Customer Demand Forecasting to Reduce the Raw Material Shortage and Opportunity Cost

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Abstract

The electronic factories have problems from the inefficiency of producing and delivering products as PER customer's order. This is because customer orders ended up being more than forecast in some periods and the factory did not have enough raw materials to produce customer demands. In duration of time, Customers have suddenly increased the volume of products. If the factory does not have enough materials and additional raw materials, orders will have a lead time of more than the date specified by the customer to deliver the product. If the manufacturer is unable to produce the product according to the Lead Time and Cost agreement with the customer, this will then affect customer confidence and satisfaction. This would cause customers to move their demand to another manufacturer then affect the opportunity cost. From the past about two years of data (2021-2023), It found that orders ended up being more than customer demands by about 51%. This study aims to reduce the problem of material shortage and opportunity cost by selecting the most impact model and doing regression by the Minitab program. The curve fitting regression was used to forecast the demand that was close to the linear line of difference customer orders. The accuracy of the forecast can be decreased to 31% It will use the curve fitting regression for forecast and prepare the material in the future and to avoid opportunity cost.

Keywords
Forecast, Shortage materials, Curve fitting regression, Minitab program, and opportunity cost

1. Introduction
Currently, the electronic assembly manufacturing industry is crucial to Thailand's economy, and equally important as other industries and businesses. Currently, the electronic manufacturing industry has experienced growth in both domestic and international. Therefore, causing very high competition in the economy. Especially the electronic parts assembly business for export. It has very high fluctuations in product demand. Therefore, there is a problem of shortage of raw materials in the production of products. The behavior of customer orders is uncertain. In case the customer orders products less than demanded. The manufacturer can keep the components or use them in other products and keep the inventory in customer consignment stock to produce products in the future. But if the customer orders more products than the forecast demanded. It will have problems with the manufacturer. For example, it affects to shortage of raw materials that will be used to produce products. As a result, the company has to purchase raw materials at a price that is higher than what was agreed upon with the customer to reduce the lead time for raw materials, Losing the opportunity to produce products. Customers may move orders to competitors instead, including future orders. Ultimately, it affects the delayed delivery of products that do not meet customer expectations, causing customers no confidence in the company.

Therefore, the forecast must be made to be as appropriate and accurate as possible. The research aims to study customer forecast and demand from January 2021 to 2023 and focus on ordering more than the forecast demand by selecting the products with affect the most. For analysis of the volume of forecast demand to be as close and appropriate as possible. As well as planning the storage of raw materials that will be used to produce products. These forecasts must be accurate in both the short and long term. Forecasting demand and planning the storage of raw materials are the measures and focus on not losing the opportunity to produce products. Thus, the company to see customer demand expectations in response to increasing volumes. To satisfy the most demanding customers as the

majority and avoid opportunities costs will be moved to competitors. To improve our production and meet shipment per customer requirements, we analyze our actual shipment and demand correction. This will help us ensure that we can deliver products to customers on time without any issues such as over-ordering. Otherwise, we risk losing customer confidence and opportunity costs.

1.1 Objectives

1.1.1To accurately forecast demand customers and reduce opportunity costs from customer purchasing orders.
1.1.2 To increase production efficiency and deliver products on time.
1.1.3 To reduce the problem of shortage of raw materials in the production of products.

2. Methodology

Klaus Altendorfer, Thomas Felberbauer(2023) The research aims to focus on customer behavior problems by forecasting demands and current situations to improve forecast accuracy, using the Discrete Event Simulation (DES) software tool Anylogic. numerical results indicate a 25% improvement in RMSE* and a 38% improvement in PRMSE*.The remediation model is applied to the entire product, reducing uncertainty in forecasting and improving production order accuracy.

Eric Ofori-Ntow Jnr , Yao Yevenyo Ziggah (2023) Due to the increase in population, the electricity demand is rapidly increasing, causing fluctuations in usage. Therefore, a study was conducted to plan for future demand. A new forecasting method has been introduced which is known as Future Extraction (FE). FE is chosen as the input variable. After conducting the evaluation, it was determined that the BPNN electricity reservation method was the most suitable one, utilizing particle swarm optimization (PSO).

Oleksandr Melnychuka , Jonas Rachnerb, Lea Kavenb , Amon Göppertb , Robert H. Schmittb, Tullio Tolioa (2022) The research conducted by global companies has revealed that a shortage of raw materials is causing delays and impacting various levels. By setting up an algorithm for online control and determining appropriate production under uncertainty of raw material shortages. Upon analyzing the data, it was concluded that the assembly process needs to be designed with production flexibility to enhance the response rate for supply chain issues.

Nipon Toin (2013) Demand forecasting and inventory planning for beverage products: A case study of the beverage control department in a hotel. The objective is inventory planning and control, and the study began with analysis and planning. Perform a demand forecasting experiment using Minitab 14 to determine appropriate forecasting methods. The researcher opted for exponential smoothing to forecast product demand. It was discovered that the annual inventory turnover rate had the potential to increase by 51.73 percent on average.

Thunyathorn Ounme (2017) The research was conducted to reduce delayed product delivery in eyeglass lens factories caused by fluctuations in product demand, specifically through forecasting and stock planning. To plan production capacity and ensure timely delivery, use ABC Classification to prioritize demand and forecast using the exponential smoothing method. The error values were 14.22 and 13.89 after testing and improving according to the aforementioned guidelines. This resulted in reducing the fine for late delivery to 0.05 percent per year.

Yasin Tadayonrad , Alassane Balle Ndiaye (2023) To research various models of performance indicators to forecast demand for inventory management. By forecasting and determining safety stock, I plan demand forecasts using historical data and other internal and external data. This analysis helps me propose new guidelines for determining suitable safety stocks. The demand forecasts result in more efficient inventory costs and reduce the risk of excess products.

Fitting Curves with Polynomial Terms in Linear Regression
The most common way to fit curves to the data using linear regression is to include polynomial terms, such as squared or cubed predictors.
Typically, you choose the model order by the number of bends you need in your line. Each increase in the exponent produces one more bend in the curved fitted line. It’s very rare to use more than a cubic term

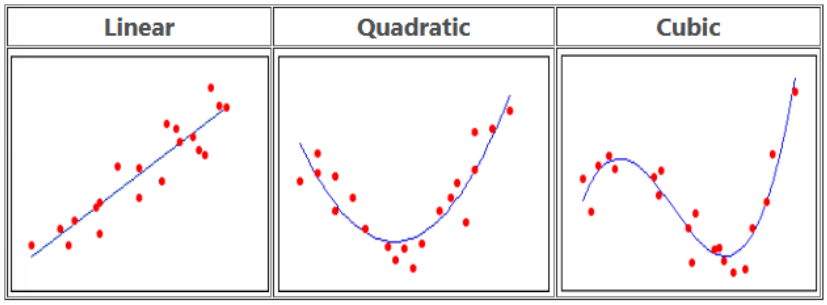

Figure 1 . Example Model Order

While the R-squared is high, the fitted line plot shows that the regression line systematically over- and under-predicts the data at different points in the curve. This shows that you can't always trust a high R-squared.

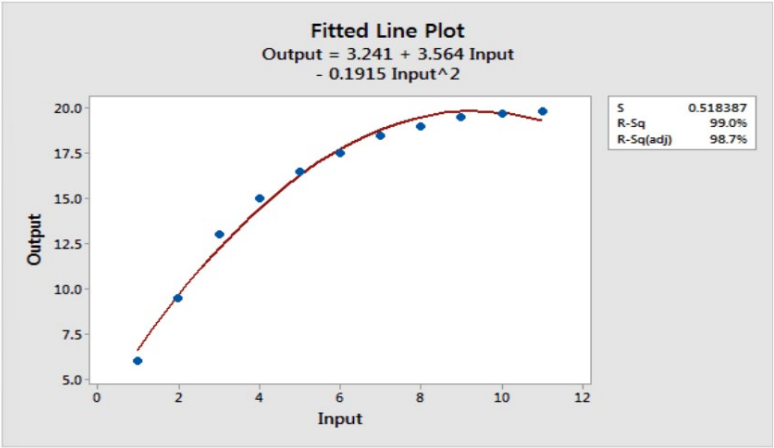

Figure 2 . Example Fitting Line Plot

3. Methods

The purpose of this research is to determine the most effective method for forecasting customer demand, by analyzing the volume of orders placed by customers and preparing the necessary raw materials accordingly. A case study company will follow the following research steps:

1. Develop a conceptual framework for the research project
2. Collect data
3. Select a representative sample
4. Take necessary actions
5. Develop a research project support system
6. Implement a research tracking system.

3.1. Conceptual framework of the research

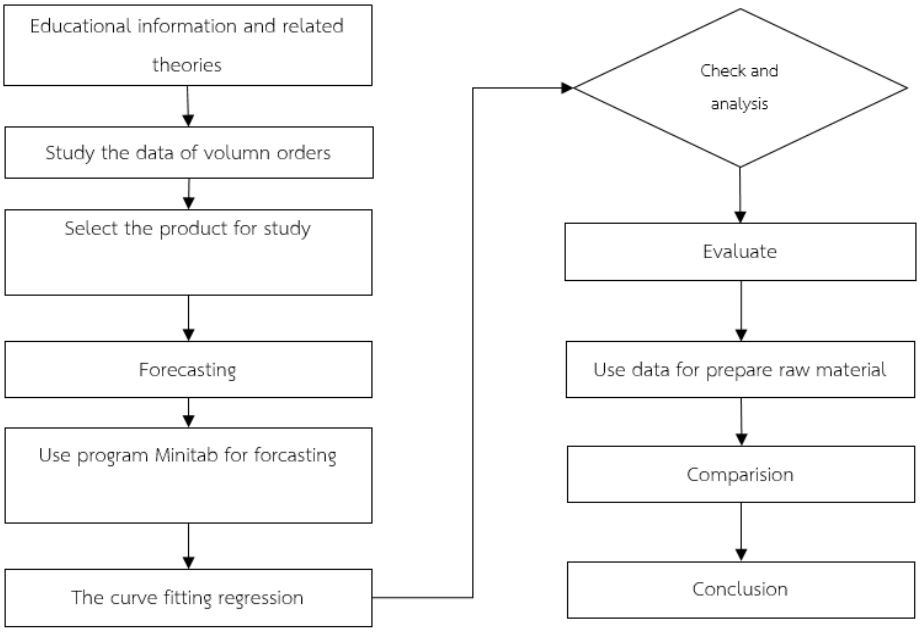

Figure 3. This is the conceptual framework that has been used for the research.

4. Data Collection

The researcher analyzed the data of the case study company, which included order forecasts about order quantities. The number of shipped products will be based on the number of product orders received each month between January 2021 and September 2023.

4.1. Sample data

To collect data on the volume of customer orders and their past deliveries. To group orders based on actual purchase quantities, Customer demand is used instead of the predicted forecast as follows.

Forecast/Model87-0007			
Jan-21	1147	Jun-22	2810
Feb-21	1632	Jul-22	2611
Mar-21	1896	Aug-22	4134
Apr-21	1656	Sep-22	4130
May-21	1632	Oct-22	3356
Jun-21	1224	Nov-22	408
Jul-21	2256	Dec-22	2010
Aug-21	1608	Jan-23	2615
Sep-21	1752	Feb-23	437
Oct-21	2040	Mar-23	1104
Nov-21	792	Apr-23	0
Dec-21	1920	May-23	1656
Jan-22	3002	Jun-23	1248
Feb-22	1420	Jul-23	2160
Mar-22	2314	Aug-23	1128
Apr-22	1584	Sep-23	1944
May-22	2588		

Figure 4. Data on the volume of customer demand.

Actual ship-Forecast 87-0007			
Jan-21	-595	Jun-22	746
Feb-21	456	Jul-22	1285
Mar-21	128	Aug-22	1527
Apr-21	-264	Sep-22	1994
May-21	-344	Oct-22	740
Jun-21	86	Nov-22	0
Jul-21	1656	Dec-22	114
Aug-21	470	Jan-23	2531
Sep-21	-2149	Feb-23	-19
Oct-21	-372	Mar-23	24
Nov-21	-836	Apr-23	-1296
Dec-21	-1392	May-23	547
Jan-22	604	Jun-23	-1104
Feb-22	-210	Jul-23	96
Mar-22	562	Aug-23	-624
Apr-22	-756	Sep-23	-95
May-22	248		

Figure 5. Data of actual shipment-Forecast.

x	Over forecast	x	Over forecast
1	24	10	562
2	86	11	604
3	96	12	740
4	114	13	746
5	128	14	1285
6	248	15	1527
7	456	16	1656
8	470	17	1994
9	547	18	2531

Figure 6 . Collect data over the forecast!

Based on Figures 4, 5, and 6, the researcher analyzed only Figure 6 over-demand and predicted data for analysis. To focus on the past 18 months as over customer forecast demand, we can find the value that is closest to the customer orders.

5. Results and Discussion

To reduce the problem of material shortage and opportunity cost by selecting the most impact model and doing regression by Minitab program and predicting the data over demand only. The curve-fitting regression was used to forecast the demand that was close to the linear line of a difference in customer orders as Figure 7. The researcher to aims forecast demand each month in the equation curve fitting regression as Figure 8.

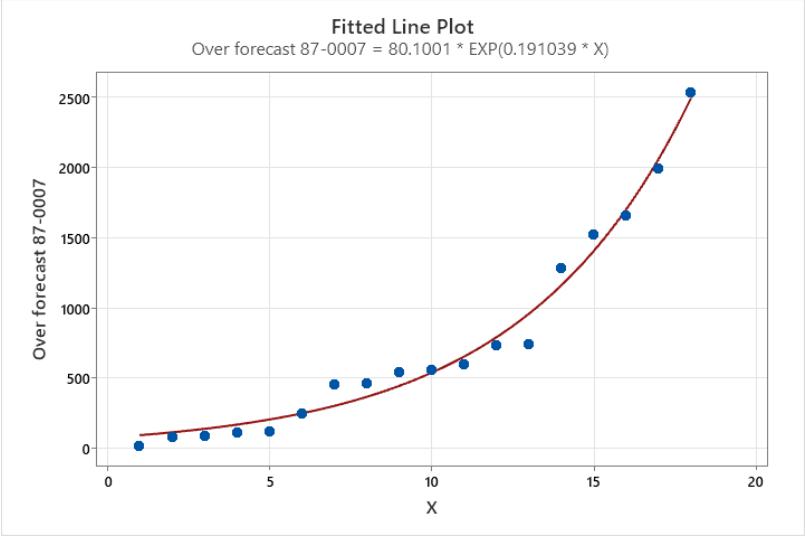

Figure 7. Use Minitab by curve fitting regression

Over forecast 87-0007 = 80.1001 * EXP(0.191039 * X)

Figure 8 . Equation of curve fitting regression

6. Conclusion

Based on the results of an experiment that compared actual order data with the original forecast, it was found that customers over-ordered 51% of the demand or loss amounting to about 270000-780000 USD per year. The model can reduce to 31% of customer forecasting demand or a total amount of 100000-170000 USD per year. Curve regression will be used to predict and prepare for future materials, which will help avoid opportunity costs.

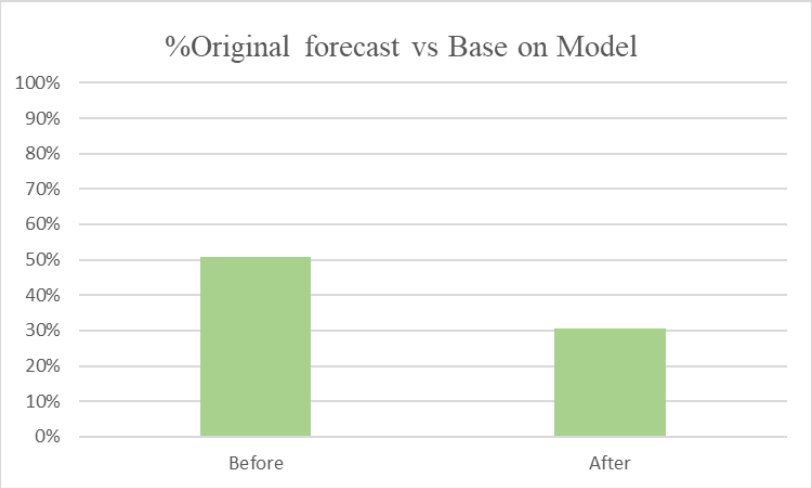

Figure 9 . Original forecast vs Base on model

References

Evaluation of Material Shortage Effect on Assembly Systems Considering Flexibility Levels Oleksandr Elnychuka, Jonas Rachnerb , Lea Kavenb , Amon Göppertb , Robert H. Schmittb , Tullio Tolioa.2023

Forecast and production order accuracy for stochastic forecast updates with demand shifting and forecast bias correction.

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Evaluation of Material Shortage Effect on Assembly Systems Considering Flexibility Levels

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Demand forecasting and inventory planning for beverage products.

Nipon Toin (2013) Business Administration Program in Logistics and Supply Chain Management, Dhuraij Pundit University

Forecasting and inventory planning to reduce the problem of delayed shipment:

Thunyathorn Ounme Master of Engineering, Industrial Development Faculty of Engineering Thammasat University (2017).

A new key performance indicator model for demand forecasting in inventory management considering supply chain reliability and seasonality.

Yasin Tadayonrad, Alassane Balle Ndiaye, Qalinca-Labs, Ecole Polytechnique, Université Libre de Bruxelles, 1050 Brussels, Belgium

Revisiting Human Behaviour Through Demand Analysis : Why an emand curve may not be downward sloping? Mohanty, Siba Sankar Doon University, Dehradun, India

Curve Fitting with Linear and Nonlinear Regression
https://blog.minitab.com/en/adventures-in-statistics-2/curve-fitting-with-linear-and-nonlinear-regression

Biography

Narinthon Sathanasaowaphak received the B.E (2014) degrees in Metallurgical Engineering from the Suranaree University of Technology, Thailand. She is currently a Program manager with Benchmark Electronic Thailand Ltd., Nakhon Ratchasima, Thailand.

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