Joint Replenishment and Base Stock Model for the U.S. Beer Industry

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Summary: This project provides a solution to the inventory deployment problem by determining how a joint replenishment approach combined with the base stock inventory policy improves the deployment of inventory across MillerCoors supply chain. A repeatable and scalable heuristic is developed which employs joint replenishment to determine economic production frequencies and links to the base stock policy across all echelons within the supply chain.

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KEY INSIGHTS

1. Linking production frequency with inventory policy can help reduce deployed inventory.
2. A multi-factor approach to inventory classification yields more accurate SKU Classifications.
3. Base stock model combined with multi-factor classification generates better inventory targets for customers in a multi-echelon supply chain.

Introduction

Multi-echelon supply chains exist across a variety of industries. A multi-echelon supply chain is one where inventories are distributed across multiple layers, called echelons. Throughout this capstone we use tiers, levels, and echelons interchangeably. The supply chain becomes more complex to manage as the tiers and number of SKUs increase. As a result, organizations have employed various strategies to manage these large portfolios of SKUs including Pareto Analysis and ABC classification. These typically focus on cost-based metrics or volume-based metrics and are one-dimensional.

This project investigates the inventory strategy of the multi-echelon supply chain at MillerCoors. This real-world context supports, motivates, and validates the insights gained from the analysis.

Operational Context

The alcoholic beverage industry in the US requires a three-tier distribution system. The three-tier system involves a manufacturer, distributor, and retailer. The manufacturer brews, packs, and ships beer to distributors. Distributors then fulfill the demand at various retail outlets including restaurants, bars, grocery stores, and convenience stores. This is because manufacturers are restricted by law from selling beer directly to consumers. This presents unique issues and challenges for the supply chain. Each tier must collaborate and communicate closely in order to be successful.

The MillerCoors brewery network consists of seven large breweries and six regional craft breweries. The large breweries are located in Elkton, VA; Albany, GA; Fort Worth, TX; Irwindale, CA; Golden, CO; Milwaukee, WI; and Trenton, OH. These breweries are strategically located to efficiently satisfy demand in all of the markets across the US. Each brewery has a production cadence, or run strategy, for each SKU they produce because of the limited storage capacity in brewery warehouses. MillerCoors seeks to improve the connection between their run strategies and the inventory deployment across the three-tier system.

In MillerCoors' current supply chain, distributors own 95% of the finished goods inventory. MillerCoors brewery warehouses are not designed to store high volumes of inventory and on average turn their inventory in less than three days. This forces operations to produce in a make-to-order model. MillerCoors is making the strategic move to buffer distributors from the breweries' run strategies by opening distribution centers (DCs) at each of its facilities to fulfill distributor demand amidst growing portfolio complexity.

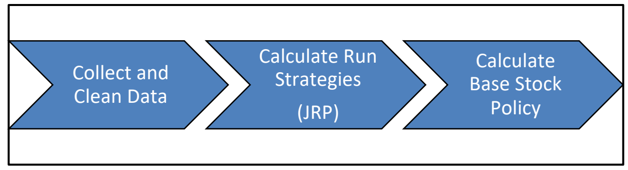
MillerCoors, like most consumer goods companies, has experienced a steady increase in the number of products within their portfolio. As a result, the increase in complexity for the breweries has added a new dimension of capacity constraints. Breweries are now running many more SKUs, which require additional changeovers between products and results in a less efficient operation.

To optimize this, MillerCoors developed a run strategy for every SKU. The run strategy corresponds to how frequently an SKU will be produced at each brewery. The run strategy defines a repeating four-week cycle. Thus, instead of planning the supply of products in monthly buckets, the team plans around thirteen four-week periods. To determine the appropriate run strategy, members of the supply chain and operations teams map the entire end-to-end production process. They identify critical processing steps, the capability of the system, and other factors that impact capacity. Once the team has a clear picture of the operation, they begin to balance and group SKUs together into the run strategy to optimize the brewery operations and improve the availability of SKUS to the distributors.

Methodology

The main steps of the methodology are as follows. First, we must collect and clean the relevant data. We then calculate the recommended run strategies based on the joint replenishment (JRP) algorithm. This allows us to categorize the SKUs and prepare them for the inventory policy portion of the heuristic.

The classification and run strategy then feed into the base stock calculation as the lead time. We calculate the appropriate inventory policy for the Distribution Center as well as all distributors.



Graphical Representation of Methodology

Once we have calculated the relative replenishment frequencies for the portfolio, using the JRP approach, we must then assign the run strategies. We have seven options to choose from. The available run strategies are listed below, which apply to a repeating 4-week cycle:

1.Produced weekly
2.Produced bi-weekly, on odd weeks
3.Produced bi-weekly, on even weeks
4.Produced one out of four weeks, on first odd
5.Produced one out of four weeks, on first even
6.Produced one out of four weeks, on second odd
7.Produced one out of four weeks, on second even

The run strategy represents the lead time used in the calculation of the base stock inventory policy.

We then calculate the base stock for all SKUs at the distribution center as well as each distributor serviced by the distribution center. This completes the heuristic used to determine production frequencies and link them to inventory policies across the multi-echelon supply chain.

Results

Out of 54 SKUs analyzed our heuristic assigned 28 SKUs, 52%, to the same run strategy as the current state (shaded green below). Of the remaining 26 SKUs, 21 SKUs were assigned to a run strategy in the adjacent tier either one level up or down (shaded yellow below). For example, if under the current-state assignment a SKU was produced weekly, our heuristic assigned the same SKU to be produced every other week. 5 SKUs were assigned to a run strategy more than one tier away (shaded red). For example, if under the current-state assignment a SKU was produced weekly, our heuristic assigned the same SKU to be produced one out of four weeks. The table below shows a matrix comparing the recommended and actual run strategies.

		Actual Run Strategy			
		4wk Cycle	Every Other Week	Weekly	**Total**
Recommended Run Strategy	4wk Cycle	23	10	2	**35**
	Every Other Week	9	2	0	**11**
	Weekly	3	2	3	**8**
	Total	**35**	**14**	**5**	

Recommended Run Strategy vs. Actual Run Strategy

The results, and differences in assignment, can be stratified into three decision classes. The first decision class is the SKUs assigned to the same run strategy by both MillerCoors and the heuristic outlined in this capstone. These represent an agreement between theoretical calculations and practical applications and are near-optimal solutions.

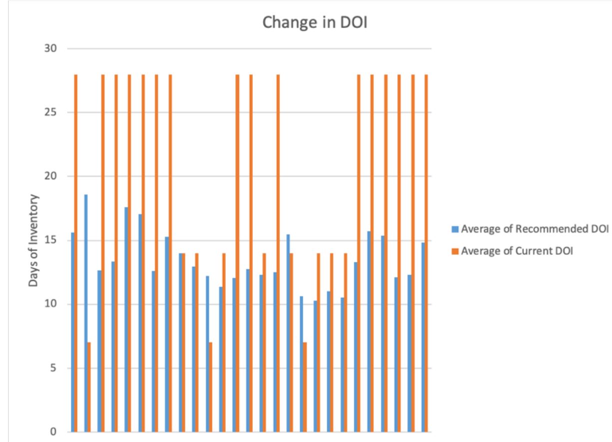
The insights we can derive from these results are that both the heuristic and MillerCoors processes converge at a near-optimal solution and there is little to no case for change to reassign these SKUs, unless a significant shift in volume or cost occurs.

The run strategies at MillerCoors are not determined within a vacuum. A cross-functional team collaborates, with representation from brewery operations as well as corporate supply chain, and gains a consensus decision on which run strategies to assign or change for the SKUs they discuss. During these discussions, the representatives from operations may call out line-specific or equipment capability considerations to influence the run strategy assignment.

Furthermore, within this decision class, the heuristic model shows that the greatest improvements occur when reassigning a SKU from a one-in-four-week cadence to a bi-weekly cadence.

We will now shift our focus to the inventory policy results of our heuristic. Under the base stock policy, all SKUs ordered by distributors have the same lead time, which is 2 weeks. This is because distributors receive their orders from the distribution center two weeks after placing their orders. This enables a shift to an indirect fulfillment model instead of a direct brewery to distributor path. As a result, the distributors are less impacted by the run strategies at the breweries since the distribution centers carry inventory to fulfill demand.

Our analysis shows that when comparing the new base stock policies to the current run-strategy driven policies, we will increase the inventory of 20% of the SKUs analyzed and reduce the inventory of 80% of the SKUs.



Distributor Change in DOI

The total inventory increase is approximately 2,800 barrels and the reduction is approximately 8,600 barrels.

Conclusions

This project develops a heuristic to combine joint replenishment with the base stock policy to improve the inventory policy of the multi-echelon supply chain at MillerCoors. Three key insights emerge from our data analysis.

First, by engaging a MillerCoors-owned distribution center tier in the supply chain between the brewery and its customers, the supply chain absorbs the variation in run strategies for each SKU and smooths the inventory planning process for the distributors. This is especially important for low-volume, high-complexity SKUs. This is important because it helps facilitate MillerCoors' strategic transition to a make-to-stock model, for the aforementioned low-volume, high-complexity SKUS, while still maintaining the shelf-life commitments associated with perishable products.

Second, implementing a base stock policy for distributors improves the alignment between demand and inventory. This is important because both cycle stock and safety stock are now tied to the replenishment cycle from the distribution center rather than the run strategy cycle. Inventory levels are also more closely aligned to how each SKU flows through the distributor's supply chain rather than MillerCoors' supply chain. The base stock policy also allows the supply chain to determine the cycle service level to deliver and make adjustments to inventory accordingly.

Lastly, this heuristic provides change management tools to facilitate conversations between MillerCoors and the distributors. The supply chain technology transformation, which aligned all ordering frequencies for SKUs sourced from a DC to a weekly cadence, also cultivated discussions around inventory levels. The more frequent order frequency tends to lead to lower required inventory levels. However, with a two-week lead time on all SKUs, seven days of coverage may lead to stockout situations under current inventory strategies. This heuristic provides numerical justification for proposed increases and decreases to inventory balances.

Overall, this heuristic improves the alignment of the production run strategies with the inventory deployed across all three tiers of the supply chain at MillerCoors. By leveraging the distribution center tier, the entire supply chain benefits.