ISEN-645

LEAN ENGINEERING

HW7

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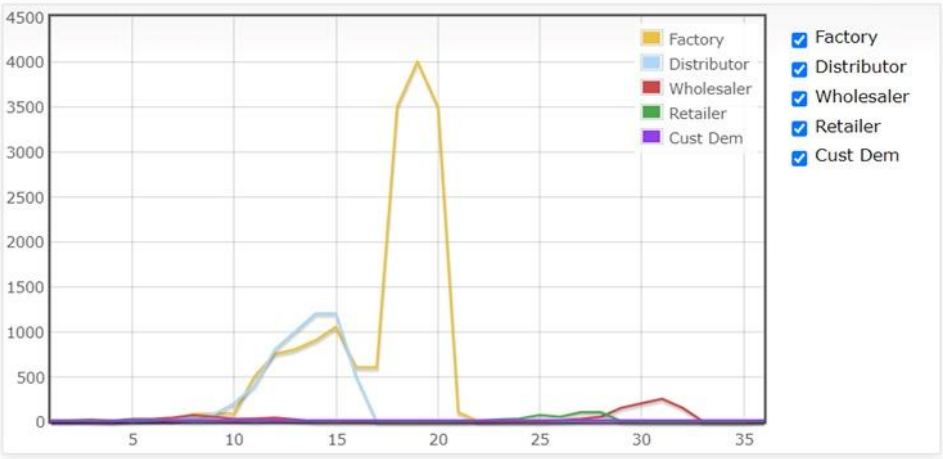
[A] NAÏVE SC BEER GAMEPLAY ANALYSIS: YOU WILL PLAY ALL ROLES BUT ATTEMPT TO OPTIMIZE YOUR COSTS LOCALLY.

a) Turn in the final plots available to you from the result screen



Note: **X -axis** represents Number of weeks and **Y-axis** represents Number of Beer cases (in units).

Entire supply chain's Inv/Bk plot

Individual Channel member plots :

Factory's plot | Distributor's plot | Wholesaler's plot | Retailer's plot

Print out supply chain's Order plot

SC Partner	Avg. Order	Max. Order	Min. Order	Std. dev. Order
Factory	463.00	4000	0	1,026.77
Distributor	153.00	1200	0	343.74
Wholesaler	32.00	250	0	60.07
Retailer	14.00	100	0	25.72
Customer	7.00	9	4	1.30

Week	Factory	Distributor	Wholesaler	Retailer
Week 1	10	15	6	5
Week 2	15	8	7	10
Week 3	20	8	1	17
Week 4	0	10	0	10
Week 5	11	0	25	20
Week 6	12	8	25	20
Week 7	17	20	40	8
Week 8	80	50	70	0
Week 9	85	80	50	4
Week 10	90	200	25	10
Week 11	500	400	30	0
Week 12	750	800	40	10
Week 13	800	1000	20	4
Week 14	900	1200	0	2
Week 15	1050	1200	0	0
Week 16	600	500	0	8
Week 17	600	0	0	2
Week 18	3500	0	0	0
Week 19	4000	0	0	0
Week 20	3500	0	0	1
Week 21	100	0	0	3
Week 22	0	0	0	10
Week 23	0	0	0	20
Week 24	0	0	0	30
Week 25	0	0	0	70
Week 26	0	0	10	50
Week 27	5	0	25	100
Week 28	5	0	50	100
Week 29	10	0	150	0
Week 30	0	0	200	0
Week 31	0	0	250	0
Week 32	0	0	150	0
Week 33	0	0	0	0
Week 34	0	0	0	0
Week 35	0	0	0	0
Week 36	10	15	0	0

b) Describe what the core issues are leading to the degraded performance.

The core issues for degraded performance. They are:

1) Lead time Variability: Higher lead time, which tends to increase transportation costs and inventory costs.

2) Lack of communication: While playing the beer game, there should be proper communication in the different steps of the supply chain. If there is any miscommunication it may lead to excess stockouts.

3)Incorrect forecasting: The judgments made at each step of the beer game are based on their own, maybe unreliable forecasts of future demand. In addition to excess inventory or backorders, this may result in overproduction or underproduction.

4)Bullwhip effect: This is a phenomenon in which tiny changes in demand are magnified as they move up the supply chain. In the beer industry, this can lead to excessive stockouts, which can lead to increased expenses and poor customer experience.

5) Increase in backorder: Here when the back order is increased, failed to fulfill them.

c) Comment on the bullwhip effect as it relates to the game

Companies do not have safety stock reasoning in the sudden spike in the graph. Also, when the distributor placed an order for a huge no. Of units, the factory produced twice of it just to be on the safer side however that was just what bullwhip effect where they produce much high expecting the demand to grow but however end up having a huge inventory. In this game, we played focusing particularly on the echelon not the entire. So, we didn't get the expected curve for the total cost. Since we didn't use the basic core principles, we didn't obtain the proper curve. If we use all the principles, we may get the optimized curve.

[B] COORDINATED SC PLAN AND RATIONALE: DEVELOP (ENGINEER) A PLAN FOR DRIVING OPTIMAL DECISIONS ACROSS YOUR SC

a) DISTRIBUTION RESOURCE PLAN

Week	0	1	2	3	4	5	6	7	8	9	10
SC forecast		22	27	26	25	10	11	12	27	25	26
In transit		40									
On order											
Projected balance	26	44	17	28	3	-7	-18	-30	-57	-82	-108
Planned shipment [order date]		37									
Planned shipment[reciept date]				37							

High			Medium			Low	
mean	21		mean	8.67		mean	4
var	12.17		var	4.22		var	0.17
STD	3.488553		STD	2.054264		STD	0.412311

Rationales

We are here following the type 2 service level, which will result in minimum buffers. We selected the service level of 0.97 and then leveraged the normal distribution parameters to calculate the safety stock every time.

Here the α is the service level, and the associated z value is then calculated.

The optimal base stock is evaluated by z=μ+zα*σ, where zα*σ, is the safety stock that is used to buffer against the fluctuations. In the event of replenishment lead time, the variance is calculated by $\ell\boldsymbol{\sigma d}\,\mathbf{2} + \boldsymbol{d}\,\mathbf{2}\sigma\ell\,\mathbf{2}$, and the standard deviation associated with the safety stock is calculated by this variance. The bullwhip can also be countered, by proper coordination and information sharing in the echelons and understanding the system dynamics.

[b] Core Principles used at work in our plan from the supply chain physics are.

- By ensuring we have the necessary safety stock at all times during the entire 36 weeks to avoid stockouts on the retailer end, so for this we have prepared a distribution resource plan in excel to make sure we are well aligned with the demand from the downstream echelon. In this, we are making use of the Safety Stock principle.
- By ensuring, we don't order in batches during the entire demand time and avoiding variabilities in the lower level, in this scenario, we are using the DRP plan and making sure all the four echelons are well aligned with the demand and avoiding stockout. In this way, we are effectively using the Bullwhip effect principle.
- By ensuing, the entire supply chain echelon family is centralized well with one common plan to achieve the objective, and the variations between various processing centers are combined to reduce the buffers. In this, we are making use of the Risk-sharing contract is followed.

[c] Turn in a 1-page summary of the article "Bullwhip Effect in Supply Chains"

"The Bullwhip Effect in Supply Chains" by Hau L.Lee, V.Padmanabhan, Seungjin Whang

This article discusses the factors that lead to a bullwhip effect in the supply chain using real-world examples and strategies that can be deployed to mitigate this undesirable effect that hugely adds up to the total costs to deliver a product to the customer. Basically, we say that a supply chain has the bullwhip effect when we see high variability in demands upstream of the supply chain than the demand found downstream. The orders demanded by the customer to the retailers get amplified more and more as it progresses through the upstream of the supply chain so much that by the time it reaches the supplier, there is almost a huge demand fluctuation that does not coincide with the initial customer order. This could be due to four main factors as stated in this article.

Firstly, demand forecast updating by each of the entities (like retailer, distributor, manufacturer, or supplier) based on the requirement of the immediate downstream entity is one the major reasons for the bullwhip effect in the supply chain. For example, when the manufacturer does material requirement planning based on the demand from its immediate downstream entity which is the distributor, it also cumulates the forecast errors (which also includes safety stock for buffer) made by the distributor based on its immediate downstream entity (retailer). So, this adds up and results in more inventory upstream to compensate for the demand fluctuations. The bullwhip effect can be worsened by the presence of safety stock, leading to increased fluctuations in the supply chain. It is logical to assume that longer lead times between restocking events could amplify this effect even further. This can be counteracted by avoiding multiple product demand forecast updates. Information sharing is a key solution for countering the bullwhip effect.

Secondly, companies tend to place orders batch by batch mostly to cut the costs incurred due to transportation. This is often done in either of the two forms of order batching, namely, periodic ordering and push order. Companies always tend to load full trucks as it will be a more economic transportation method. Usually, a full truckload of items will be a month's worth of supply. So, the order are sent in batches which require inventory. This periodic ordering amplifies the variability and costs incurred resulting in the bullwhip effect. This happens because of the higher costs of placing and replenishing an order. So, the aim should be to break the order batches and regulate the flow. This can be done by transporting different varieties of stock-keeping units of the products which are known as composite distribution. This way, the transportation efficiency is kept high, and order frequency is also increased.

Thirdly, price fluctuations are another reason for the bullwhip effect. These occur due to the discounts and offers provided by the manufacturers and distributors at certain periods of time. This results in forward buying starting from customers downstream to the manufacturer upstream. This cause can be controlled by mitigating the discount frequencies and quantities and through a continuous replenishment program. Also, an everyday low-price policy can be implemented.

Finally, rationing and shortage of gaming also result in the bullwhip effect. For example, when a manufacturer could not meet the customers' demand, it resorts to rationing its products to customers. Later in the next order cycle, the customer might overact to the rationing and order more than required to play it safe in case a shortage occurs. This is called a shortage of gaming by customers. So, in this case, the supplier will not have an idea of the actual demand for the product. So, this effect can be mitigated by allocating items to customers based on previous order sales data so that the customers will have no reason to exaggerate their orders assuming an upcoming shortage.