Comparison of Demand Forecasting Technique for Production Planning in Micro and Small Enterprise: A Case Study of Healthy Food Products

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Abstract

The research objective was to examine the appropriate forecasting model which forecasted the demand for three types of healthy food products. These included almond milk, herbal juice, and baked pumpkin chips. The study of the appropriate forecasting model has been brought about by using time series forecasting and accuracy analysis using the historical data 24 weeks from August, 2022 to January, 2023 to analyze the results. The study found that using sales data in forecasting method by adopting Moving Average, Exponential Smoothing and Linear Trend Line methods in these three products had given the different results and compared forecast accuracy by Mean Absolute Percent Error (MAPE) to gain the best optimal demand forecasting method. Firstly, Exponential Smoothing was appropriate to forecast for almond milk with MAPE at 25.667%. Secondly, Linear Trend Line was appropriate to forecast for herbal drink with MAPE at 7.796%. Finally, Moving Average was appropriate to forecast for baked pumpkin chips with MAPE at 25.169%, respectively. The results obtained from this research can be used in the business planning, ordering raw materials, sales planning, workforce, and production planning in the future.

Keywords: Forecasting Technique Model, Time Series Forecasting, Demand Forecasting

1. Introduction

According to the health-conscious trend, a well-received trend from the consumers worldwide, has made a huge impact on healthy foods and drinks to become popular these days. Moreover, the market expansion after the international re-openings from COVID-19 pandemic and the intense competition in the same industry have caused many businesses to adjust several units. For instance, being an innovative organization, strategic cost management, and digital transformation etc. One of the most necessary things for the organizational adjustment is Demand Forecasting. Thus, this study primarily focuses on Micro and Small Enterprises (MSEs) as they are easier to adjust to the new marketing strategies and also more connected to customers. Moreover, they are able to rapidly analyze the needs of the customers, as well as creating marketing strategies to target a group of customers precisely and flexibly. That is why they are considered as an important gear for the economy.

The business model in this case study is located in Nakhon Pathom. It manufactures a variety of products which most of them are processed agricultural products and sold in both retail and wholesale in nearby areas. According to the study, the demands of the products fluctuate depending on each season in each year. Therefore, the sales in each period are not in the same amounts. Some of their products include almond milk, herbal drinks, and baked pumpkin chips etc. These products have unstable sale amounts that cause them in short supply and too much more dead stock than it should be frequently. In addition, there are no production plan and systematic inventory management in this business model. Hence, it is analyzed that they should primarily adopt demand forecasting strategy as a tool for helping the organization to be prepared with the instability that might occur in the future. This would help the business manager handle the change confidently, control the business process, and make strategic decision that can drive the business to the future growth.

Apparently, there are plenty of previous researches using the most precise sale forecasting method to forecast specific value or observed value in the future such as the demand forecasting in beverage industry (Wiwattanakornwong et.al.,2023), the forecasting model for export value of squid and products (Riansut, 2020), the forecasting model for promotional sales (Chiewpanich & Mokkhamakkul, 2019), the forecasting model for UHT milk sales volume (Luanghan, 2019), the forecasting of organic food products market opportunities (Jayakumar & Ezhilvani, 2018), the comparison of forecasting technique for improving the accuracy of sales forecast in plastic bottle manufacturing (Limlawan, 2022), the sales forecasting of perishable orange drink products

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(Musora et.al.,2023), the sales forecasting of germinated brown rice of community enterprise (Pattrapon & Nujira, 2017). Besides, many studies prove that the forecasting method is used in many industrial fields. Therefore, it can be seen that the method is suitable for this study.

Having stated the source of the problem and the purpose above, the study of the appropriate forecasting model has been brought about by using time series forecasting and accuracy analysis. This method will be used as information in purchasing management so that the number of products matches with the customer's demands. Also, this can be used for sale, marketing, workforce, and production planning in the future.

2. Purposes

1) to examine the appropriate forecasting model which forecasts the demand for 3 types of healthy food products including almond milk, herbal juice, and baked pumpkin chips.

3. Research Methodology

The research methodology is organized as follows. First, the data collection, followed by the forecasting methods to find the appropriate technique. Finally, the Comparing forecast accuracy and conclusions are presented. (Gardner,1985, Johnson, 1988)

Data collection

The data in this study is collected from the sales or the demands of the three types of products in the business model which are almond milk, herbal drink, and baked pumpkin chips. From the sale revenue (baht) of the business in the case study between August, 2022 to January, 2023, in total 24 periods of time (weeks).

Forecasting methods to find the appropriate technique

The analysis of appropriate forecasting method in this study uses forecasting package software to find other statistics along with time series forecasting. There will be many MAPE values following each time used in moving average method. Then, the least MAPE value will be selected followed by Seasonal Factor and Adjusted Forecast to direct sales forecast in other periods of time. This will lead to the total forecasting result that which forecasting method has the most accurate forecasting sale. (Wofuru-Nyenke & Briggs, 2022).

Choosing a method or technique for forecasting depends on forecast time horizon, data availability, forecasting budget and availability of qualified personnel. For guidelines on choosing techniques for forecasting can be shown in table 1.

Table 1 Guidelines on choosing techniques for forecasting

Forecasting Techniques	Data Patterns	Forecasting horizon	Qualified Personnel
Moving Average	stable (without trend and temporality)	short	low
Weighted Moving Average	cycle or seasonality	short to medium	medium
Exponential Smoothing	cycle or seasonality	short	low
Simple Linear Regression Analysis (Time Series)	trends or seasonality	short to medium	medium
Simple Linear Regression Analysis (Casual Mode)	variable	short to medium	high
Holt-Winter method	both trend and seasonality	medium to long	medium

Comparing forecast accuracy.

Before comparing the forecasting models, each forecasting technique is used to obtain the best parameters using the past 24 weeks of sales data. This analysis of the most appropriate forecasting method compares the accuracy of each forecasting method with the least mistake by using the evaluation index such as MAPE. The Mean Absolute Percentage Error (MAPE) is one of the most commonly used KPIs to measure forecast accuracy.

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4. Results and Discussion

The result of data collection and sales analysis

The data is collected from the sales of the three types of products which are almond milk, herbal drink, and baked pumpkin chips. The sale revenue (baht) between August, 2022 to January, 2023 in total 24 periods of time (weeks) are shown in Table 2. Results shown in Table 3 revealed that the average sale revenue per week of three products.

Table 2 Sale revenue per week (baht)

Period	Almond milk	Herbal juice	Pumpkin chips	Period	Almond milk	Herbal juice	Pumpkin chips
1	14,200	23,350	4,850	13	37,500	25,975	8,950
2	20,400	25,550	3,600	14	33,150	30,800	6,250
3	20,500	23,625	9,750	15	27,700	29,400	8,090
4	28,000	26,875	5,000	16	24,650	31,800	6,770
5	26,200	26,250	11,750	17	33,500	26,450	5,750
6	36,500	21,200	6,750	18	36,000	27,950	7,030
7	42,200	28,325	7,400	19	34,750	23,275	6,620
8	26,100	30,925	7,850	20	22,250	32,200	9,750
9	37,500	24,000	5,480	21	27,750	30,975	8,650
10	19,100	26,550	3,650	22	25,500	29,750	10,050
11	32,700	24,900	4,700	23	14,500	26,775	8,000
12	25,500	25,900	11,750	24	17,800	30,900	7,630

Table 3 Average sale revenue per week (baht)

Products	Almond milk	Herbal juice	Baked Pumpkin chips
Average sale revenue (baht)	27,665	27,238	7,336

The result of Time Series Plot creating by collecting sales of the three products in 24 periods of time into graphic plotting between periods and sales for preliminary analysis of the data distribution characteristics as shown in Figure1. According to the graph, the data has no trend and no seasonal pattern. Thus, Time Series Plot can be used along with Moving average, Exponential smoothing and Linear trend line methods.
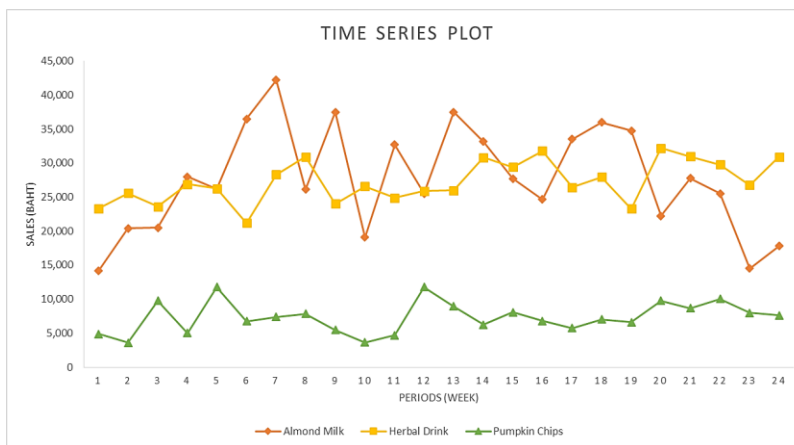

Figure.1 Time Series Plot

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The result of the data forecasting

According to the study, the data of this study is the time series data by using Moving average, Exponential smoothing and Linear trend line methods. The results of these 3 types of products which are almond milk, herbal drink, and baked pumpkin chips are shown in Figure.2-4.
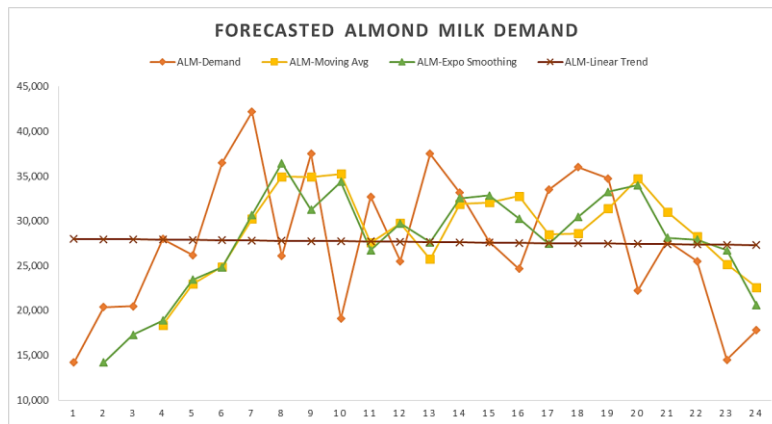

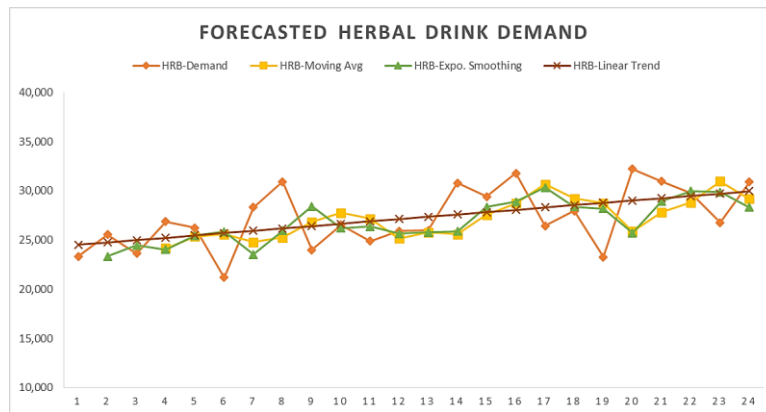
Figure.2 Forecasted almond milk demand
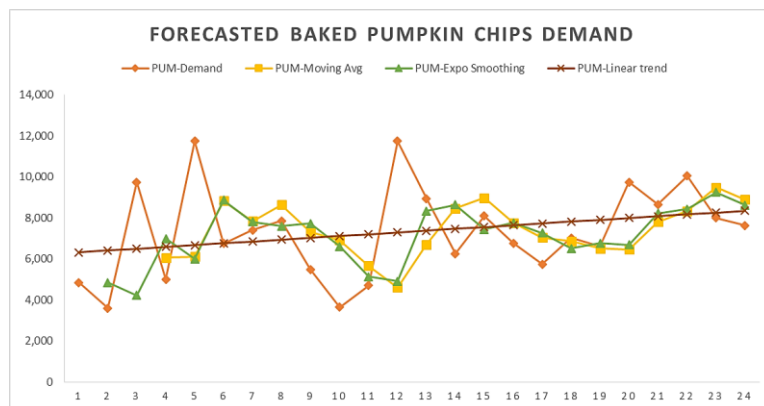

Figure.3 Forecasted herbal drink demand

Figure.4 Forecasted baked pumpkin chips demand

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Results shown in Table 4 revealed that this analysis of the most appropriate forecasting method compares the accuracy of each forecasting method with the least mistake by using MAPE index. The table of the Mean Absolute Percentage Error (MAPE) in forecast shows, that using sales data in forecasting method by adopting Moving Average, Exponential Smoothing and Linear Trend Line methods in these 3 products including almond milk, herbal drink, and baked pumpkin chips has given the different results. Firstly, Exponential Smoothing is appropriate to forecast for almond milk with MAPE at 25.667%. Secondly, Linear Trend Line is appropriate to forecast for herbal drink with MAPE at 7.796%. Finally, Moving Average is appropriate to forecast for baked pumpkin chips with MAPE at 25.169%, respectively.

Table 4 The most appropriate forecasting method compares the accuracy by using MAPE index

MAPE	Moving average	Exponential smoothing	Linear trend line
Almond milk	27.275%	25.667%	26.177%
Herbal juice	10.714%	9.633%	7.796%
Baked Pumpkin chips	25.169%	25.837%	26.167%

The result of using by many forecasting techniques which must be suitable for historical data and select the prediction technique with the smallest error value. Nevertheless, selecting an effective forecasting method needs to make statistic hypothesis testing whether it is efficient or not. The static error in the train set is analyzed if it is statistically acceptable. In case it is acceptable, the method is ready to be adopted in monthly, quarterly or yearly forecasting afterwards

The result of data evaluation regarding adopting such information in decision
According to the analysis of the static error in forecasting method as mentioned above, it is decided to use such a method as sale forecast for 8 weeks ahead in 3 products. The result shows that the sales of almond milk after forecasting are between 20,565 baht to 38,433 baht or 27,268 baht on the average. In addition, the sales of herbal drink are between 23,802 baht to 32,642 baht or 28,553 baht on the average. Moreover, the sales of baked pumpkin chips are between 4,950 baht to 7,866 baht or 6,963 baht on the average
As shown in the Table 5, the result of data evaluation regarding adopting such information in decision making by manager and five chiefs presents that the level of the total evaluation has 4.20 score (satisfied). The most rated unit is sales planning strategy followed by adequate information, the purchase management of raw material, accuracy of the result, workforce planning, as well as the ease of understanding the forecast, respectively.

Table 5 The result of data evaluation regarding adopting such information in decision

Index	Average	S.D.	Level
Sales planning strategy	4.80	0.45	Very satisfied
Adequate information	4.40	0.71	Very satisfied
The purchase management of raw material	4.20	0.45	Satisfied
Accuracy of the result	4.00	0.55	Satisfied
Workforce planning	4.00	0.71	Satisfied
The ease of understanding the forecast	3.80	0.45	Satisfied
Overall	4.20	0.55	Satisfied

5. Conclusions

This research examined the examine the appropriate forecasting model which forecasts the demand for 3 types of healthy food products including almond milk, herbal juice, and baked pumpkin chips. The study of the appropriate forecasting model has been brought about by using time series forecasting and accuracy analysis.
The study found that using sales data in forecasting method by adopting Moving Average, Exponential Smoothing and Linear Trend Line methods in these 3 products including almond milk, herbal drink, and baked pumpkin chips has given the different results. Firstly, Exponential Smoothing is appropriate to forecast for almond milk with MAPE

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at 25.667%. Secondly, Linear Trend Line is appropriate to forecast for herbal drink with MAPE at 7.796%. Finally, Moving Average is appropriate to forecast for baked pumpkin chips with MAPE at 25.169%, respectively.

6. Recommendations

The study of the most appropriate method for sale forecasting in businesses shows that there are many techniques widely adopted by organizations. The given method in the study can be used in the analyzation and adapted in other time series that have similar movements. It can also be useful for time saving in the forecasting process as well as reducing mistakes in the forecast of new data.

However, there might be other factors to consider in real situation, Qualitative Forecasting Method such as bringing up the past experience of the CEO or the employees in consideration can help them in terms of production plan more effectively. This allows micro business owners to build up their businesses into medium and large businesses afterwards. Any countries with healthy medium and small businesses will lead to stable and strong economy system such countries

7. Acknowledgement

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