



Analysis of supply chain management in overcoming the bullwhip effect of mineral water

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ABSTRACT

This study aims to identify the cause of the bullwhip effect and find solutions to overcome it. The research object is the demand and sale of mineral water for January – May 2021 at Alfamart SPBU BIMA Cirebon. The phenomenon of changes in customer demand which is relatively stable every day for weekly or bi-weekly orders from the Cirebon Distribution Center (DC), will receive orders that are more stable than the demand faced by retail companies. Sole distributor demand will also be stable, impacting the costs incurred by companies in storage. One way to analyze some of the causes of the bullwhip effect in a company is to analyze the factors causing it so that the supply chain of mineral water products runs smoothly. The bullwhip value needs to be measured to determine the bullwhip effect can be done using the data aggregation method by Fransoo and Wouters.

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INTRODUCTION

The supply chain strategy is evolving in tandem with the growing requirement for businesses to cut costs across the board. One of the issues that develop is a lack of coordination and information flow, which frequently distorts data, one of which is the occurrence of greater demand amplification in the upstream channel compared to the downstream channel, a phenomenon known as the bullwhip effect. In this situation, the supply chain system's job is to deliver the appropriate product or service to the right place, at the right time, and under the right circumstances. Logistics has evolved from inventory management and transportation to include more value-added goods and services as a result of technological advancements. Supply Chain Management (Supply Chain Management) is a study of the efficiency and effectiveness of the simultaneous flow of commodities, information, and money to unify the supply chain and the parties involved.

Upstream and downstream synchronization and coordination are at the heart of the supply chain. This is important in order to keep a chain from becoming ineffective. A supply chain can be used to connect manufacturers, suppliers, retailers, and sellers in order to produce and distribute items in the proper amounts and at the lowest possible cost. It is necessary to create a map of the

overall logistics and distribution system in order to see the product flow movement planned for distribution in each element in order to establish an effective and efficient supply chain. Coordination between supply chain participants is required to deliver the desired service. Misinformation is frequently the result of a lack of coordination, one of which is the volatility in demand that occurs in the supply chain channel. This variance causes a bullwhip effect in the downstream direction, which affects retailers and end-users, and is known as the "bullwhip effect." The upstream direction, on the other hand, is directly tied to production. According (Hasanah, 2015), the increasing development of retail businesses, both large and small, and a large number of supermarkets/minimarkets in various regions creates competitive competition in the retail business, where every supermarket/minimarket tries to gain the broadest possible market share, and as many consumers as possible. -a lot. There are times when customers need an item, especially merchandise, which usually cycles quickly (fast-moving) at a specific time, and it turns out that the item's stock is out of stock. This phenomenon will worsen the retailer's image in its business activities further; the unavailability of merchandise indicates the retailer's inability to manage the existing merchandise inventory. The condition of unavailability of merchandise (out of stock) should be avoided by retailers.

According to Peter J Metz, in his article "Demystifying Supply Chain Management," companies can gain advantages such as reducing finished goods inventory, decreasing out-of-stock incidents, increasing company income, reducing cumulative cycle time, and on-time delivery by utilizing the concept of supply chain management. increases, inventory costs drop, and the total cost share of revenue decreases. Meanwhile, according to (Sari et al., 2021), applying supply chain management has the benefit of lowering inventory levels. Inventory items that are corporate assets range from 30% to 40% of total assets, while inventory charges range from 20% to 40% of the value of products stored. The supply chain can assure the smooth flow of goods.

According to David Simchi-Levi (2000) in the book *Designing and Managing the Supply Chain*, the bullwhip effect is defined as "increased variability from the lower level to the upper level and in a supply chain network," As a result of information distortion, the bullwhip effect can be defined as an increase in demand variability at each level of the supply chain. In this case, the company lacks accurate demand information (Larson, 2001) inaccurate or distorted information at each level of the supply chain, from bottom to top, can result in a variety of issues, including excessive inventory, revenue loss, and declining sales. Customer satisfaction, ineffective delivery, scheduling problems, and wasteful use of resources are all factors to consider. How many orders (quantity), how much inventory (inventory policy) you keep, and how much it costs all depend on the length of the marketing chain.

Oliver & Weber first proposed the term Supply Chain Management (SCM) was first proposed by Oliver & Weber in thousand nine hundred and eighty-two (Putra & Putra, 2018). Supply chain management is oriented to the internal affairs of a company and external affairs concerning relations with partner companies (Hidayat et al., 2017). Supply Chain Management is a complex process that requires the coordination of many activities so that the delivery of goods and services from suppliers to customers is carried out efficiently and effectively for all parties involved (Warella et al., 2021). A supply chain is a network of companies that work together to create and deliver a product to the end-user. These companies usually include suppliers, manufacturers, distributors, shops, or retailers, as well as supporting companies such as logistics service companies (Katili et al., 2020).

Supply Chain Management is the management of various activities of procuring materials and services, converting them into semi-finished goods and final products, and sending products through a distribution system (Manambing et al., 2014). From the understanding stated above, it can be concluded that supply chain management is an integration and coordination system in planning, designing, and controlling the flow of information and materials so that goods can arrive in the hands of consumers quickly and accurately.

There are three types of flows that must be handled in a supply chain. The first is the movement of products from upstream to downstream. Raw materials transported from suppliers to plants are an example. After the products are completed being manufactured, they are sent to distributors, merchants, and finally end-users. The second is the movement of money and other goods from upstream to downstream. The third is information flow, which can happen from upstream to downstream or vice versa.

Marshal Fisher, a professor at the Wharton School, the University of Pennsylvania, clarifies activities in the supply chain into 2, namely (Cachon & Fisher, 2000) : (1). Market mediation activities are aimed at finding common ground between what consumers or customers want and what the supply chain produces and delivers. (2). Physical activities, namely activities to obtain raw materials, convert raw materials and components into finished products, storage and delivery to the hands of customers.

Incomplete information flow can cause many problems that affect the total cost of production, for example, the possibility of stock-outs that can cause rush orders and excess stock that causes phantom orders. Another problem that may arise due to inaccurate information flow is sales promotion costs and discount costs. This cost arises because the process of delivering goods to final consumers is not on time, which allows customers not to buy, so the company must bear lost sales.

The condition described earlier is referred to as the bullwhip effect, namely forecasting the number of requests that will occur will fluctuate even more if the information system in SCM is bad, meaning that if the conditions are, manufacturing is getting upstream so that the company cannot supply the existing quantity of demand, the Bullwhip effect is identical to the occurrence of distortion of demand information from the lower chain / downstream / end-user to the chain above it so that the quantity of demand often cannot be fulfilled optimally (meaning that the quantity and time are not right).

There are four factors that cause the Bullwhip effect, including Schroeder (Paminto & Adhimursandi, 2021) : a. Inaccurate demand forecasting because the Information sharing process is not appropriate. Forecasting solutions can be done by using the smoothing method from the historical data of the entire existing sales; b. Order batching can occur if there is a buildup of orders; c. Price fluctuations can trigger a Bullwhip effect because if there is a discount rush demand and, it will cause a material rush order, meaning that completing the fulfillment of increased demand will cause problems in other chains because the material rush order will increase, the possibility of ordering costs will be high, and vice versa; d. Rationing means that if demand exceeds the existing supply, the demand will be rationed using the same ratio for the order. According to Simchi – Levi (2004), the main causes of the Bullwhip effect are five, namely: a. *Demand Forecasting* → Additional orders result in higher demand forecasts. A possible solution is to provide data on consumer demand directly to upstream companies further down the supply chain; b. *Lead Tim* → defined as the length of time the order arrives received by the retailer. Lead time can increase the Bullwhip effect by increasing the variability in demand forecasting, including length of lead time, amount of demand, and inventory levels; b. *Batch Ordering* → is when the manufacturer looks at the size of the order, followed by several periods of no order, followed by another order, and so on, then the manufacturer looks at the deviation and the highest variable from the order. c. *Supply Shortages* → if the demand exceeds the existing supply, then the demand will be rationed in the same ratio as the number of products they ordered. To overcome this, consumers will exceed the demand they ordered. If the demand decreases, there will be a cancellation of the order, which is often referred to as a phantom order; d. *Price Variation* → The last cause is the frequency of variation in overall costs in the supply chain. For example, many retailers spend a lot of money on promotions.

Changes in ultimate consumer demand, which is reasonably consistent from day to day, will become weekly or biweekly orders from retail companies, causing distribution centers to get orders that are more unpredictable than retail company demand. The demand for sole distributors will

fluctuate, affecting the storage costs that the corporation will have to pay. However, to achieve the goals mentioned above, Alfamart SPBU BIMA Cirebon is still experiencing stock or running out of stock, especially Mineral Water products. This indicates that the retail store is still having difficulty determining the amount of inventory that must be available. In other words, it is still experiencing difficulties in controlling merchandise inventory. Likewise, Alfamart SPBU BIMA Cirebon is still experiencing stock or running out of stock, especially Mineral Water products. Below are sales data and out-of-stock for February 2021: Sales data and empty goods at Alfamart BIMA Cirebon gas station Sales data mineral water Plu 142579 Aqua Air Pet 330 ml Stock Out/day 118/8; Plu 5868 Aqua Air Pet 600 ml Stock Out / day 580/6; Plu 5867 Aqua Air Pet 1500 ml; Plu 5867 Aqua Air Pet 1500 ml Stock Out / day 68/2; Plu 125034 Aqua Air Click & Go Pet 750 ml Stock Out / day 54/3; Plu 990055 Le Mineral Air Pet 600 ml Stock Out / day 421/4; Plu 101642 NPL Air Pet 600 ml Stock Out / day 253/5; Plu 120607 Ades 600 ml Stock Out / day 83/1; Plu 414565 Alfamart Air Pet 500ml Stock Out / day 115/1; Plu 414566 Alfamart Air Pet 1500 ml Stock Out / day 45/1; Plu 404759 bLe Mineral Air Pet 1500 ml Stock Out / day 38/ 3.

From the data above, it can be seen that Alfamart SPBU BIMA Cirebon has not been able to manage the unavailability (out of stock) of merchandise that occurs, especially Mineral Water products. One way to analyze several factors that cause the bullwhip effect in a company is to analyze the factors that cause it to occur. Questions and answers with retailers are necessary for fulfilling information on problems that occur and efforts to be taken to resolve company problems. As the factors that can trigger the bullwhip effect in the supply chain, it is necessary to analyze how far the influence of the bullwhip effect and other causal factors is. The magnitude of the value of the bullwhip effect needs to be measured to determine the bullwhip effect, which can be done using the data aggregation method by Fransoo and Wouters.

RESEARCH METHOD

This research was conducted at the Alfamart BIMA Cirebon gas station located at Jalan Brigjen Darsono Kesambi, Cirebon. The location of the research was chosen deliberately based on the consideration that Alfamart SPBU BIMA Cirebon is one of the minimarkets that provides needed materials. Data collection was carried out in early February 2021. In this study, the population will be the inventory control data for the Mineral Water category at Alfamart SPBU BIMA Cirebon from January to March 2021. In this research, the sample is inventory control data category. Mineral water is available at Alfamart SPBU BIMA Cirebon from January to March 2021.

Data collection is a systematic and standard procedure to obtain the required data (Suliyanto, 2018). Secondary data collection methods are taken from sales data of Alfamart SPBU BIMA Cirebon, among others, namely sales data, inventory data, and data distribution of goods carried out by the distribution center (DC). Data Analysis Techniques using by Fransoo and Wouters. Bullwhip Effect Measurements. According to (Fransoo & Wouters, 2000), there are several methods to measure the bullwhip effect: 1). Order data aggregation of requests. 2). List the various causes of the bullwhip effect. One of the publications discussed how the Bullwhip Effect was measured by Fransoo and Wouters in 2000 (in Mahendrawati, 2010). They proposed a measure of the Bullwhip Effect in an echelon of the Supply Chain as a comparison between the coefficient of variation of the order created and the coefficient of variation of the demand received by the echelon that was created. The formulas used are (1)-(3)(ER & Pujawan., 2010).

$$CV (Order) = \frac{S (Order)}{Mu (Order)} \quad (1)$$

$$CV (demand) = \frac{S (demand)}{Mu (demand)} \quad (2)$$

$$BE = \frac{CV(Order)}{CV(demand)} \quad (3)$$

Where :

CV (<i>Order</i>)	: coefficient of variation of demand (<i>Order</i>)
CV (<i>Demand</i>)	: coefficient of variation in sales (<i>Demand</i>)
S (<i>Order</i>)	: standard deviation of demand (<i>Order</i>)
Mu (<i>Order</i>)	: average demand (<i>Order</i>)
S (<i>Demand</i>)	: standard deviation of sales (<i>Demand</i>)
Mu (<i>Demand</i>)	: average demand (<i>Demand</i>)
BE	: <i>Bullwhip Effect</i>

A supply chain consists of several echelons. In this case, we can measure the value of the amplification or surge in demand at each retail, namely by calculating the average sales and demand, calculating the standard deviation of sales and demand, calculating the coefficient of variability (CV) of sales and demand and then calculating the value of the Bullwhip Effect, namely dividing the coefficient of variability (CV) of demand by the coefficient of variability (CV) of sales. The formulas used in Microsoft Office Excel 2010 are as follows:

Table 1. Formula calculation table in Microsoft office excel 2010

No	Name	Formula
1	Average	AVERAGE (...)
2	Standard deviation	STDEV (...)
3	Sales variability coefficient	STDV / Average
4	Coefficient of demand variability	STDV / Average
5	<i>Bullwhip Effect</i>	CV order / CV demand
		Lead time 1 day and observation 5 months or 150 then:
		$1 + \frac{2xL}{p} + \frac{2xL^2}{p^2}$
6	Parameter <i>Bullwhip Effect</i>	$1 + \frac{2x1}{150} + \frac{2x1^2}{150^2}$
		= 1.01342
		And (no 5 <= no 6) When it happens
7	Information	Bullwhip Effect automatically value will be false and otherwise will be true.

Based on the description that has been conveyed above regarding the effect of stock availability in order to increase sales, the framework of thought that will be presented is as follows:

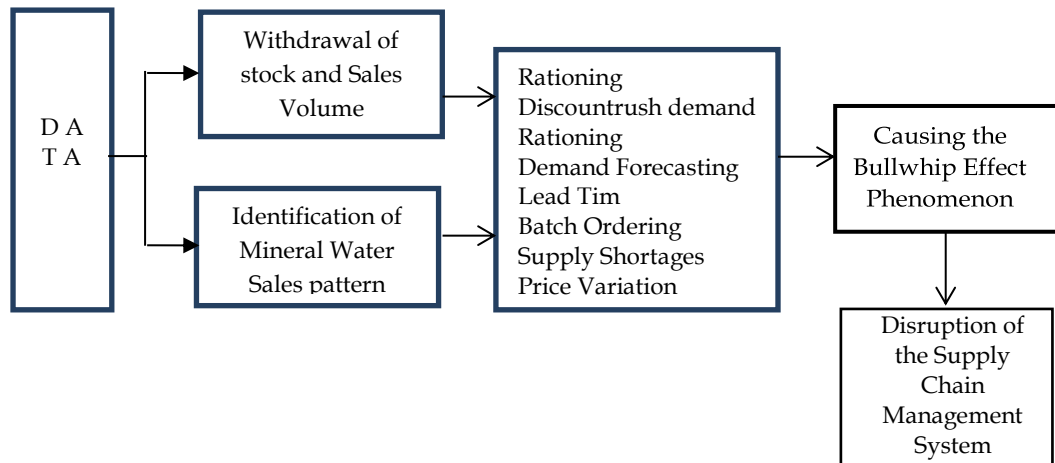


Figure 1. Conceptual framework

RESULTS AND DISCUSSIONS

The data taken is a report from the Alfamart Bima Cirebon sales database for the period January 2021 - May 2021 as follows:

Table 2. Sales data for January - May 2021

No.	DESCP	Tag-Prod	MPKM	PKM	Jan		Feb		Mar		Apr		Mei	
					OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales
1	Aqua Air Pet 330ML	F	80	240	6	74	-	275	2	176	-	254	1	169
2	Aqua Air Pet 600ML	F	358	2,830	12	726	6	1,293	3	1,516	1	1,863	-	2,022
3	Aqua Air Pet 1500ML	F	128	500	8	292	-	372	-	384	-	404	-	418
4	Aqua Air Click&Go Pet 750ML Le	F	58	62	7	88	-	171	1	117	10	59	6	83
5	Minerale Air Pet 600ML Le	F	264	2,230	9	376	-	916	-	917	-	952	-	817
6	Minerale Air Pet 1500ML	F	67	200	8	84	-	224	2	154	-	232	-	221
7	NPL Air PET 600ML	F	78	79	11	74	-	198	-	196	-	144	-	129
8	Ades Air Pet 600ML	F	42	73	15	46	-	309	-	129	-	88	-	262
9	Alfamart Air Pet 550ML	F	127	600	12	175	-	314	-	429	-	551	-	376

No.	DESCP	Tag-Prod	MPKM	PKM	Jan		Feb		Mar		Apr		Mei	
					OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales	OOS	Qty – Sales
10	Alfamart Air Pet 1500ML	F	39	43	10	46	4	56	-	112	2	68	-	144

In supply chain management, there are four supply chain performance drivers whose aim is to achieve the desired response level at the lowest possible cost, thereby increasing more profound returns in the supply chain and the company's financial performance (Hasibuan et al., 2021), including the following:

A facility is a place or location in the supply chain stage where products are stored, assembled, or produced. Two types of these facilities are production sites and storage areas. Decisions in facilities affect the role, location, and capacity that have an essential influence on supply chain performance in the form of a warehouse located on Jl. Prince Antasari Blok Kebuyan RT 013/ 005, Village Head, Kec. Plumbon, Cirebon City, West Java. Storage facilities in the form of warehouses as storage facilities for product marketing purposes. Products are stored in warehouses to be able to meet consumer needs on time. The function of warehouse activities is to maintain and protect goods until they are used, which can be divided into four parts, namely: a. Operational Warehouse: Is a warehouse that stores raw materials, semi-finished goods, or goods in the production process. This item is prepared for use in the following production process; b. Equipment Warehouse Is a warehouse to store work tools, lubricants, or other items needed in the production process that are not found in the final product. These goods are used in the production process, after which they are returned to the warehouse; c. Shipping Warehouse; a storage place for the production process results, which is usually called a finished goods warehouse; d. Seasonal Warehouse; This Is a warehouse needed by specific industries seasonally, so it must have a storage area.

DC Alfamart Cirebon, Which is located on Jl. Prince Antasari Blok Kebuyan RT 013/ 005, Village Head, Kec. Plumbon, Cirebon City, West Java is its own property used for storage according to its function. In general, the types of warehousing are divided into 6 (six) types of warehouses commonly used by business actors, namely:

General merchandise warehouse.

This warehouse is usually used as a storage place for finished goods by manufacturers and distributors to store products practically. As we know, Alfamart is a company engaged in the retail business; of course, every shophouse sells ready-to-use finished goods distributed through Alfamart warehouses.

Cold storage warehouse (refrigerator or cold storage warehouse)

This type of warehouse provides a temperature-controlled warehouse storage environment. Usually, this type of warehouse is used to store products that are perishable, frozen, and cannot be kept at hot temperatures. For example, frozen chocolate, Nugget, ice cream, and also certain drinks.

Warehouses with duty/tax (bonded warehouses)

This type of warehouse usually stores goods such as imported tobacco and alcoholic beverages. And the government is in control of the distribution of these goods to the market, and importers usually have to pay excise duties. In contrast to Alfamart warehouse, Alfamart does sell goods containing tobacco, there are also alcoholic beverages, but alcoholic beverages are very low and are not imported. So Alfamart warehousing is not suitable for us to compare with this type of warehouse.

Household goods warehouse

This type of warehousing is used for the storage of personal property. Properties that are specifically stored for a long period of time are temporary. For this type of warehouse, it is not suitable for us to compare it with Alfamart warehousing. Because Alfamart warehouse is a warehouse for business entities, not private.

The stages of data processing carried out in this study are to calculate the value of the Bullwhip Effect for each brand and type of mineral water product at the Bima Cirebon gas station as follows:

Table 3. Mineral water products that are experiencing (Bullwhip effect)

No	Brand	Item	List	Total	Average	Standart Dev	Koef Variasi	Bullwhip Effect	Parameter	Note
1	Aqua	Aqua Air Pet 330ML	Sales	948	190	79.71	42.0	1.039760649	1.01342	FALSE
		Aqua Air Pet 330ML	Demand	957	191	77.39	40.4			
		Aqua Air Pet 600ML	Sales	7420	1,484	511.16	34.4	1.012425165	1.01342	TRUE
		Aqua Air Pet 600ML	Demand	7442	1,488	506.39	34.0			
		Aqua Air Pet 1500ML	Sales	1870	374	49.15	13.1	1.076986085	1.01342	FALSE
		Aqua Air Pet 1500ML	Demand	1878	376	45.83	12.2			
		Aqua Air Click&Go Pet 750ML	Sales	518	104	42.31	40.8	1.108441386	1.01342	FALSE
		Aqua Air Click&Go Pet 750ML	Demand	542	108	39.94	36.8			
2	Le Minarale	Le Minarale Mineral e Air Pet 600ML	Sales	3978	796	239.90	30.2	1.018970854	1.01342	FALSE
		Le Minarale Mineral e Air Pet 600ML	Demand	3987	797	235.97	29.6			
		Le Minarale Mineral e Air Pet 1500ML	Sales	915	183	63.58	34.7	1.066903916	1.01342	FALSE
		Le Minarale Mineral e Air Pet 1500ML	Demand	925	185	60.24	32.6			
3	NPL	Npl Air Pet 600ML	Sales	741	148	51.62	34.8	1.096950552	1.01342	FALSE
		Npl Air Pet 600ML	Demand	752	150	47.75	31.8			
4	Ades	Ades Air Pet 600ML	Sales	834	167	113.48	68.0	1.053821303	1.01342	FALSE
		Ades Air Pet 600ML	Demand	849	170	109.63	64.6			
5	Alfamart	Alfamart Air Pet 550ML	Sales	1845	369	139.13	37.7	1.037380003	1.01342	FALSE
		Alfamart Air Pet 550ML	Demand	1857	371	134.99	36.3			
		Alfamart Air Pet 1500ML	Sales	426	85	41.41	48.6	1.12428049	1.01342	FALSE
		Alfamart Air Pet 1500ML	Demand	442	88	38.22	43.2			

In table 3 above, it can be seen that the bullwift effect occurs in all brands and types of drinking water because the above > parameter value is 1.01342, except for AQUA AIR PET 600ML < from parameter value Special commodity warehouse. This type of warehousing has many differences from the warehousing system implemented in Alfamart warehouses. Because this type of warehouse only stores one type of product, Alfamart stores almost thousands of products, and usually, this type of warehouse stores agricultural products.

Bulk storage warehouses; This type of warehousing is also not suitable if we compare it with Alfamart warehousing because this warehousing system usually stores hazardous products such as chemicals, oil, and coal. Very different from Alfamart because of Alfamart stores household products.

Inventory / Inventory; Inventory includes raw materials, work in process, and finished goods in the supply chain. If the supply chain inventory policy is changed, it will change the level of responsiveness and accuracy.

Transportation; Transportation is a vehicle that transports all supplies from one location point to another. Transportation has a variety of forms and various routes taken according to their respective advantages.

Information; Information is data about facilities, inventory, transportation, costs, prices, and customers in the supply chain process. Information has the greatest influence on supply chain performance because it affects each other's performance drivers.

By looking at the cases that occurred above, to improve the occurrence of the bullwhip effect, the efforts that can be carried out include the following: a. Place an order for a product at a manufacture or factor or product maker by paying attention to the amount of existing inventory and paying attention to the level of sales so that after the product. So the number of requests is proportional to the number of sales; b. In anticipating the occurrence of fluctuations in demand, we must pay attention to the inventory of goods in the warehouse so that we can anticipate the sale of goods and the rate of demand; c. Immediately confirm with the manufacturer or factor or product maker if there is an increase in demand so that the flow of information does not experience delays and that the flow of information regarding product requests becomes smooth.

Keep the lead time stable by making requests to manufacturer or factories or product makers according to the level of need so that there is no excessive demand.

CONCLUSION

From the Presentation of Supply Chain Analysis and the bullwhip effect in the previous chapter, it can be concluded that: a. Based on the results of calculations at Alfamart Bima Branch, it can be seen the occurrence of a bullwhip effect on the product: AQUA AIR PET 330ML 1.03976 > Parameter Value 1.01342, AQUA AIR PET 1500ML 1.0769 > Parameter Value 1.01342, AQUA AIR CLICK&GO PET 750ML 1.1084 > Parameter Value 1.01342, LE MINERALE WATER PET 600ML 1.0189 > Parameter Value 1.01342, LE MINERALE WATER PET 1500ML 1.06690 > Parameter Value 1.01342, NPL AIR PET 600ML 1.09695 > Parameter Value 1.01342, ADES WATER PET 600ML 1.05382 > Parameter Value 1.01342, ALFAMART WATER PET 550ML 1.0373 > Parameter Value 1.01342, ALFAMART WATER PET 1500ML 1.1242 > Parameter Value 1.01342; b. Meanwhile, from the product calculation, there is no bull AQUA AIR PET 600ML with a BE value of 1.0124 < from the Parameter Value of 1.01342; c. Efforts to improve the Bullwhip Effect include ordering products in manufacturers to pay attention to the amount of existing inventory and pay attention to the level of sales so that the number of requests is proportional to the number of sales, maintaining the flow of information on demand and product sales, and maintain a stable lead time.

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