MSCI 719: Operations Analytics

Assignment 8: Model Blood Bank, Indore: Supply Chain Management

Student: Advait Shah

Faculty: Engineering

Department: Management Sciences

Instructor: Prof. Hossein Abouee Mehrizi

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1. Impact of the Frequency of Camps and Target Inventory on Shortage and Wastage

MBB is interested in analysing the impact of different policies on the platelets' shortage and wastage. Suppose that the shelf life of platelets is seven days, the target inventory is 1400, and the donation camps are held daily. For both supply and demand, 10,000 random observations are provided in Data.xlsx file.

Problem Formulation:

X_i^t: Number of items of age i at the beginning of period t,i can take values from 0 to $m-1$; with 0 denotes the freshest.

R: Target level inventory for perishable item

D^t: Demand during the period t

S^t: Supply during the period t

$$X_i^t = \max[X_{i-1}^{t-1} + \max(D^{t-1} - \sum_{j=i}^{m-1} X_j^{t-1}, 0), 0] \forall i > 0$$

$$X_0^t = \min[S^t, \max(R - \sum_{j=1}^{m-1} X_j^t, 0)]$$

$$shortage^t = \max[D^t - \sum_{j=0}^{m-1} X_j^t, 0)]$$

$$wastage^t = \max[X_{m-1}^t - D^t, 0]$$

Amount of unsatisfied demand if we use items with more age than i, at previous period.

Several amount of items with age $(i-1)$ will be used to meet the demand (if there exist unsatisfied demand after using older items, and remaining will form the aged items at the next period.

1.1. Assume that the target inventory is decreased to 200 units. Calculate the daily average wastage and shortage for the blood bank. What could be the reason for such changes in wastage and shortage?

As calculated in the excel file, Daily average wastage and shortage would be,

When target inventory = 1400 units:

Average Shortage	0 units
Average Wastage	50.08 units

When target inventory = 200 units:

Average Shortage	0 units
Average Wastage	1.67 units

As we changed target inventory from 1400 units to 200 units, as the demand is not so high compared to our total target stored inventory, shortage will remain at zero. However, average wastage reduces daily from around 50.08 units to 1.67 units. The main reason can be

understood as we have reduced our target, means storage capacity. So, we are not storing now many unnecessarily extra units, and this results in better supply demand balance with respect to our FIFO scheme. And hence, now there are very less units on an average getting expired daily with the new target of 200 units compared to when the target storage capacity was 1400 units.

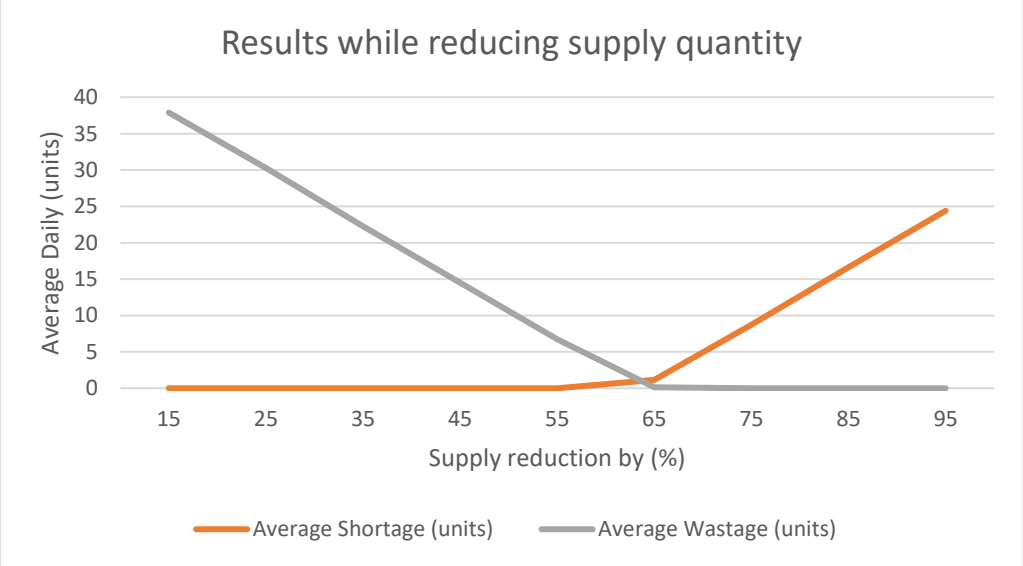
1.2. How do the average shortage and wastage change as the supply decreases?

- MBB is considering decreasing the donation camp's duration, which leads to less supply for each period. Assume that the possible (feasible) options are to reduce the supply for each period by 15%, 25%, 35%, . . ., 85%, 95% (For instance, the column "Supply (10%)" shows 10% less supply).
- When reducing the daily supply, r, we will be rounding down the values that are not integers.

We will consider target inventory as 1400 for this part.

As we calculated in the excel file, following are the results of shortage and wastages when we reduce our supply by given percentage amount:

Supply reduction by (%)	**15**	**25**	**35**	**45**	**55**	**65**	**75**	**85**	**95**
Average Shortage (units)	0	0	0	0	0	1.13	8.73	16.62	24.40
Average Wastage (units)	37.89	30.26	22.26	14.52	6.75	0.14	0	0	0



So, we can comment that as supply is reduced more and more, there is less amount of daily wastage units, but increasing number of shortage units. So, best trade-off is achieved when supply is reduced by 65% on daily basis, which results in very less average daily shortage units (1.13 units) and also minimal average daily wastage units (0.14 units).

1.3. In Lecture 9, we discussed the case that we have donation camps every day. MBB is willing to examine the impact of decreasing the frequency of donation camps on the percentage of wastage and shortage.

- What would happen if the donation camps were held,

    1. every two days instead of every day?

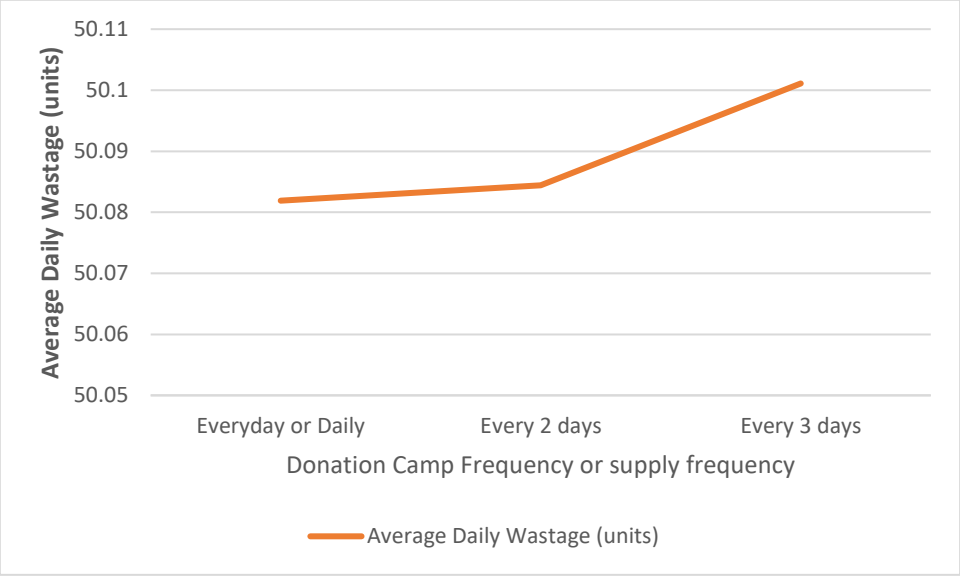
2. every three days instead of every day?

- To determine the supply for each day when the frequency is decreased to “every two days”, you can assume that the supply of day i (i = 1, 3, 5, . . .) is equal to the supply of day i plus the supply of day i+1. Similarly, the supply can be determined for “every three days” case. You can also use columns “New Supply 1” and “New Supply 2” for parts 1 and 2, respectively. Based on your results, discuss the effect of reducing the frequency of donation camps.

We will consider target inventory as 1400 for this part.

As calculated in excel, we get following results:

	Donation Camp Frequency or supply frequency		
	Everyday or Daily	**Every 2 days**	**Every 3 days**
Average Daily Shortage (units)	0	0	0
Average Daily Wastage (units)	50.0819	50.0844	50.1011



As our demand does not vary significantly everyday across the year, and follows fairly normal distribution as shown in excel, and our target inventory is fairly sufficient, shortages still remain at zero even when camps are held every two days or three days. This is also a main reason why we do not see much difference in average daily wastage units when donation camps frequency is changed. So, considering these results, we can recommend holding donation camps every 3 days, as it will not affect shortages and wastages much when compared with the figures we got when camps are held daily or every two days. This will result into much lesser overhead costs of conducting camps.

References:

[1] H A Mehrizi, eBook: MSCI 719 Winter 2023 Cases Multiple (ID: 9723713) Accessed: Jan. 22, 2023. [Online].

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