DSS5202 Sustainable Systems Analysis
Assignment #4
Due: 21 October 2024

Submission Instructions

Write your overall answers to each question in one PDF file and submit it together with any supporting Excel, py, ipynb, etc files in **ONE ZIP** file on Canvas.

Problem Description

TS is a biologics company that manufactures a potentially life-saving drug for patients suffering from rare blood diseases. The drug is first manufactured in the form of a bulk drug substance (BDS) in the Singapore plant and then dispatched to distribution centers in key regions such as Switzerland, New York, and California. After the BDS has been filled into 2.5 mL vials, it is then packed into sterile syringes. Upon completion of the packaging process, the product is ready for distribution to customers in Brazil, Japan, and Russia. Relevant data for the problem is given in the Appendix.

Answer the following questions:

1. If the manufacturing facility in Singapore has a capacity equivalent to 328,000 vials per month, formulate an optimization model in an algebraic form that minimizes the total costs to satisfy the customers' demand.

Present your solution in the following format: (20 marks)

Optimal Total Monthly Cost: _____

Distribution Center(s) to Open: _____

Quantity shipped from Singapore to the Distribution Centers:

Distribution Center	Number of vials per month
Switzerland	
California	
New York.	
Total	

Quantity shipped from Distribution Centers to Key Markets

From \ To	Brazil	Japan	Russia	Total
Switzerland				
New York				
California				
Total				

2. Suppose the manufacturing capacity in Singapore is reduced to 300,000 equivalent vials per month due to the urgent reallocation of facilities to manufacture other top-priority vaccines. Explain how your model in Question 1 can be modified to cater to this situation. Present your suggested optimal solutions in the same format as in Question 1. (20 marks)

3. What are the major advantages and disadvantages of your modified model in Question 2? (5 marks)

4. Suggest how your model in Question 2 may be improved and what additional information or data may be needed. (5 marks)

Appendix

Table 1. Customer Demands

Customer	Demand (No. of vials per month)
Brazil	140,000
Japan	80,000
Russia	108,000

Table 2. Fixed Operating Cost of Distribution Center

Distribution Centre	USD per month
Switzerland	920,000
New York	830,000
California	780,000

Table 3. Transportation Cost from Singapore to Distribution Centers

Distribution Centre	USD per vails
Switzerland	10.30
New York	15.30
California	13.80

Table 4. Transportation Cost from DC to Customer (USD per vial)

	Brazil	Japan	Russia
Switzerland	9.00	9.50	5.90
New York	6.50	10.80	8.60
California	9.00	8.60	8.30

Table 5. Distribution Canter Capacity Data

Distribution Center	No. of vials per month
Switzerland	210,000
New York	190,000
California	160,000