Reduction of Bullwhip Effect in Auto Assembly Industry

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1

Abstract

TThe main focal point of this study is to categories the reasons of Bullwhip Effect by fishbone diagram and tries to reduce bullwhip phenomenon. Three steps are followed here to resolve bullwhip effect. First, identify the causes. Fishbone diagram helps to classify the core reasons of it. The second part is to analyze the causes and discuss the effect of these causes and try to recommend some probable solutions. The third and last part is to observe the practical situation of bullwhip effect. Here, a case study is to be studied and apply the following solution of this supply chain system and observe how these solutions resolve the bullwhip phenomenon.

Index terms— supply chain, bullwhip effect, fishbone diagram.

1 Introduction

Supply Chain (SC) includes all the participants and processes involved in the satisfaction of customer demand: transportation, storages, retailers, wholesalers, distributors and factories. A large number of participants, a variety of relations and processes, dynamics, the uncertainty and stochastic in material and information flow, and numerous managerial positions prove that Supply Chains should be considered as a complex system in which coordination is one of the key elements of management.

An important observation in supply chain management was made by Forrester **??**1961), who illustrated the effect of the variance amplification, called the bullwhip effect, in a series of case studies. The bullwhip effect is a tendency for small changes in endconsumer demand to be amplified as one move further up the supply chain. Common practical effects of this variance amplification were described in cases of companies Procter & Gamble and Hewlett-Packard, and are presented to students worldwide through the business game "Beer Game" developed on MIT (Sterman, 1989).

Logistics executives at Procter & Gamble (P&G) examined the order patterns for one of their best-selling products, Pampers. Its sales at retail stores were fluctuating, but the variability was certainly not excessive. However, as they examined the distributors' orders, the executives were surprised by the degree of variability. When they looked at P&G's orders of Author ? ? ? : Undergraduate student, Department of Industrial Engineering & Management (IEM), Khulna University of Engineering & Technology (KUET), Khulna-9203, Bangladesh. E-mails : neeltoha@gmail.com, ridwan.hoque.ipe08@gmail.com, nujhat_sadmani@yahoo.com, tomal_das@live.com Materials to their suppliers, such as 3M, they discovered that the swings were even greater. At first glance, the variability did not make sense. While the consumers, in this case, the babies, consumed diapers at a steady rate, the demand order variability in the supply chain were amplified as they moved up the supply chain. P&G called this phenomenon the "bullwhip" effect.

When Hewlett-Packard (HP) executives examined the sales of one of its printers at a major reseller, they found that there were, as expected, some fluctuations over time. However, when they examined the orders from the reseller, they observed much bigger swings. Also, to their surprise, they discovered that the orders from the printer division to the company's integrated circuit division had even greater fluctuations.

2   II.

3   Supply Chain

Supply chain refers to the chain of supply of goods from manufacturer to the customer. It consists of two individual and complete words namely-supply & chain. Supply stands for providing or to furnish something of need. According to the dictionary a chain means a series of connected units of metal which are used to make a link. Generally it refers to something that helps to create a link between two or more things. Hence the meaning of supply chain may be expressed by the phrase-An interlinked process of system to provide the customers with the required goods or service.

It is clear that supply chain includes every single point that complete the chain of supply such as supplier, manufacturer, distributor, retailer, customer etc. The supply chain of a company is called successful when the flow of material from one point to another is possible at an optimum cost as well as the final product is at customers' hand at the right time.

This may seem to be contradictory at some extent. Providing service to the customer requires a good level of inventory and a shorter lead time. On the other hand if the inventory gets higher, the cost increases. The combination of these two is necessary to make a supply chain a success. For example Rahim Afrooz sells generators. Even if all know that transportation needs a certain lead time customers are not willing to wait that long. They want the service just in time. This is why the company has to maintain a minimum level of inventory depending upon their G transportation is to be taken for the process. Air is such a medium that takes a little time at a relatively high price. On the contrary water-ship is not costly but takes more time to deliver product.

A very poor result can happen to a certain supply chain if it is attacked by the bullwhip effect. There are some reasons behind this vital effect. Whatever the causes are, they are not unsolvable. Proper coordination is a must to solve the problems. Only a successful supply chain can lead a business towards prosperity.

4   III. he Bullwhip Effect

In Supply Chain, Bullwhip is an important term. Actually it is a phenomenon. The Bullwhip Effect is one of the main reasons for the inefficiencies of Supply Chain. Mainly this phenomenon is created for lacking of coordination and passing necessary information. Bullwhip Effect causes the fluctuation of demand variable and this effect the overall Supply Chain very much. Customer, Retailer, Wholesaler and Manufacturer are much related to the affect of Bullwhip effect. But increasing and decreasing demand is highly responsible for bullwhip effect. But some causes can be identified. 1. Over reaction of the backlog orders.

5   Causes of the Bullwhip Effect

Normally several causes are responsible for Bullwhip Effect in supply chain [2]. They are: 1. Demand forecast updating 2. Order batching Demand forecast generally are based on the orders of the previous echelon. But it is not based on the actual customer demand. Actually this is future plan of the demand that is to be forecasted by the manager [1]. But forecast error is a common thing, so information gap is created between the partners. So it is very tough to match the real situation and the forecasted result. That creates the bullwhip in the chain.

For example, if a manager uses, say, exponential smoothing (future forecast is always updated as demand increases) the order sent to the supplier reflects the amount needed to replenish the stocks to meet the requirements for future demands and safety stocks which might be considered necessary [2]. b) Order Batching "Cost is to be minimized", that is the main them of any company. So to reduce the fixed cost and setup cost, order batching is performed. Normally company wants to order in batches, so that the transportation cost will be minimized. To make more benefit influences a company for order batching. But Bullwhip effect is created when the forecast and order are not matched. For Example, Consider a periodic review stationary demand system with full backlogging at a retailer. The retailer would thus use an order up to level to monitor its inventory. This implies that he would order an amount equal to the preview cycle's demand in every review cycle [3].

Order batching can be defined in sentence, which is "When the cost (fixed) is not zero, the ordering is uneconomical, but order batching is occurred." Price fluctuation is another major cause of creating this bullwhip phenomenon. Normally more than 80% dealings between manufactures and distributors of an industry follow an arrangement that is known as "forward by" arrangement. That is happen but the attractive price offer by the manufacturer. Forward buying is one of the main causes of price fluctuation. Different types of offers like discounts, quantity discounts, free offers rebates and coupons are normally given by the manufacturers and distributors. These causes enhance the price fluctuation very much. [1]

6   d) Rationing & Shortage Gaming

Rationing and shortage gaming is another common reason for bullwhip effect. Most of the demands are placed on the basis of forecasting or sometimes on prediction. Sometimes demands are many but the supply are not enough. In this case, the products are ordered more than its demand, so that the number of delivered products generally is the percentage of the number of products actually needed [4].

For example, a retailer actually needs 75 units, but he orders 100 units in the hope of getting 75 units. The main output of this rationing scheme is to make a situation that the demand is raising but actually that is totally

artificial [5]. A retailer ordering based on what it expect to sell gets less and as a result loses sales, whereas a retailer that influences its order is rewarded.

7   e) Competitor

Competition is another backbone for creating bullwhip effect in supply chain. Every super market is competitor to the others. So they offer many services to their customers. Sometimes they offer discounts on many products or group of products. That is why bullwhip effect is enhanced.

8   f) Inventory

Inventory is also a responsible basis of bullwhip effect. For example, many companies make large stock of mango in its season. But their motive is to sell these mangos in offseason. That is why demand of the mango is increased and last of all; bullwhip effect is created in the whole supply chain. 4). This inbound supply chain starts with 1st tier suppliers consisting of foreign suppliers and local suppliers. Since SML imports a variety of engine components: Information is collected from the customer directly. Internet can be used for that purpose. Customer will give the order on website to the dealer on which the company will have the direct right to access.

9   Table 1 : Information of SML

In complete-knocked-down condition (CKD), therefore they constitute 1 st tier suppliers. These components in raw material form or sub-assemblies reach the factory stores for assembly. After manufacturing/assembly the finished vehicles reach the factory stockyard for dispatches to zonal offices then zonal offices send the vehicles to the dealers. Customers place the orders and get the delivery from the dealers only and not from the zonal offices or the company directly. The whole supply chain involves the 1, the outbound supply chain in SML extends from the factory to the zonal offices and from zonal offices to the dealers and then ultimate customers. Dealers collect orders from the customers and send to the zonal offices (ZO). ZOs after consolidating the orders send them to the factory for replenishment. Since, ZOs do not have any access to the customers' demand data. Therefore the demand of ZOs for LCVs is forecasted on the basis of the demand of dealers generated from the customers. The variability in orders placed by the dealers is bound to be significantly higher than the variability in customers' demand. The ZOs are forced to carry more inventories of finished vehicles than the dealers in order to meet the same service level as the retailer. This demand variability or bullwhip effect is more serious in large ZOs in south and Madhya Pradesh. This results in ineffective transportation, more carrying cost, more ordering cost and more manpower. Similarly company has to keep an extra inventory of raw materials, sub-optimal space

10   Table 2 : Orders of different stages

The total customer orders were 12975 during the year, but dealers demand stood at 13980 with an increase of 7.75%. Similarly zonal offices also inflated their demand to 14625, an increase of 12.71%. Finally SML's orders to supplies were 15360 with 18.38% increase. As a whole the total demand inflation by SML over the customer demand was 16.84% Figure 4 shows the graphical view of it. The line inflates each time when the demand travels up in supply chain.

VII. Coordination on performance in SML SML experienced complete lack of coordination, since each stage in the supply chain wanted to optimize its local objectives without considering the impact on the complete supply chain. It hurt the performance of the entire supply chain and ultimately the total supply chain profits were less than what could be achieved through coordination. SML receives demand information even during periods of time in which the dealer does not order. Therefore SML is suffering from 'Extended Bullwhip Effect'. The following bullwhip ill effects were seen.

11   VIII. Reduction of Bullwhip Effect

We can try to give many ways to solve the bullwhip effect. Here SML can be a nice way to solve that example that we have mentioned previously. SML witnessed following main obstacles to coordination in the supply chain [6]:

1. Lack of information 2. Forecasting based on orders and not on customer demand and 3. Push based production system

The following damage control measures have been adopted: Share the Information SML and its supply chain partners are in progress to use CPFR (collaborative planning, forecasting and replenishment) for information sharing and coordination. Now internet is the main way to place order. At the time for forwarding the demand to the zonal offices, the dealers also take help from internet. Here 54.63 days and 437 man hours are saved. (2185/40)= 54.63 days and 54.63x8= 437 man hours) Push pull system Push-pull production system can be very effective. The material is being pushed through assembly, but the whole vehicle is pulled through actual orders. Mainly this is monitored by forecasting. The pullthrough replenishes what is being sold from the stockyard. The production and distribution depend on the demand. For this reason they are highly related with the customer demand than forecast demand. The main strategy in SML is to avoid obstacle of large fixed and working capital

in finished vehicles. SML tries to fill the order after receiving order from zonal office. Now SML has stopped inflating the demand from zonal offices.

12 Demand generation module

Here the zonal office places their order with the factory by internet. Demand is submitted separately fro each model. First adjustment is needed the order fulfilled in the past one week. Usually a distributed order is produced, which is a consolidation of all the orders received during the past one week. This order generated ultimately determines the dispatch from the factory and the sales in the coming week. Depending on the backorders, customers, the required buffer stock, and the available stock, the order communicates with the factory.

Order from Zonal office = Dealer/Customer order + Backorders + Required buffer Stock -Available Stock Allocation Module

In this module, allocation of vehicles to the dealer is made according with the. After the day's production run, allocation is done. For each model, the stock has to perfect for meeting the demand fully. Available stocks are delivered for the lacking of actual stocks. Demand and supply for each model is measured independently. And shortfall in the supply of one model is not made up by extra supply in any other model. The allocated stocks are supplied to their destination.

13 Inventory Placement

The company maintains 10 zonal offices throughout the country; the main purpose is to reduce delivery times to its customers. A higher than expected demand from one zone /region can be offset by a lower than expected demand from another. 'Forward placement approach' is followed by the company, which means locating stock closer to customers at a zonal office and dealer's stockyard (Figure 4). Forward placement has an advantage of faster delivery times in the order fulfillment process; consequently service to the customer is quicker [6].

14 Distribution Module

Factory Stockyard (FSY): In the company, FSY is located itself and wholly owned by SML. All the vehicles are directly dispatched to the FSY and this is happened after assembly. The advantage comes from "inventory pooling", which helps to make reduction in inventory and safety stock. That is happened for the merging of variable demands from the zonal offices. G which are notified to the zonal offices. And further the zonal offices after compiling these orders send to the company for replenishments [6]. Hub & Spoke approach of information sharing Hub and spoke approach are also followed by the SML. Each spoke acts as a connection to a member of the supply chain. All the members of supply chain pass the information to a central hub representing zonal offices and each member has access to all information provided by the other members. By sharing this information, all supply chain partners can see the changes occurring anywhere in the supply chain and respond to those changes instantly. This information sharing has been made possible with the use of electronic data interchange (EDI) and Internet. This has resulted into following benefits to SML: 1. Quick information 2. Reduction of paperwork 3. Improved billing 4. Customer service improvement 5. Competitive advantage 6. Error free demand forecasting 7. Minimize the cycle time in receiving projected and actual demand information 8. Establish the monitoring of actual demand for product to as near a real time basis as possible. 9. Understand product demand patterns at each stage of the supply chain. 10. Minimize or eliminate information queues that create information flow delays. 11. Eliminate inventory replenishment methods that launch demand lumps into the supply chain. 12. Identify, and preferably, eliminate the cause of customer order reductions or cancellations.

Finally, the generous return policies that manufacturers offer retailers aggravate gaming. Without a penalty, retailers will continue to exaggerate their needs and cancel orders. Not surprisingly, some computer manufacturers are beginning to enforce more stringent cancellation policies.

15 IX.

16 Conclusion

In this paper, we have tried to focus how 'Bullwhip Effect" is created in Supply Chain. With the help of an example we tried present the overall situation of Bullwhip effect in Supply Chain. We also try to resolve the bullwhip effect by several methods. Here we can see that, the lead time of an order can amplify the variability.
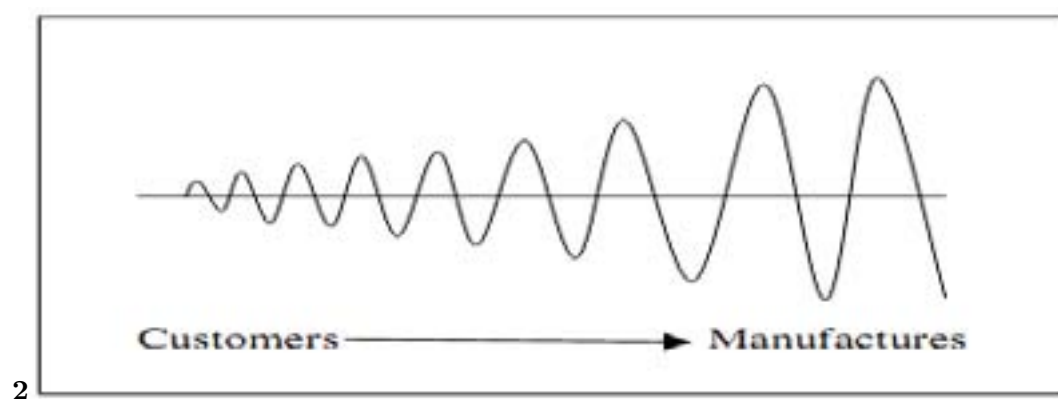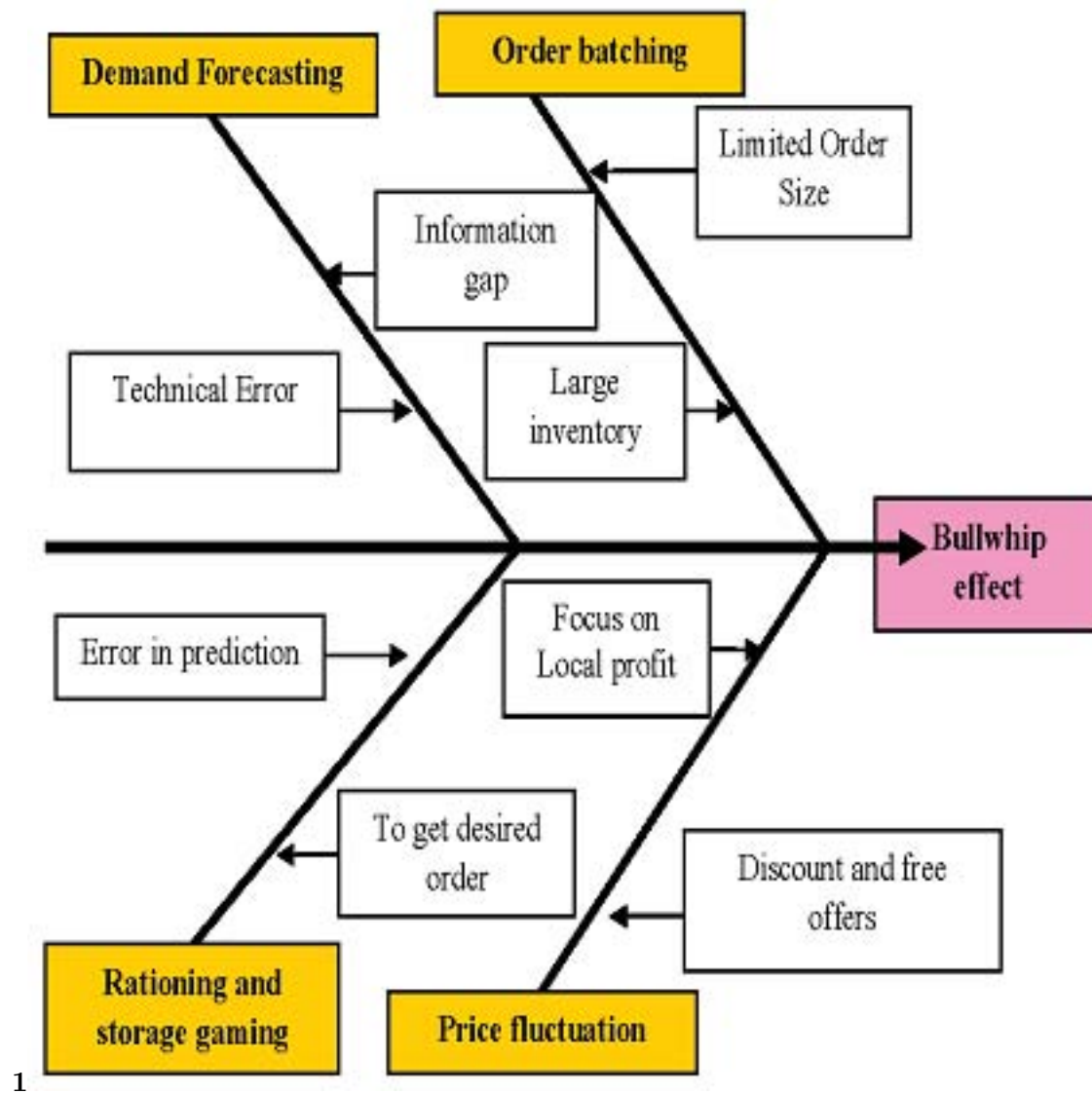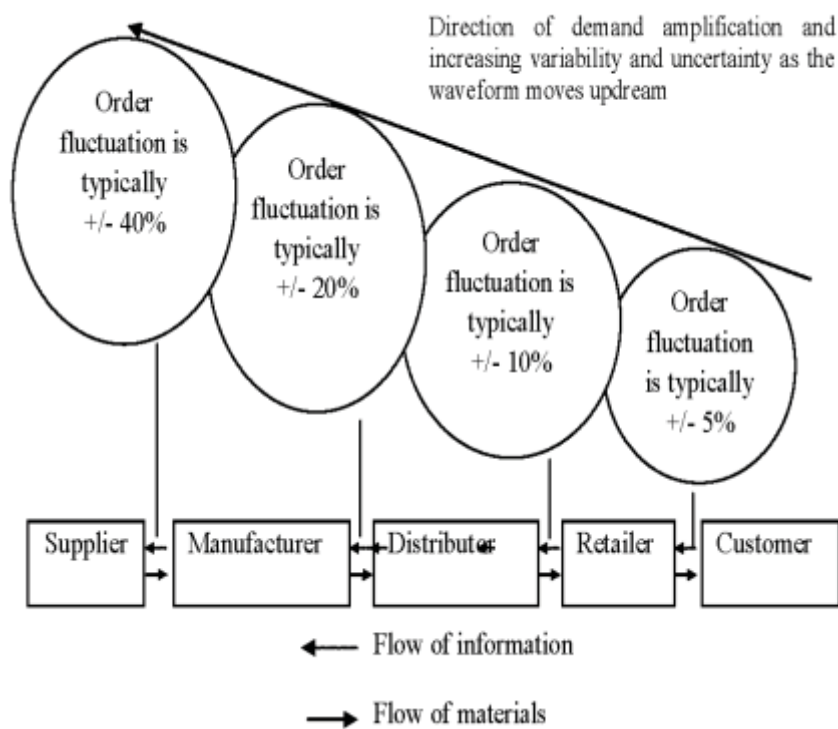
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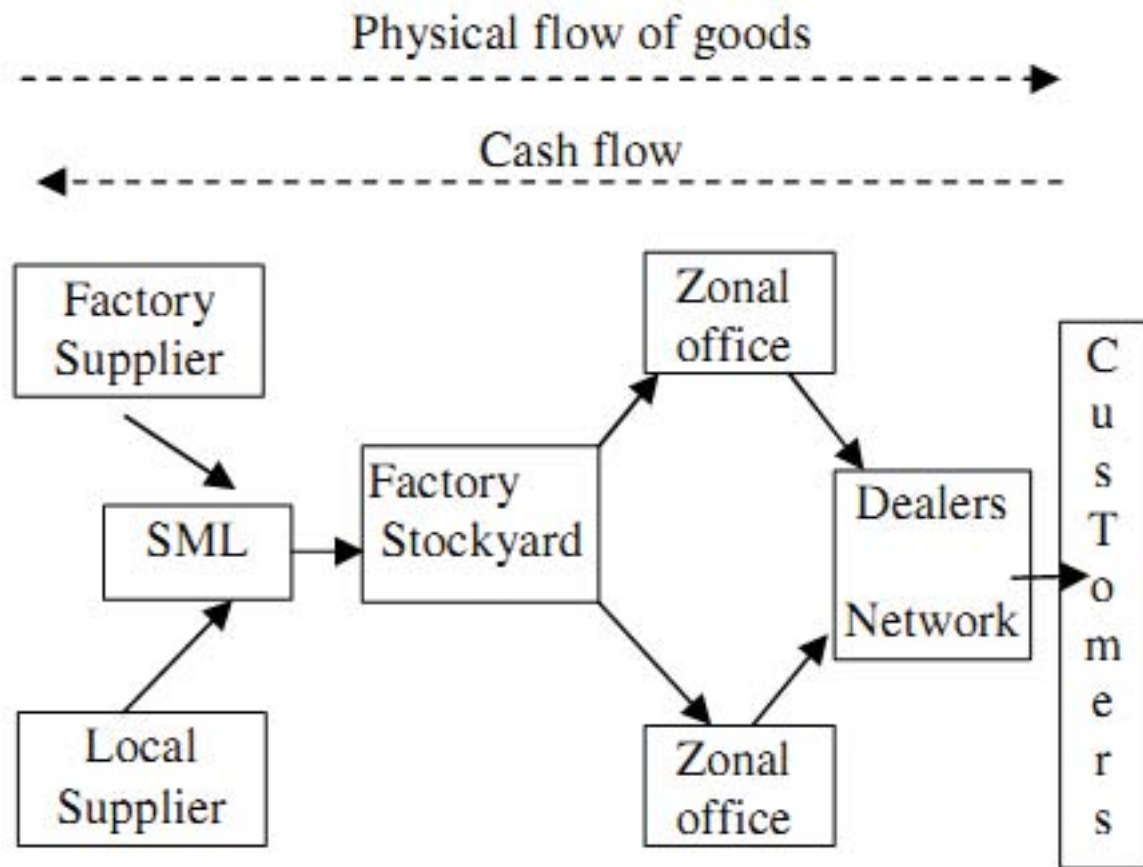
Figure 1:

Figure 2: 2 .

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Figure 3: Figure 1 :

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Figure 4: 3. Price fluctuation 4 .

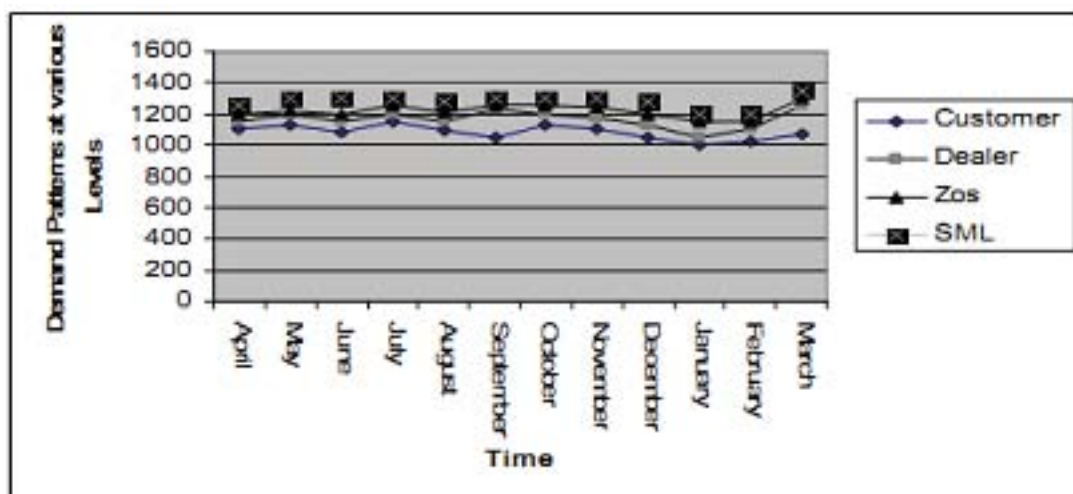|	
Company production	40 vehicles a day
Models offered	10 models with 79 variants
Manufacturing sequence	Based upon demand (flexible manufacturing)
Number of zonal office	10
Number of Dealers	130
Demand variation	Customer demand is assumed to be normally distribute.
Backordering	Backordering is allowed but returns to the factory are not allowed.
Transport lead time	2-3 days (depending upon the location of zonal office/dealers.

2

Figure 5: Figure 2 :

Figure 6: Figure 3 :

Figure 7:

1	2	3	4	5	6
2005-06	Customers	Dealers	ZOs	SML	Dev.(2-5)
April	1100	1150	1200	1250	150
May	1130	1200	1225	1300	170
June	1080	1150	1200	1300	120
July	1150	1200	1250	1300	150
August	1090	1150	1210	1280	190
September	1050	1230	1250	1300	150
October	1130	1200	1250	1300	170
November	1100	1175	1240	1300	200
December	1050	1125	1200	1280	230
January	1000	1050	1150	1200	200
February	1020	1100	1150	1200	180
March	1075	1280	1300	1350	275
Total	12975	13980	14625	15360	2185
% increase	100	107.75	112.72	118.38	16.64

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Figure 8: Figure 4 :

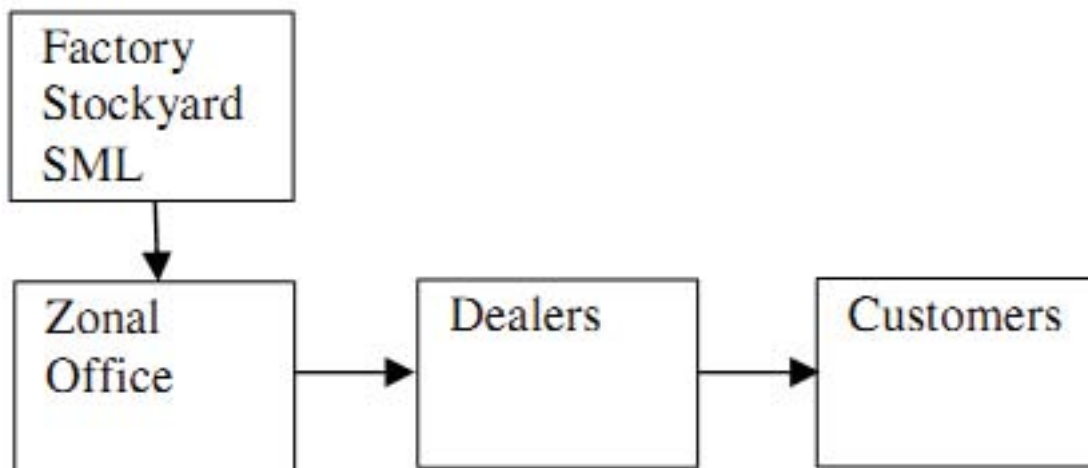| Performance Mreasure	Impact of Bullwhip Effect
Supply chain delevery reliability	
Delevery Performance	Decreased
Fill Rates	Decreased
Order fulfillment	Decreased
Supply chain Responsiveness	
Order fulfillment lead time	Increased
Supply chain flexiability	
Supply chain Response time	Increased
Product flexiability	Decreased
Supply chain costs, and	
Cost of goods sold	Increased
Total supply chain costs	Increased
Management costs	Increased
Value-added Productivity	Decreased
Returns Processing Costs	Increased
Supply chain asset management efficiency	Increased
Cash-to-cash Cycle Time	Increased
Inventoy Days of Supply	

5

Figure 9: Figure 5 :

Figure 10:

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