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# Predictive analytics to offer profitable anticipatory shipping for E-commerce Companies

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**Abstract**

Predictive Analytics due to its ability to forecast can be an industry disruptor to bring in an efficient change that optimizes the operations of E-Commerce companies. Anticipatory Shipping, by the name, suggests predicting demand even before the customers make up their mind to purchase. It can be turned into reality through the processing of massive amounts of transactional data, so as to level up to the delivery services of the brick and mortar stores. This paper deals with how can predictive analytics which when used for anticipatory shipping could turn out to be profitable. Here we have considered different factors which if monitored properly through the algorithms will ensure profits to the E-Commerce companies. This paper also deals with the threshold limits in the inventory management and the management of the perishable products which if not dealt with properly may result in losses while doing anticipatory shipping.

**Key words:** Analytics, Anticipatory, Breakeven point, Customer, E-Commerce, Predictive, Shipping, Threshold limit, Warehouse

## Introduction

Though the E-Commerce companies are efficient enough to ship the products in two days for their premium customers, they still are at a disadvantage when it comes to the brick and mortar retailers [1]. For high priority items especially, which are in daily use, the customers often prefer to buy from the retail stores if not purchased in advance. So, here comes the idea of anticipatory shipping wherein the E-Commerce company will predict the requirement of the product and will pre-ship it to your nearest geographical area at strategically placed warehouses without precisely providing the delivery address. Predicting customers' orders will help in augmenting sales and would decrease the supply chain costs involved in shipping and inventory management. Optimizing the supply chain is the biggest cost that E-Commerce companies can mitigate to improve their efficiency. So Anticipatory Shipping has helped companies like Amazon to make accurate supply and shipping decisions even before the customer makes their decisions and all this is possible because of the predictive analytics. Now, this allows companies to do standard shipping which is one-third of the cost occurred for the expedited shipping i.e. the ground shipping v/s the air freight shipping cost. And all of this is possible because of the predictive analysis [2]. Predictive analytics involves forecasting and decision making based on the company's transactional data which comprises prior customer activity, time spent on a particular page, duration of views, links clicked, hovering spaces, shopping cart activity, and saved items [3]. With the use of predictive analytics to do anticipatory shipping the E-Commerce companies will have its delivery system to transport orders within a 10km range effectively from the destination warehouses to the respective customers within minutes. The customers are here at the greatest advantage as they do not have to go through the mundane shopping and would not mind if some trustworthy companies like Amazon or Flipkart take care of this hassle [4]. This will allow the company to take care of their needs without letting them run away from the essential items. And if this implements properly and given the positive response the E-commerce giants will go further to start shipping them to your doorstep that they think you will buy [5]. So, if you want it you can keep it else you can return. Amazon and other retailers are investing heavily in machine learning to accurately pick customer demands and predict household price sensitivity and then to decide upon the deals and discounts depending upon certain geographies. All this has led to E-Commerce companies filing in for patents and Amazon has now its patent for "*Method and System for Anticipatory Shipping Package*"[6].

**Objectives**

This paper aims to make predictive analytics a method so that the E-Commerce companies are profitable while they do anticipatory shipping of the customer's orders. This leads to the establishment of the breakeven points and threshold limits and finding out strategies for the improvement of the shelf life of the products. All this in turn helps the E-Commerce companies to win the goodwill and the loyalty of the customers. This paper also focuses on increasing the product acceptability by the customers by providing them with options to choose from thereby making anticipatory shipping a win-win situation for both the customers and the companies.

**Literature Review**

In earlier days also predictive analytics was used very frequently but it was never based on the data related to the shopping patterns or the demands of the customers [7]. The Government used to deploy predictive analytics based on the meteorological department's data regarding a flood or a famine wherein they would stock necessary food items and groceries based on the population of a given area [8]. So, till now pre-positioning has been extensively studied in response to emergency and military operations but commercially this application of predictive analysis to ship orders has not been explored much [9]. During the evolution of anticipatory shipping, optimization of transportation was a necessity to locate the warehouses of the pre-shipped products in order to increase the probability so that the demand sites can now be approached from atleast one strategic warehouse located for one period [10]. Now as further studies were conducted, wherein a model was developed which used two-staged stochastic programming which not only took into account the number, demand and destination but also considered the warehouse capacity and cost required to store those demands [11]. With further evolution, it was found out, all these algorithms that were deployed did not do risk assessment, wherein they assumed that the anticipation of a demand by the customer was the preference case in that algorithm, so Noyan further incorporated the (CVaR) Conditional Value at Risk, and reformulated the model thereby redetermining the risk-based operation cost involved [12]. Furthermore, a model was developed wherein it had considered the occurrence of multi hazardous factors which was incorporated in the predictive model of multi-dimensional risks [13]. And now when analytics has made such a huge leap demand prediction is not only being done through the historical data of the customers, but also the real-time shopping patterns wherein each online movement of the customers are being tracked. Everything from the time duration spent on a product to the extent at what places the cursor hovered around, all that is been analysed to make the correct predictions.

Till now research has been done for the accurate prediction of the demand which has led to the optimization of the supply chain through different statistical and Machine Learning models [14] like Neural network [15], Support Vector Machines [16] and Time-series calculation [17]. But with the exponential increase in the data, complex computer calculations, advanced statistical modelling, it has helped the companies to make better decisions to stay ahead in the competition [18]. And on top of that Machine Learning and Big data are playing their part to help analysts juggle with the structured and unstructured data for making accurate predictions which as well go beyond Demand prediction which includes Inventory Management [19], Dynamic Pricing [20] and revenue management [21].

Amazon is the first company to go ahead and patent the concept of Anticipatory Shipping wherein it pre ships an order to the nearest warehouse and not the actual customer, and brought an improvement that if an order remains unordered then it is shifted to other destination warehouses during the next planning phase of Anticipatory Shipping. Anticipatory mechanism methods can be used for Agro-food supply chain wherein the majority of the products are perishable [22]. They therein have predicted for which product how much quantity should be considered in the algorithm of the Anticipatory Shipping. Macy, a company in 2019, implemented predictive analytics solutions from SAP to predict and act upon the customer's history of previous orders to customize email marketing campaigns by which the company can focus their spending efficiently. This initiative took them 3 months to implement by which they have now augmented their sales by 10% through segmented and targeted marketing [23]. Another retailer which is using Predictive analytics model is StitchFix which deploys a unique model encouraging their customers to fill a survey describing their preference for style of

clothes. It then uses predictive analytics to match the clothes with the survey they had filled in and then ships them. If the customer does not like the clothes, they can then return them for free [24].

This paper discusses how companies can leverage predictive analytics to do anticipatory shipping and be profitable. For this, we calculate the threshold limits for various factors so that the E-Commerce companies can imbibe those threshold points in their algorithm and find out alternatives to prevent losses. All the findings here are quantitatively stated in the form of equations that have been derived.

**Research Methodology And Findings**

Firstly, we understand the underlying concept of predictive analytics and how it helps to do anticipatory shipping. Having understood that, then we go on to identify various factors which hinder the companies from making profits. Further, we go on to quantify the threshold limits for each factor. Finally, we will conclude our research with the observations made for every factor and go on to describe any alternative strategy that can be implemented.

Now to bring this into implementation, the company very carefully must choose the geographic location as well as the product they are taking into consideration along with the breakeven point. Herein we got the motivation to do our research on breakeven point and threshold from an article on Medium [25].

Breakeven Point/Threshold Limit: The breakeven point is that level when for the company the cost of entity (which includes the production and shipping costs, or end to end cost of a product if bought) equals the revenue earned from selling that entity.

**Factors for effective Anticipatory Shipping:**

There are many possibilities of losses in anticipatory shipping using predictive analytics, which could be mitigated by proper analysis of situations that we can take control of and hence improve our algorithm to avoid any losses. The various factors that were considered for this paper are:

- Number of Orders returned
- Expiry date of the product
- Inventory costs at the cost of faster-moving items
- Extra variants for greater acceptability

**Number of Orders returned**

Herein we consider a scenario wherein, we find a breakeven point that out of a certain number of products that we deliver we need to minimize the number of returns in order to maximize the profits.

Let us consider,

- Amazon is the E-Commerce Company here.
- There is a product to be shipped to 1000 (n)customers.
- The cost of the item to be $25 (c)= S.P
- Amazon buys it at a cost of $5 (a)
- Shipping cost occurred to Amazon $7.5(s)
- Profit that occurs to amazon: $25-$5-$7.5= $12.5 (p)
- Loss that occurs to Amazon: twice the cost of shipping: 2*$7.5=$15(l)

If everyone accepts the order, the profit that occurs to Amazon =1000*$12.5 =$12500

If everyone rejects the order, the loss that occurs to Amazon= 1000*2*$7.5= (-) $15000

So, the breakeven point:

Let us assume, people who kept the order=y

12.5*y-(1000-y) *15> 0

y=546, which means that 546 customers out of 1000 customers, should keep the orders and not return them to Amazon to turn out profitable.

Now to generalize:

(Profit*people who kept the order) - (Loss *People who returned the order) >0

(p*y) – l* (n-y) > 0

yp+yl>nl

y(p+l) > nl

**y= nl/(p+l),**

where, y = number of people who kept the order, (a whole number)
n = total number of products,
p = profit = Selling Price of the product – Cost at which amazon buys – Delivery cost
l = loss = 2*Delivery cost

Findings: Now the E-Commerce companies can calculate the hit percentage by putting into the equation, number of customers, the profit and loss margins and the real costs so find their breakeven point accordingly.

Alternate Strategy: To increase the probability of accepting the order we can sell it during the first week of the month wherein everybody receives their salary, or during the time of the festival or maybe during certain seasons certain products can be sold.

**Expiry Date of the Product**

When we ship a perishable product to a warehouse, i.e. a food item etc then we need to sell it at a point that it not only reaches the customer before the expiry date, but also the customer has sufficient amount of time in hand to consume the product entirely before the expiry date.

Let us consider,

- Amazon is the E-Commerce Company here.
- There is a product to be shipped to 1000 (n)customers.
- The cost of the item to be $25 (c)
- Amazon buys it at a cost of $5 (a)
- Shipping cost occurred to Amazon $7.5(s)
- Profit that occurs to amazon: $25-$5-$7.5= $12.5 (p)
- Loss that occurs to Amazon: $7.5 = here (l/2) as there is no return, as it expired.

So, the breakeven point:

Let us assume, people to whom we can ship the order = y, and to the rest we cannot ship the order due the expiry date concern that they might not be able to use the product before the expiry date.

12.5*y-(1000-y) *7.5> 0

y=325, which means that 325 customers should be able to receive the product before it runs out of the expiry date, for Amazon to turn out profitable.

Now to generalize:

(Profit*people to whom we can ship the order) - (Loss*Orders that cannot be shipped) >0

$(p*y) – l/2*(n-y) > 0$

$yp+yl/2>nl/2$

$y(p+l/2) > nl/2$

**$y= nl/(2p+l)$,**

where, y = number of people to whom we can ship the order,
n = total number of products,
p = profit = Selling Price of the product – Cost at which amazon buys – Delivery cost
l = loss = Delivery cost for 1 time

Findings: This means that the product should be sold within the expiry date well in advance for the customers to effectively use it in time.

Sometimes the calculation is different as it gets easier, for eg milk tetra packets as it need to be consumed within 2 days after opening it. All these variable factors need to be considered before fitting it in the algorithm,

Alternate Strategy: We can start giving discounts and improve our pricing strategy to improve the average shelf life of the products.

**Inventory costs at the cost of faster-moving items**

Suppose there are two items $x_1$ and $x_2$. 1000 units of both the products $x_1$ and $x_2$ are stored in the inventory which are stored in the AC and Non-AC services respectively.

Assumption: The prices of the item $x_1$ and $x_2$ are comparable, or same, or with very little difference.

Considerations for the AC inventory:

Items($x_1$) = 1000 units($n_1$)
Average shelf life of $x_1$ = 20 days($s_1$)
Cost of keeping $x_1$ for 1 day = \$2($k_1$)
Total inventory cost = \$2 * 20 * 1000 = \$40000

Considerations for the Non-AC inventory:

Items($x_2$) = 1000 units($n_2$)
Average shelf life of $x_2$ = 10 days($s_2$)
Cost of keeping $x_2$ for 1 day = \$1($k_2$)
Total Cost of inventory = \$1 * 10 * 1000= \$10000

For the proper inventory management, we can replace some items of $x_1$ with $x_2$, which would yield us more profits, so a threshold limit must be set of how many items of $x_1$ and $x_2$ should be present:

$n=n_1+n_2$

(Item with lesser inventory cost * average shelf life * cost of keeping for 1 day) – (Item with greater inventory cost * average shelf life * cost of keeping for 1 day) > 0

$n_2*s_2*k_2 – (n-n_2) *s_1*k_1 > 0$

$n_2$*10*1 – (2000-$n_2$) *20*2 >0

$n_2$ = 1600

**$n_2 = (n\ *s_1\ *k_1)/\ ((s_1 * k_1) + (s_2 * k_2))$,**

Where, $n_1$= Number of items having greater inventory cost
$n_2$= Number of items Item having lesser inventory cost
n= Total number of items($n_1$+$n_2$)
$s_1$= Average shelf life of $x_1$
$s_2$= Average shelf life of $x_2$
$k_1$= Cost of keeping $x_1$ for 1 day
$k_2$= Cost of keeping $x_2$ for 1 day

Findings: We have found out that if we want to increase our profits, we need to stock more items with lower shelf lives as compared to the items with the same selling price but higher shelf life.

Alternate Strategy: In order to improve the shelf life without giving away discounts (as the assumption is both the products have same the Selling Price), we can do targeted and customized advertising in order to sell improve the shelf life of the slower moving product.

**Extra Variants for greater acceptability**

Here we are going to ship not only the product the customer is using but also along with it if any variant, such as with pears body wash along with the glycerine variant we also send in the cool menthol, ice fresh, coconut variant and a nearby competitor of the same price. Each of them costs equal to, less than and greater than the cost of the glycerine variant respectively. So,

**The threshold limit** here would be how many items can we send together so that it increases acceptability but does not cause any loss to the E-Commerce company because for each accepted item the rest of the items need to be returned which would cost the company one- fourth of the delivery price which occurred to send the product.

Here we would consider:

- The company is Amazon
- The current product the customer is using x with S.P = $25
- The product that the customer might want to use:
- x1(a variant of x with same price): S.P = $25
- x2(a variant of x with lower price): S.P = $20
- x3(a competitor of x with lower price and lower quality): S.P= $20
- x4(a competitor of x with higher price and higher quality): S.P = $30
- x5(a variant of x with higher price): S.P = $30
- The delivery cost of each product is: $8
- The delivery cost incurred when the product is rejected at the doorstep: $2

TABLE I

Table of Individual product variants with their parameters

| **Product** | **x** | **x1** | **x2** | **x3** | **x4** | **x5** |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Selling Price | 25 | 25 | 20 | 20 | 30 | 30 |
| Amazon Pays to buy from a vendor | 5 | 5 | 4 | 4 | 8 | 8 |
| Delivery Charges | 8 | 8 | 8 | 8 | 8 | 8 |
| Return Delivery Charges | 2 | 2 | 2 | 2 | 2 | 2 |
| If accepted, Profit | 12 | 12 | 8 | 8 | 14 | 14 |
| If Returned, Loss | 10 | 10 | 10 | 10 | 10 | 10 |

**Note:** All the numbers presented in table are in Dollars

**Source:** Authors

If the customer is given x with x1, x2, x3 and x4 respectively

TABLE II

Table deciding the feasibility of the combination of the product variants

| **Product** | **x and x1** | **x and x2** | **x and x3** | **x and x4** | **x and x5** |
|---|---|---|---|---|---|
| Profit if x, accepted | 2 | 2 | 2 | 2 | 2 |
| Profit if the other is accepted | 2 | Loss=2 | Loss=2 | 4 | 4 |
| Decision viable/not viable | Viable | Not viable | Not viable | viable | viable |

**Note:** All the numbers presented in table are in Dollars

**Source:** Authors

Findings: In this case, we find that if x is sent with a product having a price greater than or equal to x, then it is profitable, but if sent with a product having lower price then it results in a loss, so should not be sent. This finding is for this specific scenario, E-Commerce companies can likewise formulate their algorithms for different prices and products and thereby take actions based upon the outcome generated in a similar way. If we apply the same mechanism for the three products that are sent simultaneously it would lead to losses only, So the threshold here is two products together can be sent for a customer to pick one and return the other at the doorstep to the delivery boy.

Alternate Strategy: We can ask the preference from the customer through a call or a message before delivering the product so that it is a win-win situation for both the parties.

**Challenges**

- In using predictive analytics to do anticipatory shipping, there is too much intrusion in the privacy of the customer. Users might not like any E-Commerce company to invade their privacy online. A better method could be used when they send a notification prior to deliver the items online and seek permission.
- Anticipatory Shipping will not work out as desired if the Customer was looking for online items for their relative's or friend's, but they end up delivering someone else's products. An algorithm could be used to track the relatives and friends of the person by collaborating with social media platform companies like WhatsApp and Instagram with prior permission to reduce errors in delivery to wrong locations. Or, they can also start with family accounts wherein tracking would be much easier and correct.

- One more challenge posed is, it might be someone is looking for belongings for their expecting child, but unfortunately, they had miscarriage and then if the E-Commerce company gets to deliver the things in their cart, they would definitely hurt the bereaved parents.
- This initiative may also lead to loss of their goodwill and trust of their loyal base of the customers which might lead to loss of their revenue in the long term. Proper precautions and permissions must be taken before trying out such an initiative.

**Next Steps**

- E- Commerce companies must very subtly move forward as far as anticipatory shipping is concerned so that they do not end up making losses or hurt customer's sentiments.
- If this is implemented properly it could save the sales tax of the customers on transactions as E-Commerce companies do not have a physical presence. Saving money on price, shipping, transportation, and tax makes people feel victorious in the battle between buyer and seller.
- Anticipatory shipping could augment their sales by giving certain customers discounts—or even outright gifts—on products that customers received but don't want. Household price sensitivity should be adapted by the E-Commerce companies to predict the demand and the supply and based upon the outcomes certain households would be eligible for deals and discounts.
- This strategy if implemented well, would increase the base of loyal customers, as they are in this process outsourcing their purchases and making themselves free of the purchasing hassles and it is a win-win situation for the Customers and the E-Commerce companies.
- This would enable the E-Commerce companies to reduce the costs and optimize the logistics and supply chain to a great extent as now they would be independent compared to previously when they were able to rely on a very limited number of shipping companies for timely deliveries.

**Conclusion**

During the research conducted, it has been found out that Predictive Analytics could land the E-Commerce companies in losses if proper care of the factors such as Inventory Management, Costs of Inventory, Perishability of the products are not taken care of. Similarly, the number of return attempts made for an order plays a vital role in ascertaining the profits made by a company. We need in place proper algorithms to keep track of the threshold limits in order to mitigate losses. This paper also describes that different algorithms have to be deployed for the different products and customer segments based on their demographic factors for proper management. So, the algorithms for Predictive Analytics will have to be constantly monitored and Machine Learning would make the improvements in the algorithms according to the circumstances and the needs of the customer. All these efforts will in turn bring up new and increased sources of revenue, increased trust of customers in the E-Commerce companies wherein the shopping carts of the customers will be automatically managed within proper timelines thereby leaving customers both amazed and surprised at the same time that how much with the improvement in Analytics and Technology, E-Commerce giants have been able to make the lives of the people easier and affordable.

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