Supply Chain Management Analysis of Sport Obermeyer

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Abstract. Sport Obermeyer, an Aspen-based skiwear manufacturer, operates in an intricate global supply chain, facing unique challenges associated with forecasting demand and managing inventory. Navigating the sportswear market, which is marked by rapid trend changes and seasonal fluctuations, adds an additional layer of complexity. This study examines the operational challenges and inventory management of Sport Obermeyer. We delve into the company's supply chain dynamics, identifying complexities like uncertain demand and long lead times. The Economic Order Quantity (EOQ) method is analyzed for inventory management, but limitations are recognized due to uncertainty in defining key parameters. The importance of service levels in decision-making is highlighted, with a revised EOQ approach proposed. We suggest a production allocation strategy between Hong Kong and China, using the coefficient of variation and z-scores to assess risk and excess inventory. Four key recommendations are made - strategic production allocation, adoption of Just-In-Time (JIT) production, implementation of reliable demand forecasting, and enhancement of employee training. The study acknowledges inherent limitations and future influences including climate change and the COVID-19 pandemic on the industry. The study underlines the need for strategic preparedness for unexpected scenarios to ensure Sport Obermeyer's sustained success.

Keywords: Inventory Management, Operational Strategy, Supply Chain Optimization.

1 Introduction

Established in the mid-20th century by the visionary Klaus Obermeyer, Sport Obermeyer has cemented its status in the winter sportswear industry, renowned for its unyielding commitment to quality and innovation [1]. Over the decades, the firm has transformed remarkably from a humble enterprise in Aspen, Colorado, to a global powerhouse in many countries. This achievement attests to its strategic prowess and determination [2]. Sport Obermeyer's global operational structure adds complexity to its supply chain management. With its design and marketing headquarters still resid-

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ing in Aspen and its manufacturing facilities spread across various international locations, the firm faces inherent challenges associated with the winter sportswear industry. This includes managing the unpredictability of demand and extended lead times, significantly complicating supply chain operations [3]. Therefore, refining the supply chain management strategy is not merely an operational necessity for Obermeyer, but a critical component of its competitive strategy, as has been the case for other businesses operating in similarly unpredictable markets [4]. Mastering the nuances of demand forecasting and inventory management has thus emerged as a critical strategic imperative.

The academic community's interest in supply chain management has surged over the past few decades, with numerous studies illuminating critical aspects affecting its effectiveness. One such contribution is Fisher's product-process matrix, an innovative concept that stresses the need to align a product's supply chain with its demand characteristics [5]. The theory holds that firms can optimize their operational performance by effectively managing this alignment. Sport Obermeyer's struggle lies in reconciling its rigid supply framework with the inherently erratic and unpredictable demand it faces in the market. The research by Lee et al. complements this perspective, who delved into the intricacies of the 'bullwhip effect,' a phenomenon characterized by escalating variability within the supply chain [6]. Their work underscored the significance of strategies, e.g., information sharing and lead-time reduction as critical methods to mitigate the reverberations of this effect. Ferdows and De Meyer further enriched this knowledge by examining lead time compression, arguing its crucial role in boosting competitive performance in industries plagued with demand uncertainty [7]. Despite the depth and breadth of these investigations, a conspicuous gap in the literature remains. The supply chain management strategies designed specifically for the skiwear industry are inadequately explored, leaving firms like Sport Obermeyer with a dearth of strategies that address their unique challenge of concurrently managing demand uncertainty and lead times [8, 9].

Motivated by the desire to augment this body of knowledge and provide practical insights to firms grappling with similar challenges as Sport Obermeyer, this paper aims to delve deeper into how such firms can harmonize their supply chain operations with the volatile demand uncertainties and lead-time complexities inherent in their industry. The goal is to build upon existing literature, adapting and refining it to suit the unique circumstances of the winter sportswear industry. The following sections of this paper will detail the data sources and descriptions underpinning our supply chain analysis, along with the requisite calculations. Then we will present a comparative analysis of Sport Obermeyer's subcontractor factories in China and Hong Kong, examining their specific characteristics and potential implications for the overall supply chain. After that, we will critically evaluate two key order decisions made by Sport Obermeyer in the context of the broader scope of supply chain management. Concluding the paper, we will reflect on the study's limitations and prospects and encapsulate the findings in a comprehensive summary. The overarching aim is to present a robust and practical supply chain management analysis within a highly seasonal and unpredictable industry, with Sport Obermeyer as the focal case study.

2 Methodology

2.1 EOQ Method

EOQ model suggests the most cost-effective order size. It is one of the most traditional production planning models. Companies can use this technique to reduce order and store-holding expenses. This can be a useful tool for businesses to decide how much inventory to carry, how many things to order each time, and how frequently to reorder to yield the lowest potential cost [10]. Demand, ordering costs, holding costs, and lead time should be considered when applying the method. First, the EOQ method assumes that demand for a product is constant and known with certainty over a specific period, usually annually or monthly. Second, ordering costs are the expenses incurred each time an order is placed. They can include administrative, processing, transportation, and any other relevant expenses directly associated with placing an order. Third, holding Costs are the expenses incurred for holding or carrying inventory over a specific period. These costs may include warehousing expenses, storage costs, insurance, depreciation, obsolescence, and the opportunity cost of tying up capital in inventory. Lastly, lead time is the duration between placing an order and receiving the inventory. It is important to consider the lead time when calculating the EOQ to ensure that the inventory arrives in time to meet customer demand.

The EOQ method is based on several assumptions, including constant demand, a known and fixed order cost, a fixed holding cost per unit, and no quantity discounts. The EOQ formula is derived from a trade-off between ordering costs and holding costs $EOQ = \sqrt{2DS/H}$. Here, D represents the annual demand for the product, S represents the ordering cost per order and H represents the holding cost per unit per year. The EOQ formula calculates the order quantity at which the total cost of ordering and holding inventory is minimized. By finding the optimal order quantity, a company can reduce costs associated with excessive inventory holding or frequent ordering. However, although the EOQ method was commonly used by previous researchers, it is hard to apply here because we cannot identify the parameters D, S, and H, which refer to divisions in cost.

2.2 Service Level

The service level is a critical determinant of quantitative differences in the retail sector, especially concerning the uncertainty of demand. It's important to note that unit costs associated with a specific service level tend to rise exponentially as the reliability of demand data decreases. Research by Yang indicates that a retailer's response to increased risk aversion or decreased efficiency in service investment often results in a reduction of the optimal lot size, retail price, and service level [11]. Alternatively, when the supplier's capacity increases, retailers are likely to lower the retail price and raise their service level. This dynamic adjustment often leads to a higher lot size due to the decreased risk of stock-outs, enabling more aggressive inventory management.

According to Avinadav, the optimal policy for a retailer is achieved when the probability of not running out of stock in a review cycle is equivalent to the underage cost (cu) divided by the sum of the underage cost and the overage cost (co) [12]. This principle can be represented as cu/(cu+co). Applying this policy in determining the Economic Order Quantity (EOQ), we use the formula Q=mean+SD*k, where Q represents the order quantity, the mean refers to the average demand, SD is the standard deviation of the demand, and k is the z-value or service level corresponding to the ratio of cu/(cu+co). The z-value is derived from the standard normal distribution, indicating how many standard deviations away from the mean demand we should set our order quantity to achieve the desired service level. However, this model's application has certain limitations. As noted by John [13], the EOQ model assumes the certainty of input values, which is often not the case in real-world scenarios [13].

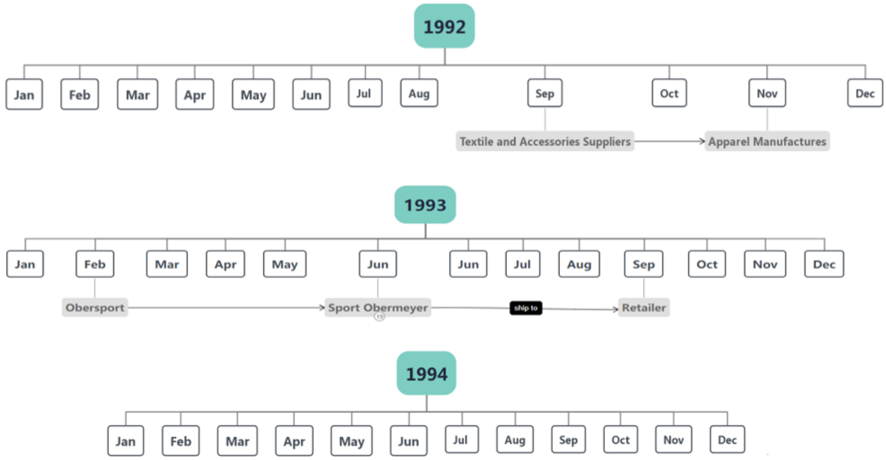

Fig. 1. The timeline that is associated with the supply chain.

2.3 Flow Diagram

As shown in Fig. 1, it is clear that the timeline of the supply chain, and it is easier to look through the whole process and costs. Based on the analysis of Hammond and Raman to Sport Obermeyer of the supply chain [14], factories decided on the design of production between February and September 1992. Here is our first step of the supply chain, factories needed to prepare components from accessories suppliers like textiles or zippers. In November, factories placed the first order for production and prepared for apparel manufacturing which is the second step. Then in February 1993, workers made production in Obersport, and factories would show some samples and deliver them to retailers in order to get some feedback. Then in March, factories receive the second order from March to June. After June, production was sent to Sport Obermeyer which is a distribution center, and Obermeyer would ship them to retailers, and consumers could buy ski parkas in retailers which is the end of our product flow. Shipment is really important in our supply chain, Hong Kong and China were different in cost. It is clearly shown in Fig. 2, the labor cost in Hong Kong was more than that in China. And because of US government policies that limited units of production imposed from China, it had more transportation fees than Hong Kong. Actually, it is one of the differences between Hong Kong and China.

Fig. 2. The timeline that is associated with the supply chain.

3 Results & Discussion

3.1 Differences between Sourcing Locations

Differences between China and Hong Kong can be divided into three parts which include product quality, the turnaround time for the product, and cost and policies. First of all, for product quality, as shown in Table. 1, Hong Kong factories have better quality. Here are two reasons. First, workers in China are less skilled than workers in Hong Kong. Chinese workers are from local communities or towns near neighboring provinces, and they need to be trained and are unfamiliar with their work. However, workers in Hong Kong are more skilled and professional. The second reason is that the Chinese production line is longer than Hong Kong, and it leads to a greater imbalance [14]. Second, based on the shown in Table. 2, for turnaround time for products, Hong Kong's sourcing has a faster turnaround time. Here are two reasons. The first one is that Chinese workers are always only trained for a single operation, and it will be slower and needs to have more time. However, workers in Hong Kong are crossed-trained, and they get more extensive training. Besides, Hong Kong workers were about 50% faster than Chinese workers. What is more, workers in Hong Kong are four times more productive than Chinese workers. Another reason for Hong Kong having a faster turnaround time is their workers are able to ramp up production than Chinese workers. And this ability is helpful to promote efficiency for small order quantities [14]. Finally, as shown in Table. 3, for cost and policies, although Hong Kong has more production costs than China, its policies are more beneficial. Here are three situations. First, wages in China are much lower than in Hong Kong, which is 0.16 dollars per hour, and at the same time, Hong Kong workers need 3.84 dollars because they have more efficiency and skills. And the second situation is for parks, the minimum production quantity for a style in Hong Kong is half of that in China which is 600 units. The most important is that the US government policies quota restrictions on products that are imposed from China. Compared to China, the policies of the US for Hong Kong were more relaxed, it will make Hong Kong companies more choices like transporting goods by air or ship to reduce cost [14].

Table 1. Difference in product quality between China and Hong Kong.

China	Hong Kong
Less skilled; unfamiliar with their work	More skilled and professional
The Chinese production line is longer which leads to greater imbalance.	Hong Kong's production line is shorter and it is more balanced.

Table 2. Differences in turnaround time for products between China and Hong Kong.

China	Hong Kong
-Trained for a single task -Less efficiency	-Cross-trained, extensive training -Four times more productive than Chinese and 50% faster than Chinese workers
Are slower in ramping up production.	Workers in Hong Kong are able to ramp up production more than Chinese workers, and it helps to promote efficiency for small quantities.

Table 3. Differences in cost and policies between China and Hong Kong.

China	Hong Kong
wages are lower($0.16/hour)	wages are higher($3.84/hour) because of more efficiency
Minimum production quantity is 1200 units	Minimum production quantity is 600 units
The US government policies quota restrictions that were imposed from China.	The policies of the US for Hong Kong were more relaxed (more flexible to choose the way of transport)

Overall, the factories in Hong Kong provide high-quality products and more skilled workers, and they also have more beneficial policies that can choose the way of transport more freely. Compared to Hong Kong, Chinese quality and efficiency are lower although they have lower labor costs, and companies in China must choose air to transport because of the US policies. The first order decision is shown in Table. 4. By understanding these dynamics and the interplay between service level, lot size, retail price, and risk aversion, retailers can make more informed decisions about their inventory management strategies.

Table 4. The results for first order.

Style	Average Forecast	Standard Deviation	2x Std. Deviation	Q(μ+z ×σ), Most	Q(μ+k×σ)
Gail	1017	194	388	1279	606
Isis	1042	323	646	1478	357
Entice	1358	248	496	1693	832
Assault	2525	340	680	2984	1804
Teri	1100	381	762	1614	292
Electra	2150	404	807	2694	1294
Stephanie	1113	524	1048	1820	2
Seduced	4017	556	1113	4768	2837
Anita	3296	1047	2094	4708	1075
Daphne	2383	697	1394	3323	905
Total	20000			26360	10000
outrage cost	8%				
underage cost	24%				
critical ratio	75%				
z value	0.6744897502				
SD	9429.482602				
k	-1.060503574				

3.2 Reactive Second Order Decision

To decide on the distribution of products between Hong Kong and China, we have to evaluate the risks of each product and the level of waste. First, the coefficient of variation reflects each product's risk level. As the ratio of standard deviation to the expected mean, CV reflected the risk level of each product. Since the higher the CV, the higher the risk, we suggest producing styles with higher CVs in Hong Kong. It is because production in Hong Kong is more flexible and requires fewer minimum order quantities, which offsets the risk to some extent. The results are shown in Table. 5.

Table 5. Coefficient of variation.

Style	Coefficient of Variation (%)
Gail	38%
Isis	62%
Entice	37%
Assault	27%
Teri	69%
Electra	38%
Stephanie	94%
Seduced	28%
Anita	64%
Daphne	58%

Table 6. The z value for Hong Kong and China.

Hong Kong	China	Style	z-value for Hong Kong	z-value for China
606	1200	Gail	-1.074742268	0.4716494845
600	1200	Isis	-0.6842105263	0.2445820433
832	1200	Entice	-1.528225806	-0.3185483871
1804	1804	Assault	-2.830882353	-1.948529412
600	1200	Teri	-0.656167979	0.1312335958
1294	1294	Electra	-1.920693928	-1.177199504
600	1200	Stephanie	-0.4895038168	0.08301526718
2837	2837	Seduced	-3.070080863	-2.530997305
1075	1200	Anita	-1.287488061	-1.00095511
905	1200	Daphne	-1.279053085	-0.8486370158

Second, we evaluate the level of waste. In the former calculation, the question requires ignoring the minimum order quantity. However, in the actual case, when considering whether to place orders in Hong Kong or China (seen from Table. 6), the company should evaluate how close (or more than) each style's optimal production level is to the minimum requirement. We use z-scores to measure excess risk. Specifically, the z-value is the difference, in standard deviation, between the actual order quantity and the minimum order quantity. A positive z-value indicates that the actual order size is greater than or equal to the minimum order size required by the supplier, meaning there is no excess risk. Conversely, a negative z-value indicates that the actual order size was less than the minimum order size required by the supplier, implying that there is a risk of excess. Although all z-values for China are larger, the styles we select for Hong Kong have relatively larger z-values when compared to other products in Hong Kong. Since the results from both methods generally correspond to each other, we suggest producing Isis, Teri, Stephanie, Anita, Daphne in Hong Kong. For products with low excess rate (large z), we order them from China to take advantage of the lower unit cost.

3.3 Recommendation & Suggestions

Modern business environments are characterized by quick change and escalating competition. Therefore, organizations like Sport Obermeyer, a well-known sportswear manufacturer, must be skilled at creating and putting into practice strategic solutions to address operational challenges. This report provides Sport Obermeyer with four crucial suggestions that it could use to enhance its operations, lessen current difficulties, and strengthen its market position. The first suggestion relates to Sport Obermeyer's factories in China and Hong Kong strategically balancing production. Sport Obermeyer can take advantage of the particular advantages that each of these locations offers. Hong Kong, for example, provides quicker turnaround times and more flexibility, making it a perfect location for the production of styles with erratic demand and fewer orders. China, on the other hand, is better suited for styles with predictable demand and larger orders due to its cost-effective manufacturing environment. Sport Obermeyer can efficiently use resources, reduce potential trade policy risks, and enhance its overall production efficiency by strategically selecting the manufacturing location based on the style and level of demand for each product.

Second, adopting a Just-In-Time (JIT) production methodology is advised. By producing and delivering goods only when they are required, this lean manufacturing technique lowers inventory costs, reduces excess stock, and lessens the need for end-of-season markdowns. Sport Obermeyer can improve its profit margins and streamline its production process by implementing JIT.

The third suggestion calls for the development of a reliable system for demand forecasting. This system, which is based on historical data and market trends, can improve inventory planning, and production scheduling and help businesses make informed decisions about what to buy that are in line with customer preferences. Sport Obermeyer can lessen the likelihood of overproduction or stock-outs and boost its financial performance and customer satisfaction levels by accurately anticipating future customer needs.

The final suggestion is to improve employee training at both manufacturing sites. Sport Obermeyer can increase the skill level of its workforce through the investment in training and cross-training programs, resulting in more effective production lines and higher overall productivity. Additionally, a trained workforce is better able to adjust to shifting consumer preferences, which improves Sport Obermeyer's flexibility and responsiveness in the fast-paced sportswear market.

In conclusion, these suggestions have the potential to significantly enhance Sport Obermeyer's operations and assist the business in overcoming its current major challenges. Sport Obermeyer can guarantee sustainable growth and profitability by enhancing worker training, implementing JIT production, utilizing demand forecasting, and optimizing production across locations. Due to their interdependence, these tactics should be used in concert for maximum effect. Sport Obermeyer can anticipate a future of improved operations, increased market competitiveness, and long-term success in the sportswear manufacturing sector owing to these strategic improvements.

4 Limitations & Prospects

Based on the analysis, Sport Obermeyer finishes the supply chain and sells products to customers well, but there are many limitations in this process which lead to income loss. The most important thing to note is how to predict correctly before starting the design. According to the analysis of Hammond and Raman [14], ski parkas' sales depend on the accuracy of Sport Obermeyer's fashion predictions for this year. It clearly shows that prediction is the biggest challenge for the whole supply. However, as the types of products increase, the accuracy of the factory's forecasts declines. As a result, it will cause the income of the factory to become unstable. This situation reveals that Sport Obermeyer may not collect the latest and most accurate information.

Moreover, limited production is also another challenge for Sport Obermeyer. After the Las Vegas show, Obermeyer will receive 80% of the annual volume of orders, and the minimum quantity and limited ability of production delay Sport Obermeyer buying raw materials to predict the fashion of this year's ski parka and finish the second production order. And then, it takes six weeks to ship production to the distribution center. If Sport Obermeyer chooses Chinese to produce, the US government policies restrict the amounts of production imposed from China, and this results in factories having to choose air to transport, and it will certainly increase the cost.

Besides, Sport Obermeyer needs to analyze their competitors more comprehensively. It needs to compare differences among various companies, sometimes, Obermeyer has diverse competitors since components are made from different factories. A good producer needs to learn strengths from other competitors and figure out why they have higher income. For example, when Obermeyer researches others, they should know if competitors' ski jackets are waterproof and wear-proof or if their coats can keep warm. Hence, the lack of opposition research is also a kind of limitation.

At present, with the development of tourism and people's interest in skiing increasing day by day, the ski industry is becoming more profitable. However, the future sales of ski parkas also connect to climate change. With the warming of the global climate in recent years, the natural snowfall has been decreasing [15]. This may cause an increase in the cost of making artificial snow, and ski resort tickets are likely to rise. If people do not change their budget, factories selling ski equipment such as ski parkas will decrease the price. Otherwise, there is a massive loss of passengers. Besides, COVID-19 has affected people's lives since 2019, and now as the epidemic fades away gradually, people start to exercise outdoors, the sales of the ski industry can go back. However, on the other side, the epidemic does not disappear completely, so some people will not choose outdoor sports as fast as possible, opting instead for safer indoor sports. As a result, COVID-19 influences the earning of Sport Obermeyer. In general, the future of Obermeyer does not entirely depend on climate change or the epidemic. The factory needs to have strategies to deal with special situations like COVID-19, and how to minimize the loss is the most crucial.

5 Conclusion

In summary, this study aimed to unpack the challenges and propose strategic solutions for Sport Obermeyer, a key player in the sportswear manufacturing industry. Throughout the paper, we emphasized the application of methods like the EOQ model for effective first-order decisions, the role of service levels in determining retail variability, and the critical factor of manufacturing location selection. Furthermore, the research underscored the importance of a precise forecasting system, implementing Just-In-Time production, enhancing employee training, and carrying out a thorough competitive analysis for improved operations and competitiveness. Yet, it's crucial to note certain limitations, e.g., the assumptions of certainty inherent in the EOQ model and the inherent unpredictability of fashion trends, which might hamper the accuracy of our demand forecasts.

In the future, Sport Obermeyer will need to improve its forecasting mechanisms, explore alternative production strategies, and expand its competitive analysis scope. Further, the company will need to anticipate and respond to changes in the broader context, such as the impacts of climate change on ski tourism and the ongoing repercussions of the COVID-19 pandemic. The insights provided by this research offer significant value not just for Sport Obermeyer but for similar businesses as well. By adopting these strategies and remaining adaptable to evolving market conditions, companies can enhance their operational efficacy, optimize costs, and strengthen their market positioning in the fast-paced world of sportswear manufacturing.

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