

Demand Forecasting for European Automotive Market

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Abstract: - Today's globally changed world, especially after Covid-19 Pandemic, supply chain systems gained even more importance than ever before. With the competitive market, customer demand needs to be immediately satisfied; "how" is irrelevant. Businesses must increase the efficiency of their supply chains now more than ever in order to preserve a competitive advantage. The lean manufacturing and just-in-time (JIT) inventory control concepts that propelled companies like Toyota, Dell, and Walmart to the top of their respective sectors are still valid. Moreover, leading businesses are using advanced analytics and new technologies to make their supply chains more responsive to client demand. Customers have become more demanding with growing preferences as a result of severe competition, fluctuating market demand, and expanding customer expectations. The aim of this study is to forecast demands in automotive sector to respond changing customer demands. In the study, Norway market is chosen to apply forecasting method.

Key-Words: - Automotive Market, Forecasting, Supply chain management

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1 Introduction

Customers have become more demanding with growing preferences as a result of severe competition, fluctuating market demand, and expanding customer expectations. This is due to market changes such as shorter product life cycles, more competitive product releases, and demand volatility, all of which make life-cycle demand more uncertain and difficult to forecast.

In order to improve customer satisfaction and supply chain efficiency, supply chain management (SCM) strategies began to shift toward to the first step of supply chain; which is demand planning. JIT, supplier base rationalization, virtual inventory, outsourcing, tailored and worldwide networks, material, capacity, and time buffer reduction, and a reduction in the number of distribution facilities have all improved supply chain performance, notably in terms of cost reduction. However, the demand planning gained more and more importance especially after the modern humanity experienced a pandemic.

The automotive industry in the twenty-first century has created significant opportunities while also placing pressure on manufacturers to improve quality, improve styling, increase organizational efficiencies, and include innovative features in their products in order to attract customers and expand into new markets, thanks in large part to globalization. Because of these obstacles, car

manufacturers must be adaptable and sensitive to client needs if they are to prosper. Therefore, this study focuses on supply chain management, especially demand forecasting. Demands in automotive sector in Norway Market is forecasted employing Holt-Winters method.

2 Supply Chain

Supply Chain term refers to all the direct and indirect processes needed to respond to a customer request. It includes manufacturer, supplier, transporter, warehouses, retailers and even customers. New product development, marketing, distribution, operations, finance, customer service and waste management are the functions that are involved in supply chain. This dynamic function requires constant information flow for all stages of the product. For example, when a customer goes to a big retail store to buy some detergent, that supply chain starts with that customer, continues with retail store, store's inventory, distributor which brought that detergent to the store, distributor's third-party logistics firm, manufacturer of the detergent, manufacturing plant's raw material suppliers, the packaging firm for the detergent. All of these functions serve the purpose of satisfying the customer needs while gaining some profit; therefore, customer is the essential part of the supply chain. In this network, there can be many stages and many parties involved such as:

customers, retailers, wholesalers/distributors, manufacturers, component/raw material suppliers.

Purpose of every supply chain is to generate maximum value, respond the customer needs and generate profit. Supply chain consists of a company, suppliers and customers as a very basic form. In the broad form, there are supplier's supplier, ultimate supplier and service providers.

Producers

This function is the organization that creates the product. Raw material producers and the end product producers fall into this category. Sometimes, these producers make intangible products such as software or designs.

Distributors

This function is the companies which take the material from producer's inventory and deliver to the customers. They are also called wholesalers since they sell to other companies and they are inclined to sell products in large quantities. They may buffer the fluctuations of the product demand due to the fact that they stock inventory. They work as the "Time and Place" function, that is; they provide the product to the customer when and where the customer wants. Distributors may also own inventories of the products or they may act as the brokers between the producer and the customer. They may also realize the inventory management, warehouse operations and product transportations.

Service Providers

Service providers are the organizations that give service to manufacturers (producers), retailers, distributors and customers. Transportation and warehousing services can be listed as the most common service providers. Logistics companies are the good examples of this category.

These organizations have special expertise and skillset so that they can provide their services effectively and efficiently, [1].

3 Supply Chain Management

While the global economy starts networking and inter-networking, companies that are linked in regards of business form up electronically in order to keep up with the customer needs in the fast-paced changing world. Their main purpose of doing so is to coordinate the actions better and minimize the costs out of their operations. Now, the business itself is as important as the end product, mainly due to the fact that product life cycles are getting shorter and shorter every single day. Customer needs and preferences change faster than ever, product inventories face the danger of being redundant and irrelevant. As the counterpart, businesses are trying their best to expand and improve their expertise and

efficiencies in building new products, delivery process and service. It is certainly clear that the companies which have higher skill levels in these areas can respond better to the change and benefit from developments in the markets. All the processes of a product, from the raw state until the end-product, containing the design, build up and delivery to the customers are called Supply Chain Management (SCM). Since companies cannot maintain high skill levels in every area of supply chain, they choose to focus on their core strengths. They decide on the expertise they want to excel in and partner up with others to have the full complementary skills. This dynamic forms the structure of modern supply chains.

Supply chain management term created first in the late 1980s but used in widespread manner particularly in 1990s. Before then, these activities were usually referred as usually logistics or operations management. However, SCM and the traditional logistics concept differs in many ways. Logistics is used for the activities of a single company while supply chain calls for the cooperation of multiple companies working together and their coordination to deliver a product, [1]. Activities and firms in a supply chain is illustrated in Figure 1, [2].

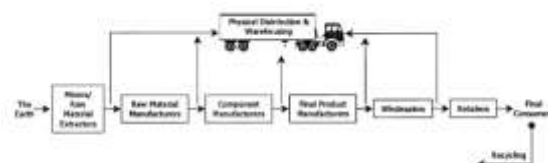


Figure 1. Activities and firms in a supply chain [2]

4 Supply Chain Management Elements

Planning

Planning forms core of the supply chain. It refers to all operations needed to develop operations of other categories. Demand planning, product pricing and inventory management fall into this category, [1]. In the fast-paced business environment, supply chain planning systems should be able to overcome any obstacle. Also, with new technologies, planning becomes somehow easier, although many businesses still depend on manual systems, [3]

Source (Procurement)

In this category, source refers to the activities necessary to gather the source in order to form products or services. Procurement, which is the purchase of the required materials and services, is

realized. This is an important process, purpose of which is to alter the means of material sources, develop cooperation with suppliers, manage supplier risk management and ameliorate the planning process. Procurement is formed by the strategic decisions with the purpose of improving supply chain efficiency and effectiveness, [1]. Usually the cost of the material is considered as the largest cost component, that is; where the money lays. This also brings attention to the importance of the supplier and procurement.

Make

This category refers to the operations to make products and services. Product design, production management and facility management are included in this process, [1].

Deliver

This category refers to the activities of receiving customer orders and delivering the orders to them. Order input and product delivery compose main elements.

These elements are illustrated in Figure 2.

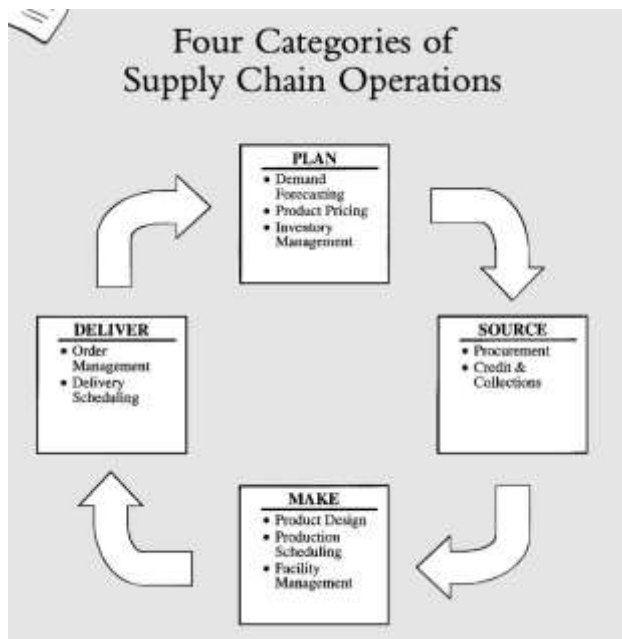


Figure 2. Four categories of supply chain operations [1].

5 Supply Chain Strategies

For the sustainability of the supply chain systems, supply chain strategies must be created. Businesses consider the strategies big part of their decision making and these strategies must be designed thoroughly since the results of these directly affect operations, success and efficiency. There are variety of classification approaches such as lean and agile, efficient and responsive, pull and push. Lean

strategy focus on value-oriented activities and rule out all the waste in operations of supply chain whereas agile strategy values flexibility. Agility is especially important in competitive markets as it reacts better to demand fluctuations, [4].

Pull-push strategy is also important, especially in automotive sector. Push and pull systems have been the foundation of modern production since years. There are miscellaneous definitions and way of using this strategy. Push system corresponds to satisfying demand from inventory. This system is capable of achieving high-capacity utilization, yet there is always the risk of excess stock. Pull system corresponds to satisfying demand by producing in accordance with order, that's why it can be flexible when it comes to handling fluctuations of demand, however has a tendency of long delivery terms. In order to have a balance between inventory and lead-times, pull-push systems can be implemented as hybrid systems. In these systems, usually the production is categorized into two phases. In the first phase, semi-finished product is manufactured whereas in the latter phase semi-finished product is customized with order-specific features and components, as to become the end product that customer ordered in the first place. First phase is the push system whereas the second one is pull. In order to illustrate this system, Phillips computed tomography (CT) is a good example. The company produces a basic CT model and keeps it in their stock. After receiving and order, this basic model is customized and assembled with order-specific components per customer request, which becomes an end product and delivered to the customer. Since the basic model composes 70% of the total cost of the end product, the company focuses on keeping the stock of basic model. By keeping the basic model steady, company reduces the delivery lead time of the product. This is a perfect example pull and push systems, since the basic model is the semi-finished good and customized upon customer order. Apart from the healthcare industry, assemble to order systems can be used in different sectors, especially automotive [5].

5 Demand Planning

Supply chain management is founded with some predictions over which products will be required in what amount and exactly when. This process is called demand planning whereas the prediction of the demand refers to demand forecasts. It is related to all arrangements including forecasting. The

ultimate aim is to enable company to provide customer orders when the customers ask for it. Therefore, demand planning starts with the trigger of forecasting and brings a series of other actions. Many companies rely on mainly demand planning for their internal operations and satisfy the customer demand. Flexibility and adaptability are very important in supply chain systems and with efficient and accurate demand planning, companies can cope with the ambiguousness in demands and respond well to the fluctuations in demand [1].

When the companies can reduce their inventories, large benefits can be realized in SCM, which can be achieved by decreasing the safety stocks. Since these safety stocks are the byproduct of the uncertainty, main goal in many supply chain systems is to reduce this uncertainty. There are mainly two sources of uncertainty; process uncertainty which includes fluctuation in lead-times, untrustworthy production processes and demand uncertainty which means the discrepancy between the estimated demand and the actual orders. Therefore, goal of demand planning is to develop decisions to increase demand accuracy and accurate safety stocks. Customer demand determines all the process decisions in supply chain, which means the more accurate the demand planning is, the more efficient the whole supply chain is. Accurate supply chain leads to smooth operations in the later processes, all processes rely on the its accuracy and quality [6].

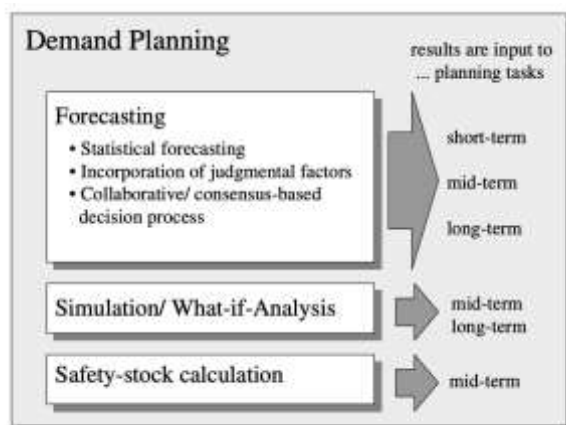


Figure 3. Demand planning tasks [6]

Demand planning has 4 major variables to comprehend market conditions; these are demand, supply, product characteristics, competitive environment. Demand is considered as the overall demand of market for a product or service. If the market is inclined to grow or decline, rate of

growth/decline should be determined for a specific period of time; such as yearly, quarterly or monthly. In other cases where the market is mature, prediction of demand could be relatively easier since the demand is stable at a level. In addition, variety of products have a seasonal trend. For example, swimsuits are in demand in summer while snow jackets are in demand in winter. Moreover, there are some products which are fairly new to the market without any prior sales data, which makes it difficult to do demand forecasting.

Supply is affected by the number of producers since lead times depend on the producers. Lead times are in inversely proportional to the number of producers, that is; the more the producers there is, the shorter the lead times are, as the variables are more predictable. If the product is manufactured by a certain number of producers or when number of suppliers is few, lead times are usually long, which causes an uncertainty in the market. Demand fluctuations and uncertainty in the market make forecast relatively harder. Moreover, long lead times mean that forecasts must cover a long period of time; which results in difficult forecasting.

Product characteristics stand for the attributes of a product that will likely steer customer demand. It depends on if the product is fairly new or developing, or mature and has a slow change. For mature products, forecasts can be used for longer periods of time whereas for fairly new products, forecasts cover only a certain time of period. It is also significant to know if a new product will get some of the demand of another product. If it is a substitution product or a complementary one, the demand of each product can be affected by the other ones. Therefore, forecasts for the competing or complementing products should be done together.

Competitive environment stands for company actions and the competitor's reactions. It mainly depends on the market share of the company, and also whether the total size of the market is increasing or decreasing. Competitor's trend in market share also matters. Moreover, forecasts are influenced by product promotions, price changes and product launches. Forecasts should also consider the product promotions and price changes of the competitor products [1].

Demand planning is realized by forecasting. Forecasting is a technique which predicts the future trends based on historical data [1]. They are used for marketing, purchasing, manpower, financial planning, production. Long term strategic decisions

are influenced by forecasts. Companies use objective and subjective factors while forecasting, usually human insight/input is needed to take some action. Customer's past behavior can tell a lot for the firms and companies must have a balance with these historical data, factors that may affect the future trends and finalize their predictions as forecasts. Therefore, market knowledge is essential to forecasting. There are also other factors that may affect forecasting:

- Past demand
- Lead times
- Marketing promotions
- Planned advertises
- Price discounts
- Economic conditions in the country
- Competitors

6 Case Study

Automotive sector is famous for adopting mass production since the beginning of the sector's emerging. While Henry Ford benefited from economy of scale with use of mass production, the sector had come a long way and adopted mass customization method. In this method, usually the hybrid model of pull-push strategies are used for car production. With Toyota's groundbreaking supply chain strategies, many companies in this sector embraced their supply chain improving policies.

Based on the forecasts, material parts ordering is realized. Usually, the parts are country specific and cannot be substituted for one another, thus, material ordering is extremely significant as the production may not cover the demand unless the right amount of materials are supplied. On the other hand, factory does not prefer the cautious material stocking policy due to excess material risk. Supply chain strategies such as Just In Time, supplier park and so on are not available; which makes forecasts even more significant. Gross materials such as engine are usually imported and have relatively long lead times; around 50 days. There is no possibility of air freight for these gross materials, production of these cars would be postponed in any case of material constraint.

Forecasts are used for all European countries. There are distributors throughout Europe and they are expected to conduct their own forecast calculations. However, distributors depend on dealers and in some cases, they have no expertise in supply chain and demand planning. For these situations, the factory is responsible for forecasting.

In this study, two Norway Market is selected for forecasting practices. In order to do forecasting accurately, factors that affect forecasting are identified as

- Order history
- Sales
- Stock levels
- Market situation
- Competitors
- Promotions

Norway has a balanced order history. Their order quantity decreased in years as shown in Table 1.

When we review the order line chart given in Figure 4, we can see the seasonality, Norway has an order peak in summer months.

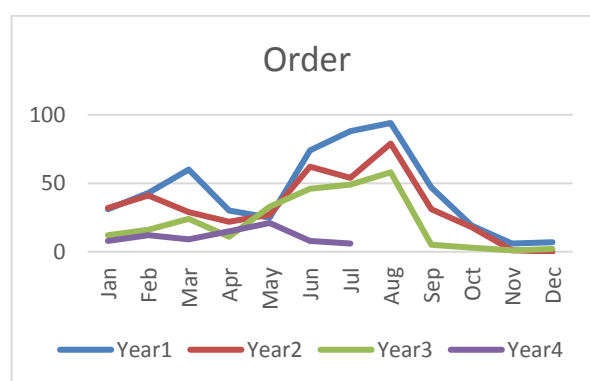


Figure 4. Order Chart of Norway Market

Sales performance of the distributor is very similar to order trend. They have a peak season in autumn, which explains the order peak in summer months. Retail sales are consistent in the other seasons, and especially in the last quarter, the sales decline visibly. Sales history of Norway market is given in Table 2 and Figure 5.

Table 1
 Order History of Norway Market

Order	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TTL	AVG
Year1	31	43	60	30	25	74	88	94	47	19	6	7	541	45.1
Year2	32	41	29	22	27	62	54	79	31	18	1	0	396	33.0
Year3	12	16	24	11	33	46	49	58	5	3	1	2	260	21.7
Year4	8	12	9	15	21	8	6						79	11.3

Table 2
 Sales history of Norway Market

Retail Sales	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TTL	AVG
Year1	17	13	23	30	9	22	36	66	98	52	26	10	402	33.5
Year2	14	19	29	33	18	16	30	45	70	22	11	6	313	26.1
Year3	7	10	17	11	10	15	21	28	30	23	14	4	190	15.8
Year4	5	9	14	10	8								46	3.8

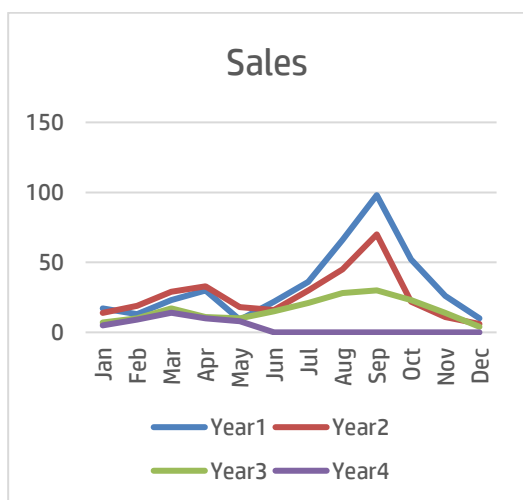


Figure 5. Sales chart of Norway Market

When we look at the comparison of the last 4 years illustrated in Figure 6, it is clear that the demand has declined linearly. Sales and order demand can be used with exponential smoothing model.

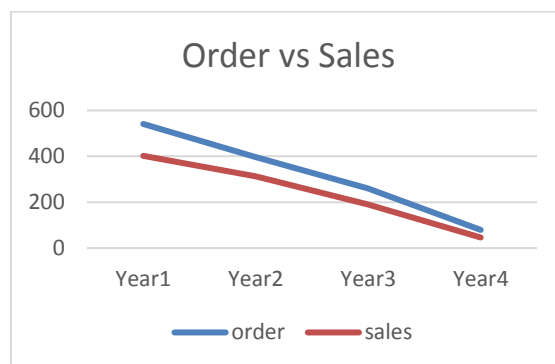


Figure 6. Order vs Sales chart of Norway Market

Stock level in the relevant year, shown in Table 3, is consistent with the order and sales outlook. Distributor has the needed stock level while preparing for the high sales season.

Table 3
 Stock level of Norway Market

Stock (MoS)	Jan	Feb	Mar	Apr	May
Year4	1.5	2	1.8	1.9	2.2

Based on the order and sales figures, it seems that the distributor has losing their market share, they are not succeeding. When we look at the actual situation, it is true, because the Norway automotive sector is proceeding to electrical cars. Market shrinks and the decline in sales trend is a reflection of that.

Exponential smoothing is suitable for this case, as the market shrinks and there is seasonality. When there is seasonality, Holt-Winters method can be applied [7].

$$\text{Seasonal factors } S_1 = \frac{Y_1}{\text{average}(Y_1, Y_2, Y_3, \dots, Y_{12})}, S_2 = \frac{Y_2}{\text{average}(Y_1, Y_2, Y_3, \dots, Y_{12})} \quad (1)$$

$$\text{Initial level at 1 year } L_{13} = \frac{Y_{13}}{S_1} \quad (2)$$

$$\text{1 time period } T_{13} = \frac{Y_{13}}{S_1} - \frac{Y_{12}}{S_{12}} \quad (3)$$

$$\text{Level update } L_t = \alpha \frac{Y_t}{S_{t-M}} + (1 - \alpha)(L_{t-1} + T_{t-1}) \quad (4)$$

$$\text{Trend } T_t = \beta(L_t - L_{t-1}) + (1 - \beta)T_{t-1} \quad (5)$$

$$\text{Seasonal factor } S_t = \gamma \frac{Y_t}{L_t} + (1 - \gamma)S_{t-M} \quad (6)$$

$$\text{Forecasts within data set } F_{t+1} = (L_t + T_t) S_{t-M+1} \quad (7)$$

$$\text{Forecasts } F_{t+k} = (L_t + k * T_t) S_{t-M+k} \quad (8)$$

k = number of forecasts into the future

α, β, γ = smoothing constants

When the method is applied, chart given in Figure 7 is calculated, where α, β, γ are calculated as below to minimize the forecast errors.

$$\alpha = 0,314$$

$$\beta = 0,121$$

$$\gamma = 0,559$$

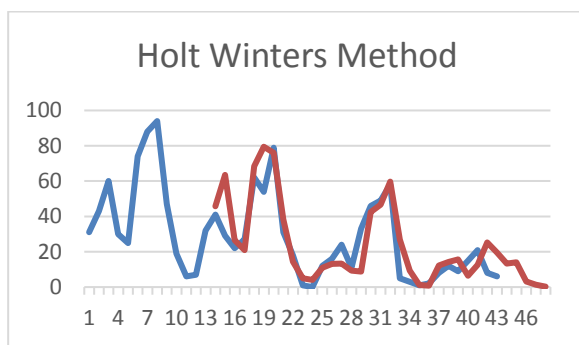


Figure 6. Holt Winter’s Method

According to this method, the trend will decline as expected.

7 Conclusion

To manage customer demand, appropriate demand planning is essential in efficient supply chain management systems. Statistical forecasting approaches are very effective, particularly when the historical data sets are available. This study aimed to forecast automotive demand for Norway Market. The exponential smoothing method, Holt Winter’s method, which is used for seasonal trends. This method is applied for the shrinking market, where the recent data carry the importance and the whole data set showed seasonal fluctuations. The technique used in the study is able to respond efficiently to the market needs in regards of forecast. In practice, this study may serve as a useful benchmark for decision makers while selecting a method for forecasting. Future researches will focus on applying different forecasting to different markets.

Acknowledgement

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