

Big Depot Hurricane Planning Game

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1 Introduction

Big Depot is a retailer of appliances, furniture, and general home improvement products. During the hurricane season, the firm aims to efficiently provide products required by the stores during the pre-strike and post-strike phases in an accurate and timely manner. The Disaster Management Team (DMT) is in charge of planning Big Depot's supply chain operations during the disaster preparedness and response phases.

The DMT has to decide how many units of each group of products highly demanded during the hurricane season should be reserved and paid in advance through contracts with their vendors. Also, the DMT has to decide how the reserved inventory should be allocated among Big Depot's four regional warehouses. The DMT expects that with adequate pre-purchasing and proper allocation of the products, total procurement and inventory re-allocation transportation costs are minimized.

2 Background

Big Depot is a company committed to respond to the communities it does business with after they are hit by a disaster such as a hurricane, by staying in operation and offering products according to the pre-strike and post-strike needs of the community. A sample set of key products is listed and grouped as follows:

- ❖ Cover set: blue tarp, plastic sheeting, etc.
- ❖ Lightening set: batteries, spotlight, flashlights, etc.
- ❖ Generators
- ❖ Bottled water
- ❖ Recovery set: rope, ladder, extensions cords, rakes, shovels, scoops, etc.
- ❖ Cleanup set: cleanup products, sponges, brushes, towels, mops, brooms, buckets, trash cans, trash bags, etc.

Big Depot's vendors for pre-strike and post-strike items offer the company discounted prices when the company reserves these items and pays them in advance, i.e. before the storm strikes. When Big Depot reserves and pays for products in advance, vendors ship the reserved items to Big Depot's four regional distribution centers (DCs), according to DMT's allocation decisions. Then, a few days before or right after a hurricane strikes, these items are shipped from the DCs to the Big Depot stores within the area. *If the stores' demand exceeds the regional warehouse inventory, the stores meet the unfulfilled demand paying higher prices to vendors for the expedited delivery of the required products.* These prices are higher than the discounted prices since expedited transportation is more expensive, limited supply of required products after a disaster strikes may cause prices to raise, and it is easier for vendors to plan their processes when demand is known, which allows them to execute their supply processes more efficiently. Nevertheless, Big Depot has an inventory policy that limits company's working capital; therefore, *the DMT has a limited budget for the advance orders*; hence, the budget cannot be exceeded when making their purchasing contracts.

Additionally, lead times when shipping from company's regional DCs to stores are shorter than when the supplies are shipped directly from the vendors. For instance, pre-loaded trailers can be dispatched from DCs to stores right after a storm strikes. Given that usually more than one region is affected during the hurricane season, the reserved inventory for the hurricane season is usually allocated in more than one regional DC. *Big Depot's fairness policy is that all regions should be served equally.* This is why Big Depot's DMT seeks to allocate the reserved inventory to each warehouse proportionally to the projected demand of the region, such that the expected portion of demand fulfilled directly from the regional DC opposed to from vendors by expediting shipping is the same for all regions. *For example, if 25% of the demand is projected to be located in one DC, then 25% of the reserved inventory should be allocated to that DC.* Demand locations are projected based on the hurricane path. Once the hurricane path is known, the reserved items might be required to be re-allocated before the storm strikes in order to maintain a fair inventory distribution among the regions according to the latest information, incurring an additional transportation cost.

You just have been hired as the Big Depot's new DMT. Therefore, you will make recommendations on the reservation quantities for each group of items and the allocation of these items among Big Depot's DCs for the next season.

3 Purchasing decisions

Demand is uncertain for each group of items: cover set, lightening set, generators, bottle water, recovery and cleanup sets. According to historical data, demand for each group follows a normal distribution. *Table 1 shows available demand information and the discounted prices agreed to pay to vendors when the items are reserved and paid in advance.* Observe that the expedited prices from vendors are greater than the discounted prices for all the products. This difference reflects the expected increase in prices once the hurricane strikes, or when it is about to strike.

There is an available budget of \$950,000 to pay in advance for the contracted items. However, if real demand is greater than the reserved quantity, expedited prices will be paid for all required extra units. There is not a budget for these expedited units. If real demand is less than the reserved quantity, extra inventory is assumed to be disposed with no salvage value.

	Cover Set	Lightning Set	Generators	Bottled Water	Recovery Set	Cleanup Set
Prices (\$/unit)						
Discounted Price, c_i	\$60.00	\$15.00	\$100.00	\$3.00	\$25.00	\$10.00
Expected % increase in price	90%	150%	200%	20%	50%	30%
Expedited Price, p_i	\$114.00	\$37.50	\$300.00	\$3.60	\$37.50	\$13.00
Demand (units)						
Mean	4,500	14,000	2,500	35,000	5,000	8,000
95% Percentile	8,612	19,757	4,967	46,514	9,935	14,908
5% Percentile	388	8,243	33	23,486	65	1,092
Std Dev	2,500	3,500	1,500	7,000	3,000	4,200

Table 1. Price and Demand Information

As the DMT, you must now decide how much to reserve and pay in advance for each product item type without exceeding the budget.

TASK 1: Fill out Purchasing Decisions section from Big Depot Answer Sheet (Excel file).

4 Allocation decisions

The vendors will ship the reserved quantities directly to Big Depot's DCs. Transportation costs are included in the prices listed in Table 1 for all the item groups.

Demand distribution among the regional warehouses is uncertain and depends significantly on the hurricane path. *Table 2 shows the potential scenarios for demand locations. This table includes the probability for each scenario to occur, and the expected demand distribution among regions given each scenario.*

Hurricane Path:	Prob:	Demand distribution among regions			
		DC1	DC2	DC3	DC4
1	40%	40%	30%	20%	10%
2	30%	20%	30%	50%	0%
3	30%	0%	10%	20%	70%

Table 2. Potential demand locations scenarios

A few days before a hurricane hits, more information is revealed about the hurricane's particular path and the regions it will affect the most, and therefore about the demand locations; also, the reserved inventory of the hurricane seasonal products is already allocated in Big Depot's regional warehouses according to the DMT's shipping instructions to vendors.

Following the company's (fairness) policy, these products should be allocated to the DCs according to the latest information about the demand distribution among the regions, in order to provide same service level to all regions. *Consequently, once the hurricane path is revealed, product might have to be re-allocated to another warehouse such that the proportion of inventory in a regional DC versus total company's inventory equals the region's percentage of total relief demand. Additional transportation costs would be incurred from shipping products from one DC to another DC, given this re-*

allocation activity. Table 3 shows the average unit transportation cost among all pairs of DCs. For simplicity, an average transportation cost is used instead of using a unit cost per product type. This is a reasonable assumption if the mix of products is constant.

DC/Region	DC1	DC2	DC3	DC4
DC1	\$0.00	\$0.75	\$1.71	\$2.62
DC2	\$0.75	\$0.00	\$1.21	\$1.90
DC3	\$1.71	\$1.21	\$0.00	\$2.04
DC4	\$2.62	\$1.90	\$2.04	\$0.00

Table 3. Average unit transportation cost among DCs

Once the purchasing decisions are made, you as the DMT must decide how to allocate the reserved inventory among Big Depot's regional DCs, considering all possible demand locations scenarios, in order to minimize the re-allocation transportation cost once the hurricane path is revealed.

TASK 2: Fill out Allocation Decisions section from Big Depot Answer Sheet (Excel file).

5 Using decision support tools

Two decision tools were developed to support DMT's decisions: Allocation Decision Tool and Procurement Decision Tool (the instructor will give the group the password to open the MS Excel files with the decision support tools).

The Procurement Decision Tool computes the total reservation cost given a quantity to reserve and pay in advance, and notifies if the budget limit has been violated. This tool also computes the expected expedited cost given the reservation quantities and demand information, and it computes the total procurement cost (reservation plus expedited costs). The Procurement Decision Tool can also evaluate the total procurement cost given a particular demand scenario.

The Allocation Decision Tool can compute the expected re-allocation transportation cost given a set of initial inventory allocation decisions, as well as evaluate such allocation decisions for specific demand locations scenarios (i.e., demand distribution among the four regional DCs).

As the DMT, now you can use the given tools to evaluate your proposed decisions, that is, to calculate their expected cost. Following, you may look for better procurement and allocation solutions (if any) with the aid of the tools.

TASK 3: Fill out Decision Support Tools section from Big Depot Answer Sheet (Excel file.)

6 Revealed demand

The storm is about to strike and the real demand distribution among the regional DCs is now revealed given that the hurricane path is now known (the instructor will provide this path). Regional DCs inventory should be allocated according to the revealed demand locations scenario; therefore, inventory might have to be re-allocated among the DCs. *As the DMT, you must determine the inventory quantities to be re-allocated such that the distribution of inventory among the DCs equals the distribution of demand according to the hurricane path. Re-allocation transportation cost must be determined as well* (the Allocation Decision Tool might be used for this purpose).

Once the storm strikes, total demand is known (the instructor will reveal this total demand). If the inventory in the regional DCs is greater than the total demand for all group of items, there will not be need of purchasing any extra product units. *However, if total demand is greater than the total inventory for a certain group of items, as the DMT you should order additional product units to be shipped directly to stores and pay an expedite price for such units. You also must compute the procurement cost of the expedited units and the total procurement cost* (the Procurement Decision Tool could be used for this reason).

TASK 4: Fill out Revealed Demand section from Big Depot Answer Sheet (Excel file).

7 Discussion questions

- a. Two common decisions for disaster planning were analyzed in this case study: to contract and reserve inventory in advance, and to allocate the reserved inventory. Discuss other important decisions to prepare and respond to a disaster in an efficient and timely way.
- b. Demand uncertainty (size and location) was identified in this case study as a very important logistics challenge when planning for a disaster. Discuss other logistics challenges that may not have been explicitly mentioned, but that could arise in disaster planning and response. How are these challenges similar or different from the ones faced during day-to-day operations of a company such as Big-Depot?
- c. How might operations research or supply chain management methods can be used to address challenges such as those discussed in question b?
- d. The game was solved in two phases. During the second phase, a decision support tool was provided. Such tool calculated the expected cost given a strategy, and allowed to study how this cost would change under different demand scenarios. What are the benefits of using a decision support tool like the one used in this exercise? How could these decision support tools be improved?
- e. Suppose that the DCs are not prepared to storage the generators and significant additional warehousing costs might be incurred. These additional costs are estimated to be about 20% of the generators' discounted price. Warehousing costs information is own by DMT's Logistics Department, but the procurement decisions are made by the Merchandising Department. How this situation could affect procurement decisions? Why is important that everyone involved in the supply chain is aware and participates in the planning process of other operative departments?