

The Improvements in Supply Chain Management through Beer Game

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Abstract- In 1960's an excellent game named "The Beer Game" was developed to provide a useful learning experience about the supply chains. This research work was made to explain certain behavior of supply chain systems with the help of beer game that was basic necessity of most of supply chains systems. This research is a real life example of how organizations are working on basis of simulation playing method of beer game. The major aim of this research was to reduce the total cost, for every member in the supply chain, by maintaining low stocks with proper delivery of orders. Research explained how the value of sharing information across the various components of supply chain helps to increase the efficiency of system. Beer game actually helped to reduce the cost as much as possible and manages the flow of material at right locations at the right time with the right quantity. In result, it helped to reveal all the hidden problems to the entire supply chain system.

I. INTRODUCTION

How the Beer Game is played:

In beer game there are four players named as

- a. Retailer
- b. Wholesaler
- c. Distributor
- d. Factory

The major goal of all supply chain members is to reduce total cost for the system and for the individual as well.

Basically, it is just a simple procedure to supply beers from factory to retailer with the coordination of wholesaler and distributor. It helps in transferring of orders from retailers to factory by taking the help of decision makers like wholesaler and distributors. There is a fixed lead time and order delay time between each player with the maximum try to minimize the backorders (If any orders cannot be met then it is recorded as backorders) and inventories. Supply chain tries its best to meet the demand of orders and is completed as soon as the inventories are available. In supply chain, each player of each item costs \$

0.50 per case for inventory and \$ 1.00 per case for Backlog. It is compulsory to welcome every order in the system.

In addition to this, the wholesaler keeps some inventory to complete the orders of retailer, in the same way the distributor keeps some inventory to complete the orders of wholesaler and the factory owns both the inventory in transit to the distributor as well as the items being manufactured.

The beer game starts as first you have to take the order in, try to complete that order by moving shipment in and then move order out to the supplier. In the mean time the inventory and backlog should be recorded.

In one week, the order of each supply chain member arrives at the supplier. The most recent try of supplier is to fill it with available inventory, and then there is a delay of two weeks because of transportation before the material being shipped by the supplier and arrives at the customer.

II. Research Elaborations & Explanation:

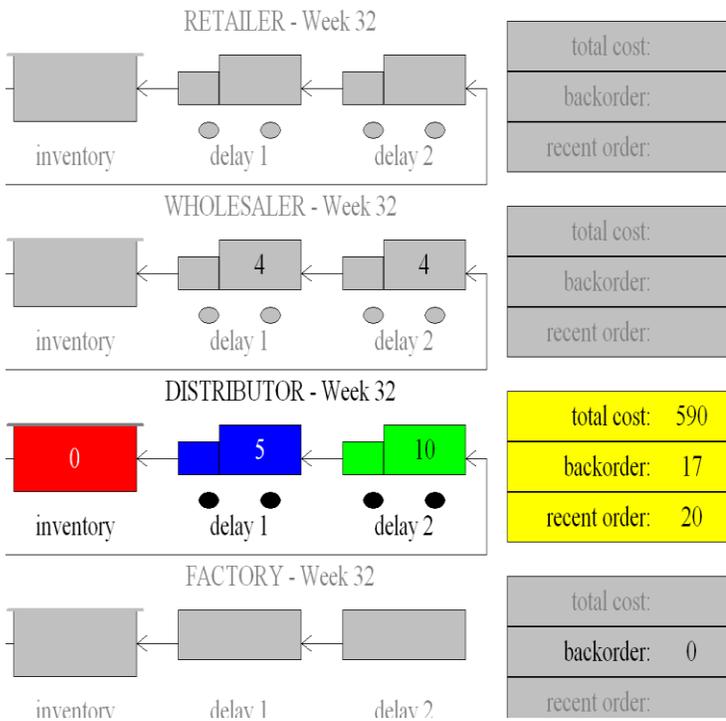
Playing of game for 32 weeks as the Distributor

Without changing any default settings, game was played for 32 weeks as a distributor. The details of the Inventory, backlog, recent orders and total cost for each week are mentioned in table given below.

Weeks	Inventory	Backlogs	Recent orders	Total cost
1	8	0	2	6
2	12	0	3	12
3	0	8	4	26
4	0	13	5	46
5	0	36	15	84
6	0	32	8	120
7	0	32	8	155
8	0	33	20	190
9	0	32	20	126
10	0	32	30	267
11	0	7	0	293
12	5	0	0	316

13	3	13	6	328
14	30	5	1	348
15	30	0	1	366
16	25	0	1	382
17	23	0	0	395
18	16	0	1	411
19	12	0	1	423
20	6	0	1	432
21	0	0	2	438
22	1	0	1	442
23	0	0	1	443
24	0	0	1	444
25	0	9	9	455
26	0	13	3	469
27	0	22	3	492
28	0	14	4	511
29	0	14	4	531
30	0	12	4	547
31	0	17	10	569
32	0	17	20	590
Total	171	361	189	10657

The results of beer game after playing for 32 weeks as a Distributor is as shown below:



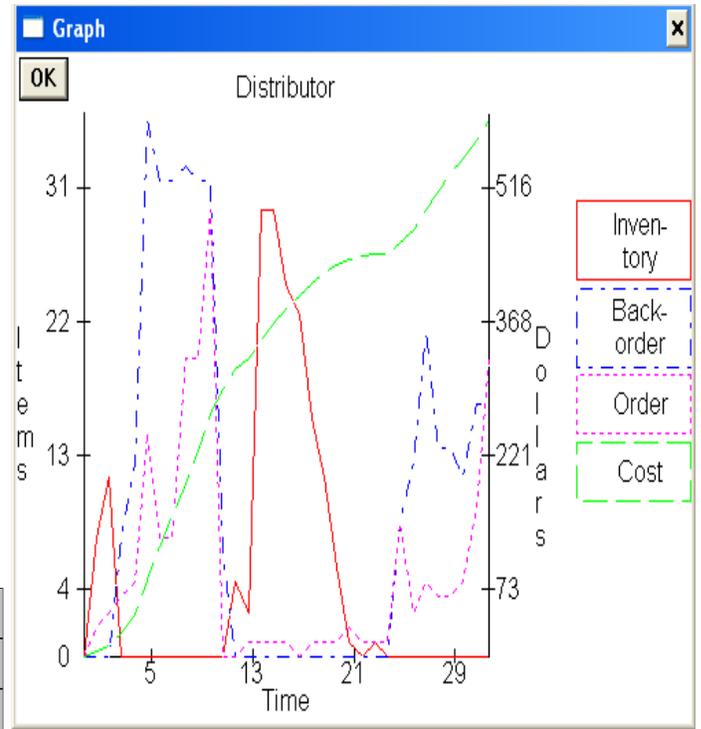
3. Total cost of playing the game without strategies

At the end of the game total cost of playing the game as distributor is \$ **590** with 17 back orders and zero inventories.

As the total cost of the whole system is

$$\begin{aligned} \text{Total cost} &= \text{Sum of Inventory cost of each week}/2 + \text{sum of backlog cost of each week} \\ &= 171/2 + 361 \\ &= 446.5 \end{aligned}$$

4. Results of the beer game on Graph



As it is obvious from the graph that in the start of 3rd week the backlog starts to increase and reaches up to 32 items on the 10th week. There are the following reasons behind that:

- a) Very high increase in demands from the wholesaler side.
- b) The delay from the factory regarding supply of items.

That high increase of backlog resulted in increase of cost. At the end of 12th week, the inventory started shooting up because of proper supply of items from the factory and as a result, all the back orders got completed properly. But on the other side the cost started shooting up because of very high inventory from week 12 to 22. From week 22 to 25 both the inventory and backorder got managed. But From the week 25, orders from wholesaler suddenly got increased. As a result, the back order started shooting up and it reached up to 17 items at the end of 32 weeks.

5. Use of available strategies in the game:

From the available strategies in the options of the beer game, following two strategies got selected:

- a) Short Lead Time

b) Global Information

Reasons for how the strategies improve the performance of beer game

a) Short Lead Time

By using the short lead time we can reduce the delay factor for one week however in any other strategy this option is not available. By reducing the delay factor it is easier to reduce back order and to manage inventory and cost of the inventory.

b) Global Information

In this strategy, the most attractive point is that we have open information of all the supply chain players, about their back orders, inventories and even orders that they are placing to their suppliers. So it becomes easier to predict the order of wholesaler and to place the order properly to the factory.

In short both of these strategies helped us to increase the efficiency of game and to reduce the cost of game.

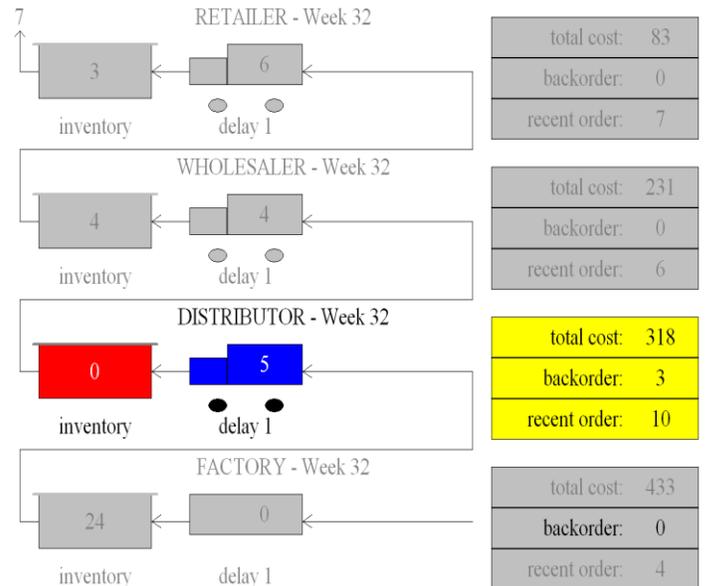
6. Playing the Beer Game for another 32 weeks using the above strategies

After changing default settings, game was played for 32 weeks as a distributor. The details of the Inventory, backlog, recent orders and total cost for each week are mentioned in table given below.

Weeks	Inventory	Backlogs	Recent orders	Total cost
1	8	0	4	4
2	8	0	4	8
3	8	0	15	14
4	0	3	2	23
5	0	6	3	29
6	0	9	2	38
7	2	0	1	48
8	0	1	1	51
9	0	3	2	54
10	0	10	10	65
11	0	18	10	84
12	0	12	4	101
13	0	6	3	112
14	0	5	10	119
15	0	17	0	137
16	0	13	5	155
17	0	20	15	175
18	0	25	10	203

19	0	15	5	225
20	0	14	5	242
21	0	7	10	254
22	0	5	5	261
23	2	0	1	266
24	2	0	2	270
25	0	0	10	271
26	0	5	10	281
27	0	0	1	286
28	8	0	20	291
29	0	1	0	297
30	13	0	0	306
31	4	0	5	313
32	0	3	10	318
Total	55	198	185	5301

Output of the Beer Game using strategies after 32 weeks is as shown below.

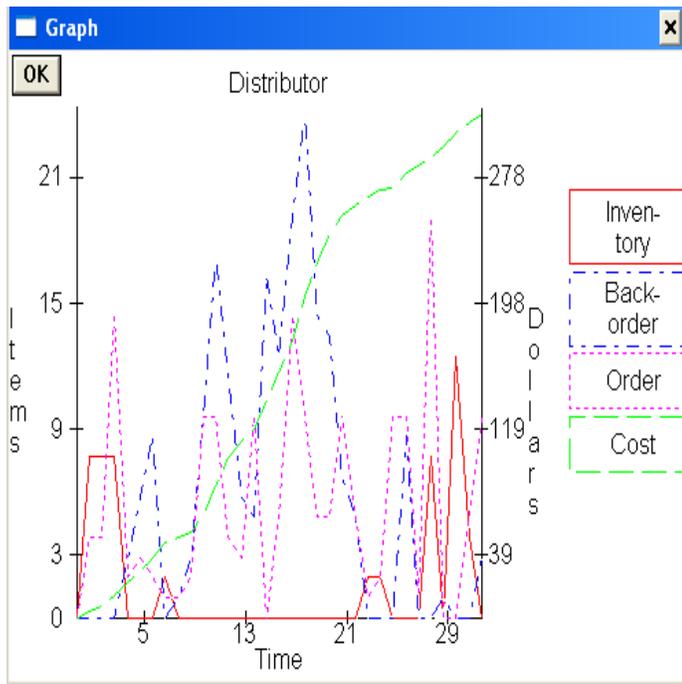


7. Total cost of playing the game with the above strategies:

After setting the strategies such as Short Lead Time and Global Information, game was played again for 32 weeks as a

distributor. At the end of the game total cost of playing the game was \$ 318 with backorders of 3 and 0 inventory. By using the same formula as mentioned above the total cost of the whole system is \$ 225.5

8. Explanation of the graph from the new beer game:



In the start, the trend of the graph with strategies is same as the graph without strategies because the back order started increasing up in the same way as it was in case of previous graph without strategies and the reason behind is that there is no supply from the factory side. The most important factor that should be noted is from 2nd week to 26th week. Even there was a facility of strategies like short lead time and global information, but due to very high level of demands of wholesaler these strategies did not helped to reduce back log. However very high level of demand from wholesaler keep on increasing till the end of the game, from 25th week to 32nd week, it get managed at the end by increasing inventory by giving more orders through method of order demand fluctuation and order forecasting.

Results & Conclusion

Comparisons of the results from two Beer Games:

Following are the major points that need to be discussed during comparison:

1. Distributor Cost

The most prominent difference between the two graphs is the decrease in cost of distributors. The cost was \$590 and after using strategies it gets decreased to \$316.

2. Total Cost

The difference between the total costs of the system is one of the obvious differences. The cost of the system before the use of strategies was 446.5 and it got decreased to 225.5 after the implementation of strategies.

3. Backlog Control

The backlog started from 2nd week to 12th week in the graph without strategies and reached to the value of 37 however after use of strategies the graph shows us that there is no extraordinary shooting of back order even at the start of the game and back order only reaches to the value of 23.

4. Inventory Control

The graphs show us that there is a good control on the inventories when we implement strategies and it is clear from the pattern of graph if we compare it from week 5th to 25th week. Secondly the maximum value of inventory in graph without strategies is 30; however the other graph has a maximum value of 13. So the difference is obvious.

5. Total Control on System

One of the common problems in supply chain is that in the start the orders of wholesaler are always very high so it's not possible to control that backlog without proper ordering information of all the players in the game. While using strategies we can utilize this information and creates more control on all the orders of the distributor even if the amount of orders of the system is very high.

9. Implementation of adopted strategies in an actual supply chain

a) Implementation of global Information strategy

The global information strategy can easily be implemented in supply chain by using the IT Software system. The advancement in the technology of information system has created a huge impact on the evolution of supply chain management. Because of these extra-ordinary technological advances, supply chain players and partners can now work more efficiently with a very high level of information flow to optimize the chain-wide performance. The name of this highly efficient enabler is IT (information technology). The implementation of global

information strategy through IT provides us following advantages in actual supply chain:

1. Proper designing and managing of supply chain.
2. Excellent Modeling of supply chain dynamics.
3. Timely investigation of problem.
4. Good idea of demand forecasting.
5. More responsive atmosphere.
6. Proper calculation of demand fluctuation.

b) Implementation of Shorter lead time

In order to improve any supply chain performance, it is an important factor for groups in a supply chain to focus on the reduction of lead time like they are focusing on the implementation of global information. Even the theory of supply chain management suggests that lead time reduction is important in adjusting production to fit actual customer demands and helpful to reduce uncertainty which is one of the primary goal of supply chain management. There is a common observation that to begin with proper information transfer improvement; we can easily ignoring the problem of long lead times. So again IT is helpful to reduce lead time. One of the leading advantages of implementation of shorter lead time is the reduction inventory cost of the system and secondly the system becomes more efficient and simple as well.

References:

Baker Graham 2010, Lectures of Advance Supply chain Management Greenwich University

de Treville, S.. "From supply chain to demand chain: the role of lead time reduction in improving demand chain performance", *Journal of Operations Management*, 200401

Ralf Hieber. "Impacts of SCM order strategies evaluated by simulation-based 'Beer Game' approach: The model, concept, and initial experiences", *Production Planning and Control*, 2003

Joanna Kołodziej. "Task Allocation Oriented Users Decisions in Computational Grid", *Studies in Computational Intelligence*, 2011

Chen, F., J. Ryan, and D. Simchi-Leiv (1997) *The Impact of Exponential Smoothing Forecasts on the Bullwhip Effect*. Working Paper, Northwestern University.

Drezner, Z., J. Ryan and D. Simchi-Levi (1996) *Quantifying the Bullwhip Effect in a Simple Supply Chain: The Impact of Forecasting, Lead Times and Information*. Working Paper, Northwestern University.

H.L. Lee, P. Padmanabhan, and S. Wang (1994) *Information Distortion in a Supply Chain: The Bullwhip Effect to appear in Management Science*.

Lee, H. L., P Padmanabhan, and S. Whang (1995) *The Paralyzing Curse of the Bullwhip Effect in a Supply Chain to appear in Sloan Management Review*.

Sterman, John D., *Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment Management Science 35(1989)*, pp. 321-339.

Sterman, John D., "Teaching Takes Off: Flight Simulators for Management Education" *OR/MS Today* October 1992 pp. 40 - 44.

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