

Impact of Perishable Products' Inventory Policies on Retailer's Profits

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1.0 Abstract

Managing inventory of perishable items, for example bakery items with only a one day shelf life, is especially challenging. Ordering too many or too few of these items directly impacts sales and profits. Using 63 days of sales data from a retailer, performance of the currently deployed inventory ordering policies is measured. A large product proliferation and high variability in daily sales makes forecasting sales difficult, leading to *ad hoc* and *gut-feel* inventory ordering. Analytical models developed in inventory management literature often fail to incorporate real-world constraints and hence their direct applicability is limited. Therefore, a mixture of basic analytical approaches, that factor-in retailer's constraints, is used to develop an inventory ordering policy for each of the eight stock-keeping-units. The superior performance of the recommended policy over the existing policy is noted.

3.0 Techniques and Approach

Research divided into 3 phases

1. Understanding & measuring the performance of current inventory management policies.

(data collection and acquaintance phase)

- a) 63 days of data collected for 8 perishable bakery items.

Includes: (daily demand, COGS, revenue, quantity discarded and quantity unaccounted for)

Current state of inventory management is characterized by:

- Ad hoc inventory ordering policies.
 - Errors in record keeping leads to difficulty in reconciling daily levels of inventory ordered/sold.
 - Accurate impact of SKU level inventory on profitability is mostly unknown.
- b) Variation in the difference between daily quantity ordered and sold is measured; performance of the current inventory ordering policy is measured by calculating the

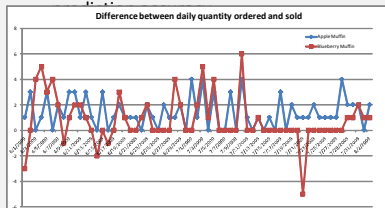


Figure 1

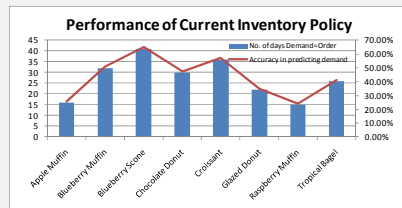


Figure 2

2. Using analytical methods to evaluate alternate inventory policies (how much to order when) for each of the 8 perishable bakery items. (analysis phase)

- a) Using 63 days of sales data stationery probability distributions were calculated for each of the 8 perishable bakery items.
 - b) Customer service-levels (probability of meeting customer demand from stock at hand) were calculated for all alternate inventory ordering policies. (i.e., what if the order placed was for 1,2,3,4,5, or 6 units)
- a) Comparison of profits under the existing and the proposed ordering policies.
 - b) Most and least profitable SKUs.

3. Recommend alternate optimal solutions to the retailer. (implementation phase) - pending

5.0 Conclusions

This research addresses the issue of managing inventories of perishable products at a high volume retailer. Using analytical techniques, an inventory ordering policy is developed. The proposed policy has the potential to at least meet (and under mild assumptions, exceed) the retailer's current profit from these items and improve customer service levels. As the next step, the proposed policy will be presented to the retailer and subsequently implemented. The resulting increase in real profits (if any) will then validate the efficacy of the solution approach developed in this research.

2.0 Background & Motivation

High volume retail outlets (for example: a coffee shop) often carry a plethora of products and face uncertain customer demand, creating difficulties when managing inventories. With the growing emphasis on controlling supply chain costs, better inventory planning at the SKU level is gaining increasing attention. This research proposes simple analytical based techniques that can help such businesses better manage their inventories and increase their profitability.

4.0 Results and Analysis

1. Eyeballing "best" inventory ordering policy based on expected service levels by analyzing distribution of daily sales.

Daily Sales	Apple Muffin (4)		Blueberry Muffin (4,6)		Blueberry Scone (6,4)		Chocolate Donut (4)		Croissant (6,4)		Glazed Donut (6)		Raspberry Muffin (4)		Tropical Bagel (4)	
	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %	Frequency	Cumulative %
0	4	6.35%	3	4.76%	0	0.00%	4	5.25%	4	6.35%	2	3.17%	4	6.35%	2	3.17%
1	9	20.63%	1	1.56%	1	1.11%	4	7.94%	0	0.00%	3	7.94%	5	14.29%	9	17.46%
2	11	38.30%	8	19.05%	3	15.87%	10	23.81%	5	14.29%	0	7.94%	9	28.57%	14	39.68%
3	23	74.07%	11	38.57%	13	38.57%	10	49.21%	10	39.68%	10	23.81%	24	66.67%	11	37.44%
4	16	100.00%	19	88.89%	18	98.43%	10	98.43%	10	98.43%	12	42.86%	15	98.43%	16	98.43%
5	0	100.00%	3	93.60%	1	98.43%	1	98.43%	2	98.43%	11	60.12%	3	98.43%	1	100.00%
6	0	100.00%	1	95.24%	0	98.43%	1	100.00%	0	98.43%	22	98.43%	3	100.00%	0	100.00%
7	0	100.00%	2	98.43%	0	98.43%	0	100.00%	0	98.43%	2	98.43%	0	100.00%	0	100.00%
8	0	100.00%	0	98.43%	0	98.43%	0	100.00%	0	98.43%	0	98.43%	0	100.00%	0	100.00%
More	0	100.00%	1	100.00%	1	100.00%	0	100.00%	1	100.00%	1	100.00%	0	100.00%	0	100.00%

Figure 3

- a) Forecasting next day sales (at SKU level) is next to impossible.
- b) Distribution of daily sales helps in better understanding the underlying structure of daily demand.
- c) For any given service level (probability of fulfilling demand from stock at hand) inventory ordering policy can be determined. A recommended policy is provided in Figure 4.

	Current Ordering Policy	Recommended Policy Based on Distribution of Demand
Apple Muffin	4 units / day	4 units / day
Blueberry Muffin	4 or 8 units / day	4 units / day
Blueberry Scone	0 or 4 units / day	4 units / day
Chocolate Donut	4 units / day	4 units / day
Croissant	0 or 4 units / day	4 units / day
Glazed Donut	6 units / day	5 units / day
Raspberry Muffin	4 units / day	4 units / day
Tropical Bagel	4 units / day	4 units / day

Figure 4

2. Evaluating alternative inventory ordering policies based on marginal (profit) analysis:

- a) What would have been the profits (for each SKU) if a different level of inventory was ordered, assuming that the daily demand was the same? (i.e., the actual realized demand)

Profit w/ Curr Policy	Alternative Inventory Policies								
	1	2	3	4	5	6	7	8	
Apple Muffin	\$ 129.50	\$ 63.88	\$ 112.00	\$ 140.88	\$ 129.50	\$ 90.13	\$ 50.75	\$ 11.38	\$ (8.00)
Blueberry Muffin	\$ 236.80	\$ 68.78	\$ 135.80	\$ 188.83	\$ 222.60	\$ 198.63	\$ 169.40	\$ 138.43	\$ 103.95
Blueberry Scone	\$ 240.52	\$ 63.37	\$ 124.99	\$ 181.35	\$ 214.97	\$ 182.09	\$ 147.46	\$ 112.82	\$ 78.19
Chocolate Donut	\$ 145.74	\$ 53.31	\$ 100.62	\$ 132.93	\$ 141.24	\$ 104.55	\$ 66.36	\$ 26.67	\$ (13.02)
Croissant	\$ 222.33	\$ 60.50	\$ 120.99	\$ 173.24	\$ 199.08	\$ 167.18	\$ 131.97	\$ 96.76	\$ 61.56
Glazed Donut	\$ 202.14	\$ 52.44	\$ 100.38	\$ 148.32	\$ 181.26	\$ 196.20	\$ 194.64	\$ 166.08	\$ 122.52
Raspberry Muffin	\$ 167.72	\$ 62.93	\$ 117.11	\$ 155.54	\$ 151.97	\$ 122.15	\$ 87.08	\$ 46.76	\$ 6.44
Tropical Bagel	\$ 105.16	\$ 41.73	\$ 74.91	\$ 94.78	\$ 104.21	\$ 88.94	\$ 72.72	\$ 56.49	\$ 40.27

Figure 5

Total profit (63 days) w/ current policy	\$ 1,449.91
Profit (over 63 days) w/ consistent ordering policy	\$ 1,374.72

Figure 6

	Nb. of Days Demand Met with Stocks	Service Level
Apple Muffin	47	74.60%
Blueberry Muffin	56	88.89%
Blueberry Scone	61	96.83%
Chocolate Donut	61	96.83%
Croissant	60	95.24%
Glazed Donut	38	60.32%
Raspberry Muffin	42	66.67%
Tropical Bagel	62	98.41%

Figure 7

3. Using the above two tables, maximum profits achievable under each alternate inventory ordering policy are noted. The recommended ordering policy is same as from point (1) above, except for Apple Muffins and Raspberry Muffin (order 3 each day instead of 4). However, profits are lower than actually realized.*

* Because of unreliability of data (for some days quantity sold was higher than quantity ordered (!), the actual realized profits would be different. Assuming, that the sales can never be more than quantity ordered, the real profits would have been \$1,354.46. These are lower than the profits from the recommended consistent ordering policy (\$1,374.72).

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