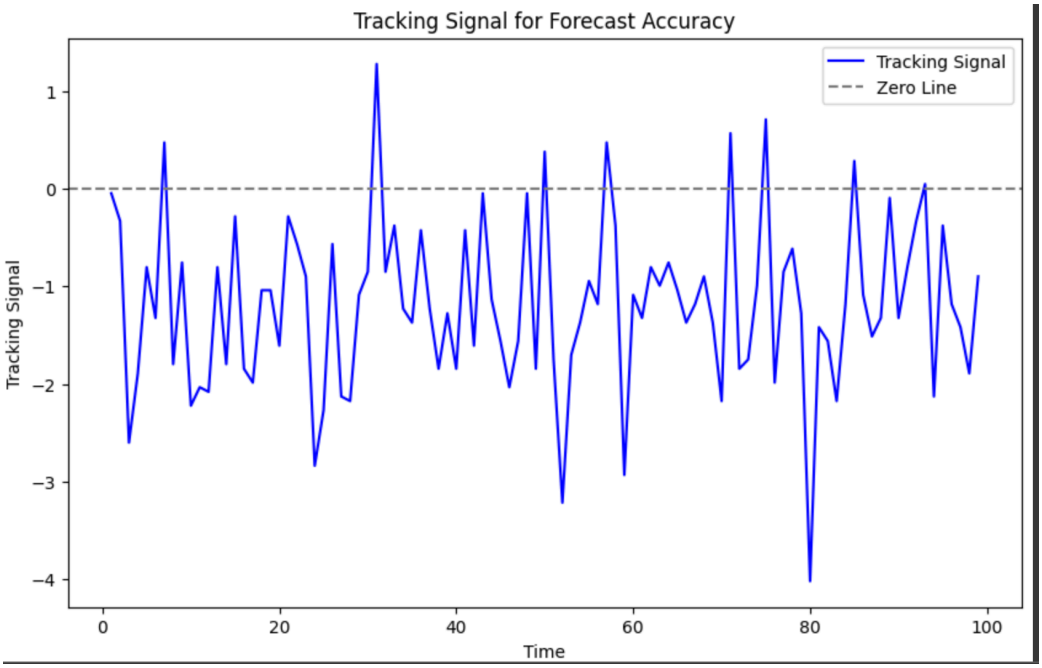
Results:

Naive Method:

```
MAPE: 15.54%
Mean Absolute Deviation (MAD): 21.14
Mean Squared Error (MSE): 696.37
```

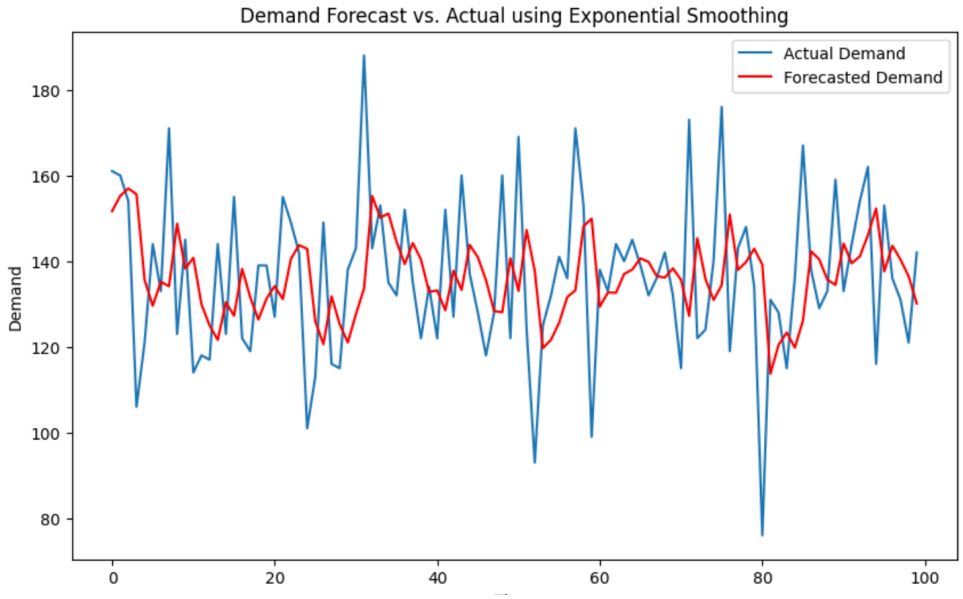


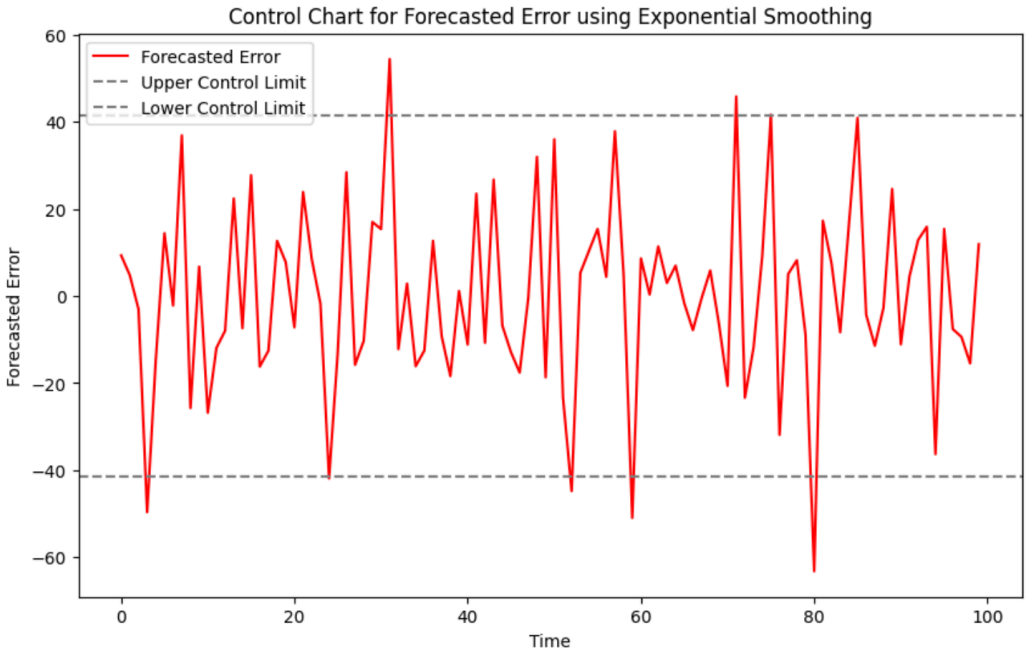


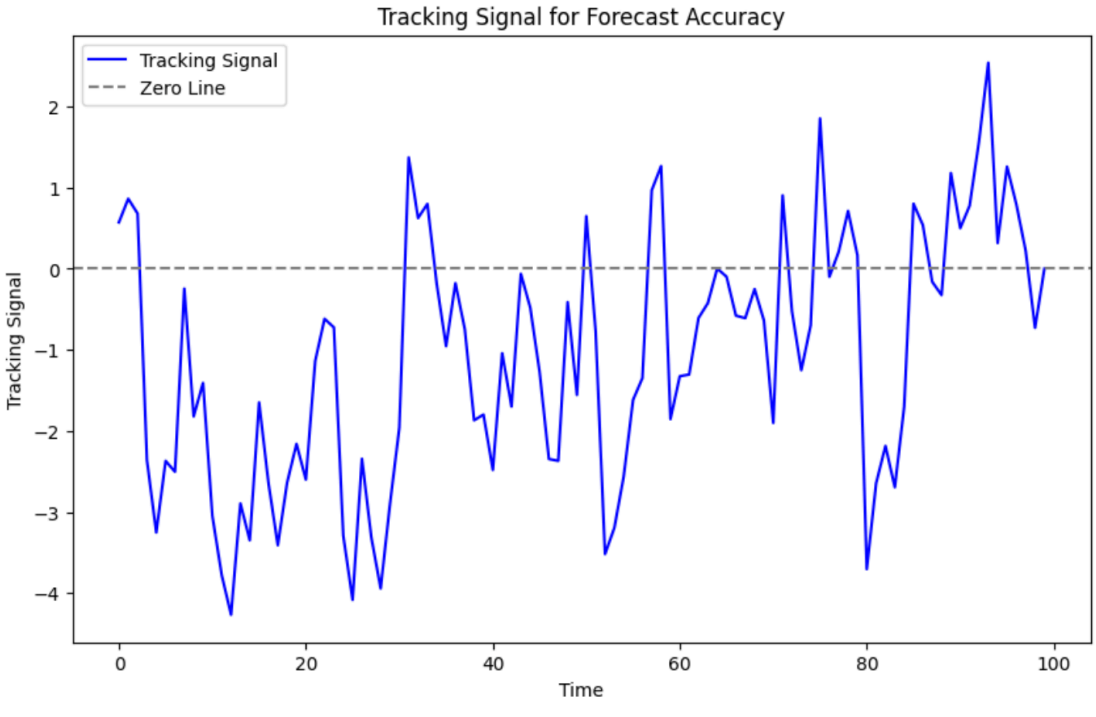


Exponential Smoothing (alpha=0.4)

```
MAPE: 11.98%
Mean Absolute Deviation (MAD): 16.32
Mean Squared Error (MSE): 444.08
Variance of Forecast Errors: 444.08
```

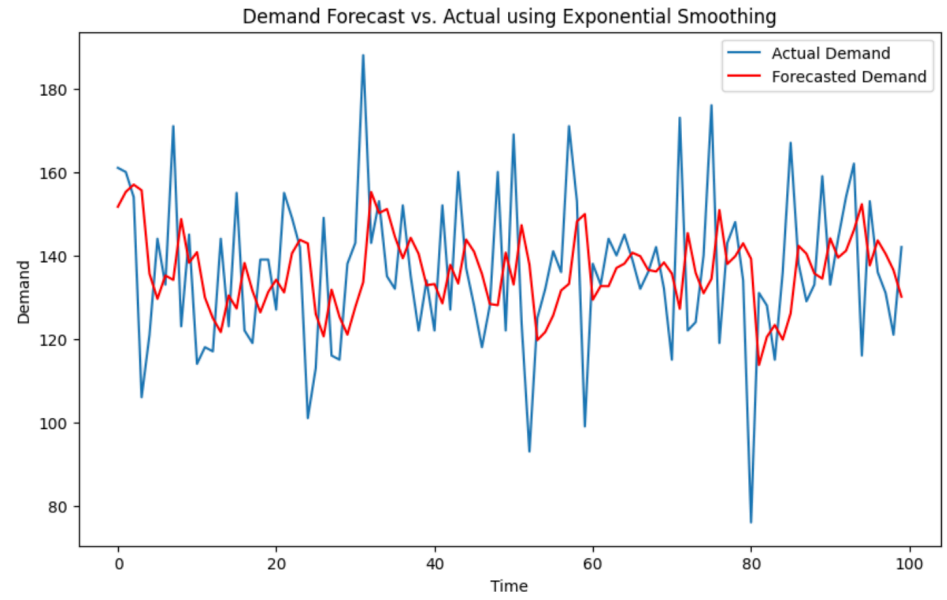


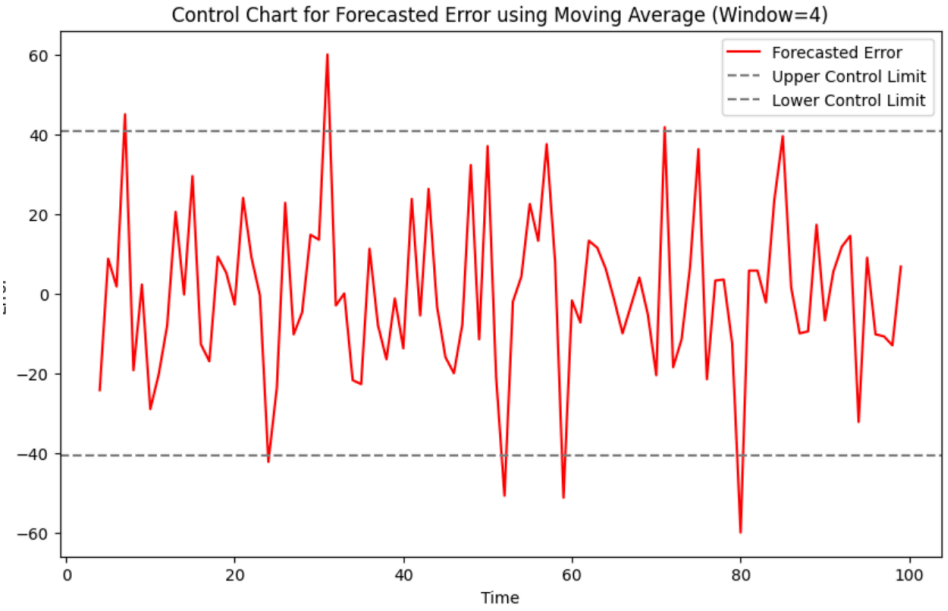


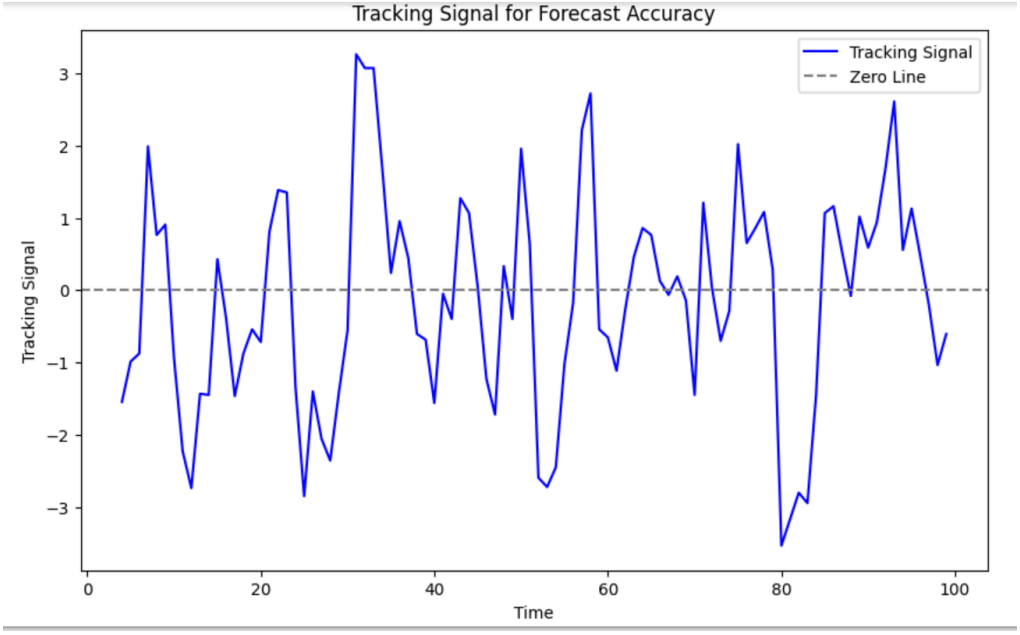


Moving Average (window=4)

```
MAPE: 11.98%
Mean Absolute Deviation (MAD): 16.32
Mean Squared Error (MSE): 444.08
```

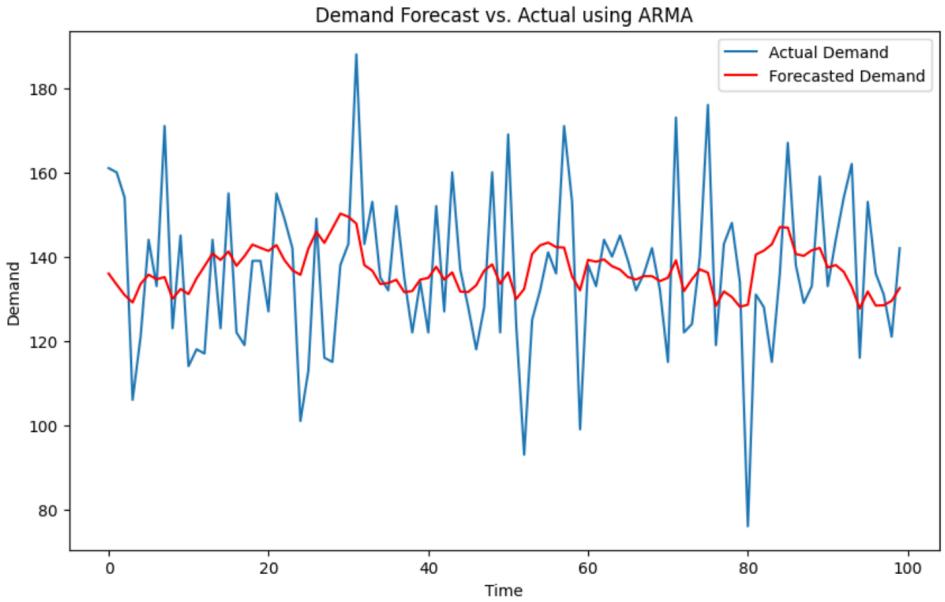


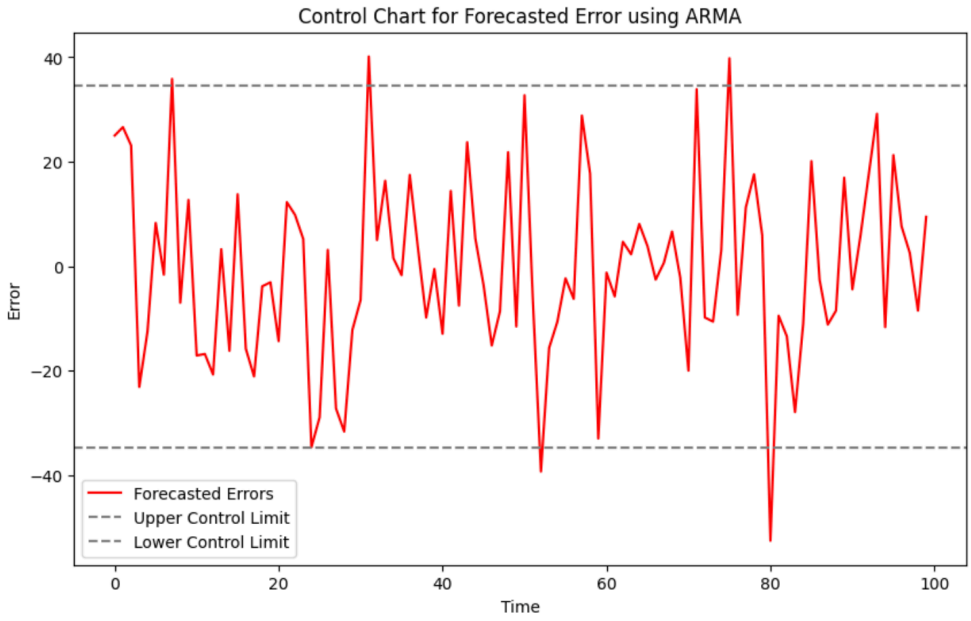


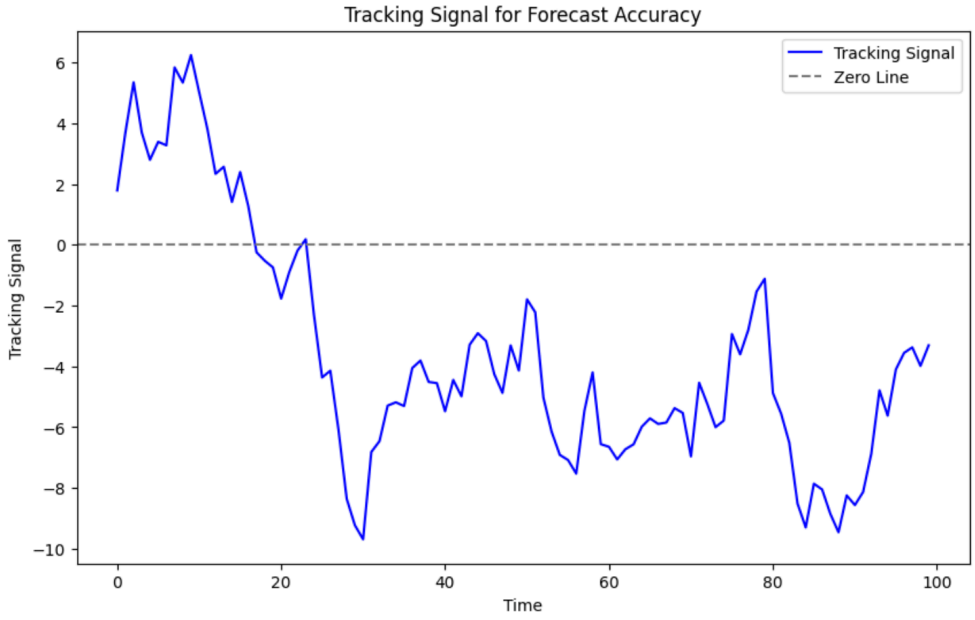


ARMA

```
MAPE: 10.26%
Mean Absolute Deviation (MAD): 13.98
Mean Squared Error (MSE): 313.28
```







Dataset:

forecasted_demand_and_tracking

Actual Demand	Forecasted Demand
161	135.97664228122800
160	133.3703492129650
154	130.87803554945000
106	129.11669017525600
121	133.52659597102300
144	135.7253659789960
133	134.62074179112700
171	135.1369165044740
123	130.00152247189000
145	132.30688346117200
114	131.1096231126600
118	134.8146617154480
117	137.7431534745050
144	140.73587370276000
123	139.20896053573800
155	141.2253212612220
122	137.8225089678200
119	140.1159264842150
139	142.8585113728980
139	142.08892329344300
127	141.35113065602000
155	142.73622621931700
149	139.17425561531700
142	136.77230603313200
101	135.67794100204400
113	141.93183445124100
149	145.88191605931800
116	143.2566193706200
115	146.67323386387700
138	150.2005019174820
143	149.46295074496700
188	147.83672081768800
143	137.98901606901500
153	136.64644223765600
135	133.48420469640200
132	133.7224132604080
152	134.5121646752540
135	131.5578559212100
122	131.8351637780730
134	134.5400043342580
122	134.94064541463500
152	137.5912072913700
127	134.5381550019650
160	136.26198261084600
137	131.7089924373130
128	131.59452982723600
118	133.19030189266900
128	136.66179129501200
160	138.17036257046700
122	133.54506835503100
169	136.2595132308590
124	129.9297892278410
93	132.32677916572900
125	140.6407753498610
132	142.67745527269500
141	143.33794088224200
136	142.25533988360700
171	142.15511846384700
153	135.29254897671900
99	132.00837748581200
138	139.2297673171050
133	138.79061482098000
144	139.32865544768800
140	137.7225613983980
145	136.91583013934000
139	135.14602463272700
132	134.56789463658700
136	135.36229737576200
142	135.36575692948100
132	134.19653172269900
115	134.99695560621800
173	139.11535543933800
122	131.82347164460200
124	134.6145430045130
140	136.98087672227500
176	136.17889005367400
119	128.312375509888
143	131.73996952403700
148	130.40696747966200
134	128.10323271974800
76	128.58154104643100
131	140.48834864033300
128	141.42029730780500
128	141.42029730780500
115	142.93538971555600
136	147.00332558325300
167	146.88090031705100
138	140.631140246878
129	140.18213379883800
133	141.51967019680300
159	142.05243713857700
133	137.4283541966620
144	138.00395252814900
154	136.39222054988000
162	132.81110543904100
116	127.67471025353400
153	131.7233281821740
136	128.38062839603800
131	128.4479184056360
121	129.50853873127200
142	132.5492276967640

Conclusion:

- From our observations, we find that ARMA is the best technique for forecasting sales for the given dataset.

- The MAPE value of 10.26% indicates that, on average, the forecasted values deviate by approximately 10.26% from the actual values. This suggests a relatively accurate forecasting performance.

- The MAD value of 13.98 implies that, on average, the forecasted values differ from the actual values by approximately 13.98 units. Lower MAD values indicate better accuracy.

- The MSE value of 313.28 indicates the average squared difference between forecasted and actual values. Lower MSE values indicate better precision in forecasting.

- On using the relation [alpha=2/n+1], we obtain variance values 184.04 for MA(4) and 177.82 for ES(alpha=0.4) which are quite close.

- This shows that ES and MA forecasts are consistent with each other.