The analysis of the Bullwhip effect on the supply chain management of perishable products

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Abstract

Wholesale Market is a distributor of vegetables and fruits that places orders for products to suppliers and then distributes them to each retailer, where the distribution destinations that supply vegetables and fruits, Wholesale Market is present in the region of Gafsa, Tunisia. In meeting the demands of retailers, the company exceeds the number of orders to suppliers by 9% to 40% depending on the type of product to anticipate the defects / damage because the product is perishable or not durable. The consideration of overestimating the order was found to have an impact on the bullwhip effect or an increase in demand variability. Therefore, the objective of this study is to determine the value of the bullwhip effect at the distributor, retailer, and product category retailer level, so that the value of the bullwhip effect is the basis for determining the improvement recommendations to overcome the bullwhip effect +problem in the company. The results of the calculations show that the bullwhip effect is 90% at the distributor level, 70.99% at the retailer level, and 70.66% at the retailer level of the product category. The products and categories that experience a bullwhip effect where the BE value is greater than the parameter is influenced by a significant difference between demand and orders, while the products and categories that are in a stable position are influenced by the difference between demand and orders that are not significant so that the BE value does not exceed the parameter.

Key words : *bullwhip effect, Wholesale Market, distributor, retailer, perishable products.*

1. Introduction

Wholesale Market is a distributor of vegetables and fruits whose business is to buy products from suppliers, sort them and distribute them to each retailer. The distribution destinations that supply vegetables and fruits to Wholesale Market are located in the Gafsa region of Tunisia. Since the COVID-19 pandemic, Wholesale Market has been able to maintain its existing distribution network, despite a 46% drop in demand caused by a decrease in consumer demand at the retail level, as well as a decrease in demand from retailers to the company.

To meet the demands of retailers, Wholesale Market places orders with suppliers by exceeding the order amount by 9% - 40% depending on the type of product in order to anticipate product defects/damage

prior to shipment to each retailer, as the company's products are not durable or known to be perishable products. Considering overestimating the order was found to have an impact on the bullwhip effect. Therefore, the objective of this research is to determine the bullwhip effect value at the distributor, retailer, and product category retailer level, so that the bullwhip effect value is the basis for determining improvement recommendations to overcome existing problems.

2. Literature Review

Supply chains connect customers with retailers, manufacturers and suppliers. Decisions made during this process increase or decrease the cost of ownership and the level of service you provide to your customers. One of the phenomena that occurs is the bullwhip effect, which represents the amplification of demand fluctuations upstream in the supply he chain (Lee et al (1997a)).

According to (Lee et al (1997b)), the term bullwhip effect was first used by Procter & Gamble, when they experienced significant amplifications in demand for their diaper product Pampers. (Lee et al (1997a, 1997b)) describe the bullwhip effect as the result of information distortion in a supply chain, where upstream firms lack information about actual consumer demand. As a result, their ordering decisions are based on incoming orders from the downstream firm.

Similarly, (Pujawan & Mahendrawati (2017)), the bullwhip effect is a phenomenon where there is an information distortion in the supply chain that is a source of obstacles to creating an efficient supply chain. When information exists about consumer demand for a product is relatively stable over time, but orders from stores to distributors and from distributors to factories are much more volatile than the pattern of consumer demand. In other words, demand that is actually relatively stable at the end customer level turns into fluctuations up the supply chain, and the higher the level upstream, the greater the increase.

Researchers like (Barlas et al. (2011), Cho & Lee (2012), Zhang & Burke (2011)) point out that demand management is a relevant factor in measuring the impact of the bullwhip effect. The seasonality of demand can cause sales promotions in periods of low demand; Price changes lead to increased sales can be another critical factor that increases the bullwhip effect. References. (Ma et al. (2015), Braz et al. (2018), Zhang & Burke (2011), Zotteri (2013)) give this price variation reinforces the previous order of the chain. This is proposed in this order of ideas (Zhao & Zhao (2015)) indicates that the price variation is the most crucial cause of the bullwhip effect.

According to (Pujawan & Mahendrawathi, (2017)), the information distortion in the supply chain called bullwhip effect is caused by several things, including demand forecast update, order batching, price fluctuations, and the game of rationing and shortage. Meanwhile, the reduction of bullwhip effect can be done if the parties in the supply chain understand the causes well, including sharing information, shortening or changing the structure of the supply chain, reducing fixed costs, creating price stability and reducing lead time.

3. Methodology

The calculation of the bullwhip effect performed refers to (Pujawan & Mahendrawati (2017)) and (Holmström (1997)) using the demand and order data which can be systematically formulated as follows:

$$\text{BE} = \frac{CV\ orde}{CV\ demand} = \frac{\frac{S\ order}{mu\ order}}{\frac{S\ demand}{mu\ demand}} \quad (1)$$

One of the publications that discuss how the bullwhip effect is measured is (Fransoo & Wouters (2000)), where they propose a measure of the bullwhip effect parameter that can be systematically formulated as follows:

$$\text{Parameter} = 1 + \frac{2L}{P} + \frac{2L^2}{P^2} \quad (2)$$

With conditions :

- ✓ If the value of a bullwhip effect > parameter, then there is an amplification of demand or an increase in demand variability for the product.
- ✓ If the value of a bullwhip effect < parameter, demand is still stable

Where:

BE = Bullwhip effect

mu = Mean

CV = Coefficient of Variance

L = Lead time

S = Standard deviation

P = Period

4. Results and Discussion

The demand data is obtained from the company's retailer demand data, while the order data is obtained from the wholesale market order data to suppliers or farmers for tomato (T), bell pepper (P), potato (PT), carrot (C), melon (M), and lemon (L) products which are presented in the following graph:

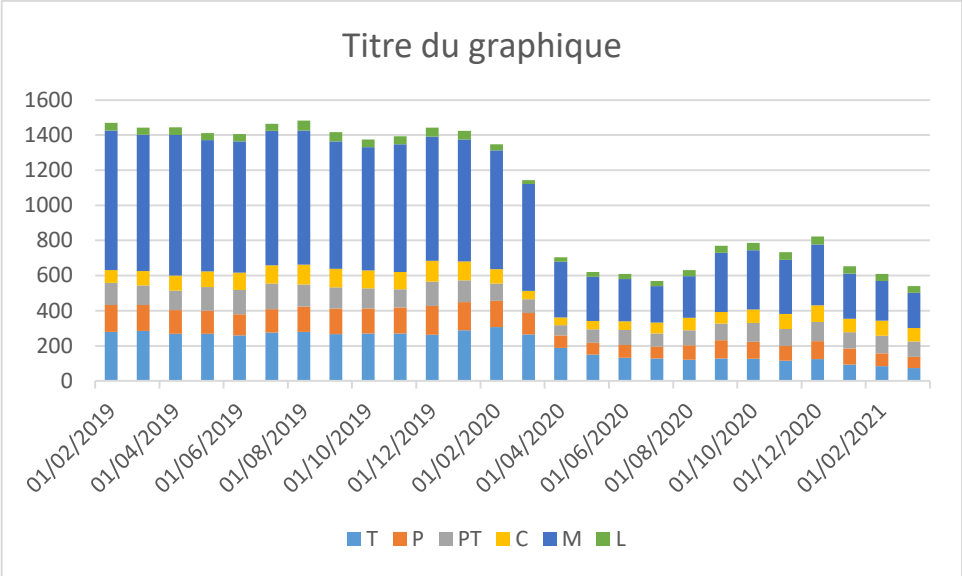

Figure 1. Demand Graph

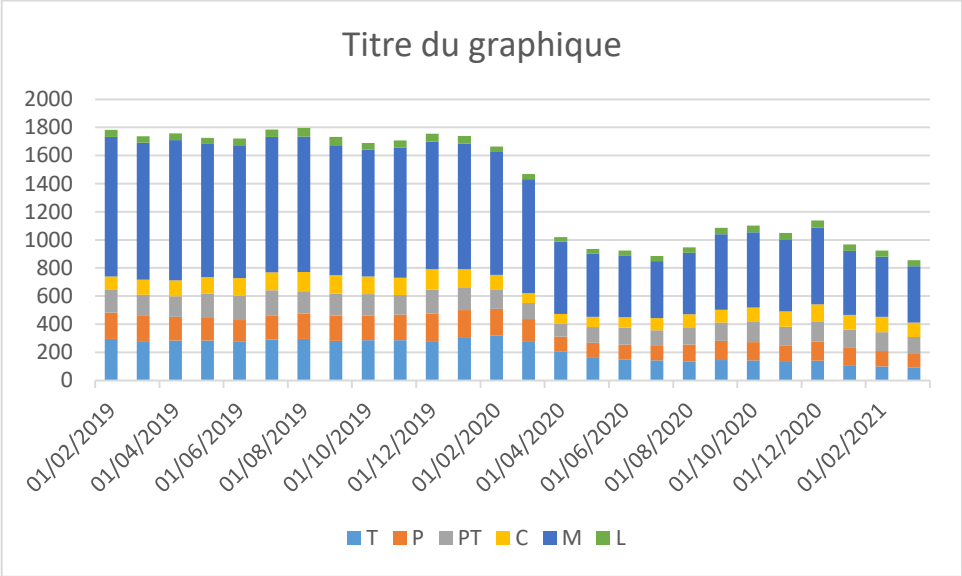

Figure 2. Order graph

The calculation of the bullwhip effect parameter is performed as a reference for the value of the occurrence of the bullwhip effect on each product studied. If the procurement lead time is 1 day and the period is 26 months with 1 month = 30 orders, then :

$$\text{Parameter} = 1 + \frac{2*1}{780} + \frac{2*1^2}{780^2} \quad (3)$$

4.1. Distributor-level bullwhip effect

Based on the above demand and order data, the value of the distributor-level bullwhip effect for each product is as follows:

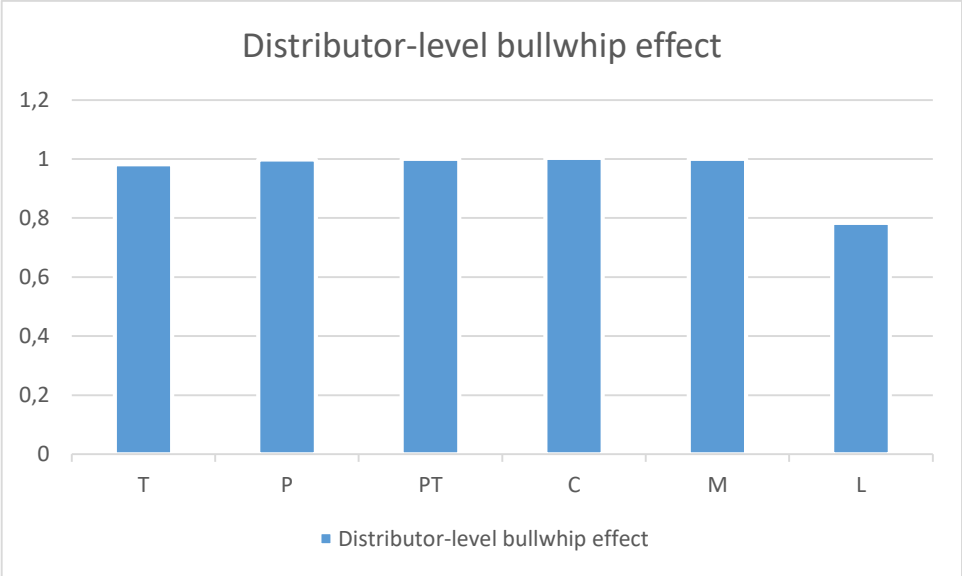

Figure 3. Distributor-level bullwhip effect

4.2. The bullwhip effect at the retailer level

While the value of the retailer-level bullwhip effect on the three retailers and each product based on equation 2, namely:

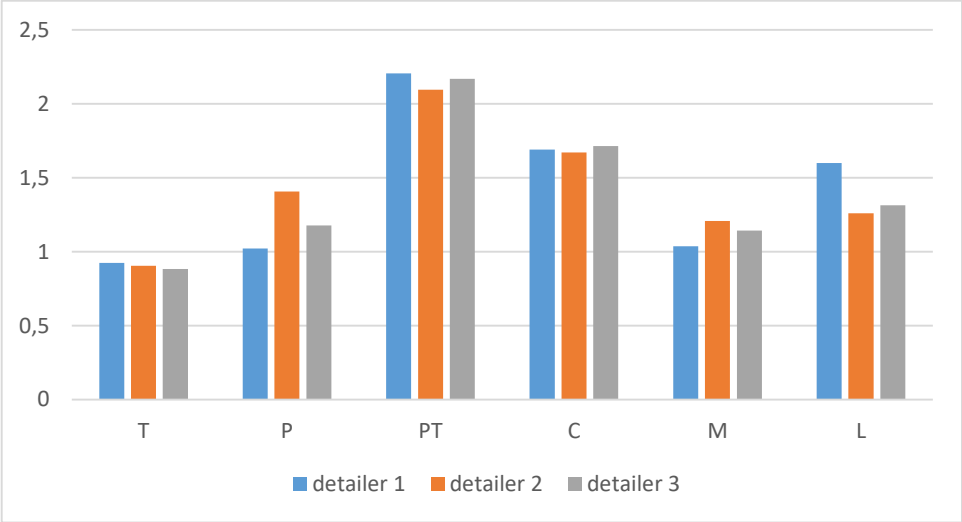

Figure 4. Retailer Bullwhip Effect

4.3. Bullwhip effect at the retailer level of the product category

While at the retailer level, the product category is divided into 2 categories, namely the vegetable categories including tomatoes (T), peppers (P), potatoes (PT) and carrots (C) while the fruit category includes melon (M) and lemon (L). Thus, the bullwhip effect value in each category is :

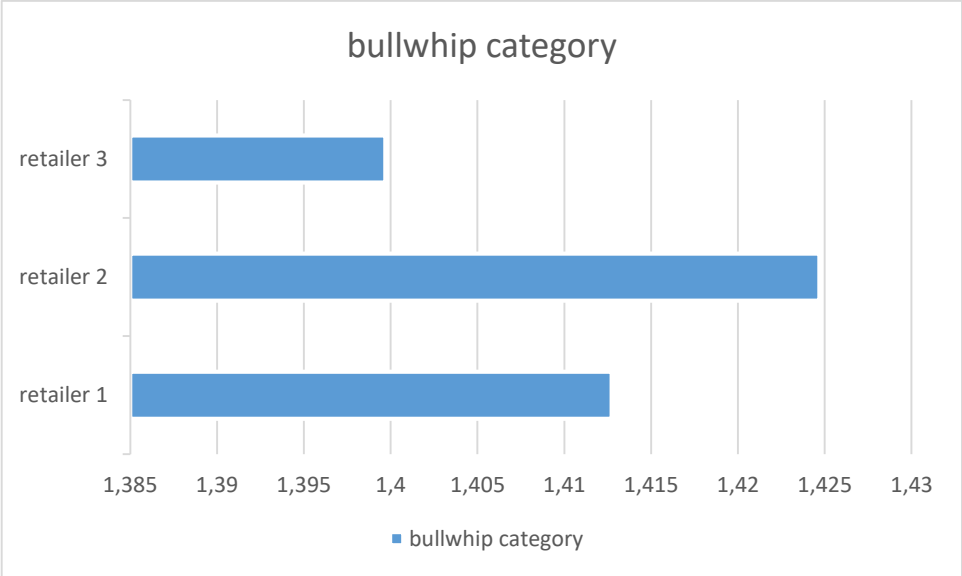

Figure 5. Bullwhip effect at retailer level for product category

The BE value calculation above shows that there is a demand amplification or pumping effect of 90% at the distributor level, 70.99% at the retailer level, and 70.66% at the retailer level of the product category. Based on these calculations, the BE value marked in green is a stable product or category where the BE value is below the parameter of 1.00257. Other than that, products and categories experience demand amplification or increase in demand variability when the BE value is above the 1.00257 parameter. The increase in demand variability at these three levels is influenced by the instability of demand during the study period, so that there is a significant difference between demand and orders, which leads to an increase in the BE value. Meanwhile, some stable products and categories are influenced by insignificant differences in demand and orders so that the BE value does not exceed the parameter.

Based on the high value of the bullwhip effect at both the distributor, retailer, and product category retailer levels, corrective action is needed. Suggested recommendations for minimizing the bullwhip effect include periodically analyzing the renewal of customer trends so that consumer needs can continue to be matched to the company's products and appropriately handling perishable products, such as purchasing refrigerators to maintain the product's shelf life so that it does not deteriorate quickly.

5. Conclusion

Based on the results of the above analysis and discussion, the conclusions that can be drawn from this study are as follows:

- ✓ The calculation of the bullwhip effect in this study was done at the distributor, retailer, and product category retailer levels.

- ✓ Based on the calculation, it shows the occurrence of bullwhip effect on 90% of the products at the distributor level, 70.99% of the products at the retailer level, and 70.66% of the categories at the retailer level of the product category.
- ✓ Products and categories with increased demand variability where the BE value is greater than the parameter (1.00257) are influenced by demand instability during the study period such that there is a significant difference between demand and orders. While stable products and categories are influenced by insignificant differences between demand and orders so that the BE value does not exceed the parameter.

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