IE 460 Fall 2023 Comments on Homework #1

General Comments:

This homework is more demanding than the following two homework – HW#2 and HW#3. It is also interesting that these two questions cover a lot of ideas we have been touching on in this course. Nevertheless, the problem environments are non-complicated (all deterministic and constant), making it possible to solve.

My expectations when asking these questions were twofold:

1. Each part of the question is building additional complexity (no optimization, a simple optimization, a joint optimization, etc.), allowing one to notice the alternatives for improving the system's performance. IE's role is to utilize the skill background to come up with a better solution.

2. One would systemically approach the solutions. Being systematic means that one will set up a simple computational environment (in this case, EXCEL is sufficient), where implementing the formulas obtained from the optimization models and computing the average cost will be straightforward. Using a computer aid for homework computations may seem more than necessary. However, it is the only way to do this if you want to avoid making any computational errors and ensure that the formulas' implementation is correct. Being more general than the current requirements is an inescapable part of the engineering approach.

The existence of the background, generality and rigor will allow you (IE) to verify the models you are using (make sure that (i) they are correctly written – debugged; (ii) they give the intended results in the extreme cases) and efficiently carry out a similar set of computations when the parameters are different (sensitivity, responding to what-if questions, etc.).

Homework 1 statistics:

Average: 1.43 (out of 2), Standard Deviation: 0.56

Grades	**0**	**1**	**2**	**3**
# of students	4	15	16	2

Question 1

The question exemplifies a typical situation in supply chains: Depending on the organizational structure, delivery (or procurement) decisions to different customers (or from other suppliers) can be made by various departments in the name of specialization. Although specialization has clear benefits, supply chain decisions require coordination among those decision-makers for understandable economic concerns.

In Part a), there is a basic assumption that a truckload will always be used. Having full truckloads will best utilize the capacity. This line of thought is only sometimes correct as there are economic concerns if one thinks all the cots simultaneously (systemic approach). One should remember that (i) there are a few truck types with different capacities (in other words, one cannot find any arbitrary capacity available); (ii) TopOil probably has its fleet or an agreement with a logistics firm and hence the truck capacity (and the cost associated) is given.

Solution: There needs to be optimization as the frequency of shipments is constant (and hence the lot size). You are asked to evaluate the costs.

Part b) investigates a better policy, as shipping in full is not necessarily optimal. Still, customers are treated independently.

Solution: Solve EOQ for each customer. In the optimal solution, the optimal delivery quantities are less than the truck capacity. So, the answer is straightforward.

Additional Question: What happens if the unconstrained optimal (as the EOQ problem doesn't consider the capacity limitation) is larger than the capacity?

Part c) asks you to aggregate the shipments to all customers (incurring additional cost per stop) and solve the related optimization problem. Now, we are getting somewhere by spending more effort to improve the system performance (in other words, to reduce the average cost).

Solution: The description clearly states that the truck will visit each customer every time. Hence, the problem becomes finding the best visit frequency (from there, one can determine the quantities for each customer). The description fits the standard milk-run problem mentioned in the class. In the optimal solution, the sum of the optimal delivery quantities is less than the truck capacity. So, the answer is straightforward.

Additional Question: What happens if the optimal frequency found (which doesn't consider the capacity constraint) is not feasible?

Part d) may instill exciting arguments. One approach was detailed in class, which allowed for delivering some customers every cycle, or once every two cycles, etc. One may want to see what we did for that model and adapt this problem to the model. Here, the critical issue is getting the intuition: The small customer in part a) receives a vast inventory, increasing its average cost. When one operates with the standard milk run (visiting all customers each time), the fixed cycle time computed may not fit well for customers of any size. (Think: What works well? Hint: If the cycle time obtained is close to that under independent EOQ, we mean it fits well.) It will unlikely provide a good solution for the small customer if it does well for the large customer.

<u>Comments regarding your performance and Grading:</u>

- In *part a*, the order quantity equals the truck capacity for all customers, which is 12.
- Most calculated days of inventory values by wrong formulas. The formula for days of inventory is Q/(2D), where D is the daily demand (or annual demand/365).
- Some needed clarification about assigning correct fixed order costs. Specifically in part d when calculating n values.
- Some tend to round up/down numbers even if unnecessary. For example, in part a, the number of orders for the small customer can stay at 0.7, and one does not need to round it up to 1.
- In *part d*, some of you did not compare the total cost with the total cost in *parts b* and c.
- In *parts c* and *d*, some did not consider the truck capacity and did not check whether the calculated quantities were feasible.

- Grading: In general, if the formulas were not provided but the answers were clear (the numbers are explained in a way) and correct, no points were deducted. If formulas were provided, but there were some mistakes, and the final answers were incorrect, no points were deducted. Students who solved all four parts entirely or with minor errors got full points (2 points) from this question. Students who solved all four parts with fewer crucial mistakes or did not solve one of the parts received 1.5 points. Others got 1 point (out of 2). Receiving 0 points means that your solution is either entirely wrong or there is no solution.

Question 1 Statistics:

Average: 1.34 (out of 2), Standard Deviation: 0.36

Grades	0	1	1.5	2
# of students	4	10	13	10

Question 2

This question summarizes a comprehensive example of understanding the idea of quantity discounts in a supply chain environment.

Part a) is the typical quantity discount model you have learned in IE375, with the effect of the retailer's choice on the supplier. From the problem statement, we understand that the manufacturer is setting up only the quantity ordered by the retailer (lot-for-lot is the term we use for this or a similar situation). So, once the retailer decides on the amount to order, one can compute the associated cost to the manufacturer. However, one can optimize the manufacturer's operations by letting her produce more (an integer times the order quantity stated by the retailer). In this problem, it is always the same lot size for the retailer and manufacturer.

Solution: The retailer orders her EOQ, and the manufacturer follows.

Part b) asks you to solve the supply chain problem, again under the lot-for-lot assumption. In this case, we can further analyze the situations where the manufacturer's production quantity is an integer multiple of the retailer's order quantity.

Solution: You need to carefully add up all the costs to solve the supply chain problem using the EOQ approach.
Part c) and Part d) ask about the effects of a possible discount given by the manufacturer to the retailer. This time, the EOQ value is known in both parts, but one of the parameters is unknown - unit cost and fixed cost, respectively, for parts c) and d). In both cases, the EOQ formula is used.

Comments regarding your performance and Grading:

- In this question, some assumed the problem was a multi-echelon problem and solved it accordingly. These students received no points for this question.

- Some of you needed to explain your solution more thoroughly and/or provide the necessary formulas. In this case, points were deducted when your answer was incorrect. Please provide the formulas you use in the solution (or Excel).

- Most solved *parts a* and *b* correctly.

- Some did not calculate the reduction in cost in *part b*.

- Most of you did not attempt to solve parts c and d or made serious mistakes.

- Grading: In general, if the formulas were not provided but the answers were clear (the numbers are explained in a way) and correct, no points were deducted. If formulas were provided, but there were some mistakes, and the final answers were incorrect, no points were deducted. Students who solved all four parts entirely or with minor errors got full points (2 points) from this question. Students who solved all four parts with fewer crucial mistakes or did not solve one of the parts received 1.5 points. Others got 1 point (out of 2). Receiving 0 points means that your solution is either entirely wrong or there is no solution.

Question 2 Statistics:

Average: 1.05 (out of 2), Standard Deviation: 0.54

Grades	**0**	**1**	**1.5**	**2**
# of students	10	10	10	7