Homework #3

Brian Gao

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Product 1

Regional distribution center

```
import numpy as np

# Define parameters
review_interval = 6  # days
lead_time = 5  # days
cycle_service_level = 0.95
holding_cost_per_unit_per_day = 0.15
inbound_transportation_cost_per_unit = 0.09
outbound_transportation_cost_per_unit = 0.10

# Calculate z-score for 95% cycle service level
z_score = 1.645  # Approximate value for 95% service level

# Extract data for Product 1
product1_data = data['Product1']

# Initialize a dictionary to store the results
results = {
    'Region': [],
    'OUL': [],
    'Average Order Quantity': [],
    'Average Cycle Stock': [],
    'Average Safety Stock': [],
    'Average Inventory': [],
    'Daily Average Inventory Holding Cost': [],
    'Daily Average Transportation Cost': [],
```

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    'Total Daily Average Cost': []
}

# Perform calculations for each region
for region in product1_data.columns:
    daily_demand = product1_data[region]
    d = daily_demand.mean()
    sigma_d = daily_demand.std()

    # Calculate Safety Stock
    SS = z_score * sigma_d * np.sqrt(lead_time)

    # Calculate Order-Up-To Level (OUL)
    OUL = d * (review_interval + lead_time) + SS

    # Calculate Average Order Quantity
    average_order_quantity = d * review_interval

    # Calculate Average Cycle Stock
    average_cycle_stock = average_order_quantity / 2

    # Calculate Average Inventory
    average_inventory = average_cycle_stock + SS

    # Calculate Daily Average Inventory Holding Cost
    daily_average_inventory_holding_cost = average_inventory * holding_cost_per_unit_per_day

    # Calculate Daily Average Transportation Cost
    daily_average_transportation_cost = (inbound_transportation_cost_per_unit + outbound_tra

    # Calculate Total Daily Average Cost
    total_daily_average_cost = daily_average_inventory_holding_cost + daily_average_transport

    # Store the results
    results['Region'].append(region)
    results['OUL'].append(OUL)
    results['Average Order Quantity'].append(average_order_quantity)
    results['Average Cycle Stock'].append(average_cycle_stock)
    results['Average Safety Stock'].append(SS)
    results['Average Inventory'].append(average_inventory)
    results['Daily Average Inventory Holding Cost'].append(daily_average_inventory_holding_c
    results['Daily Average Transportation Cost'].append(daily_average_transportation_cost)
```

```
    results['Total Daily Average Cost'].append(total_daily_average_cost)

# Convert results to DataFrame for better readability
results_df = pd.DataFrame(results)

results_df
```

	Region	OUL	Average Order Quantity	Average Cycle Stock	Average Safety Stock	Average In
0	Region1	346.640522	179.252690	89.626345	18.010591	107.63693
1	Region2	347.500020	179.002225	89.501112	19.329275	108.83038
2	Region3	349.871140	180.935009	90.467504	18.156957	108.62446
3	Region4	344.533564	177.996310	88.998155	18.206996	107.20515

National distribution center

```
 # Define new transportation costs for the National distribution center
national_inbound_transportation_cost_per_unit = 0.05
national_outbound_transportation_cost_per_unit = 0.24

# Combine the demand data from all regions to represent the National distribution center
national_daily_demand = product1_data.sum(axis=1)
d_national = national_daily_demand.mean()
sigma_d_national = national_daily_demand.std()

# Calculate Safety Stock for the National distribution center
SS_national = z_score * sigma_d_national * np.sqrt(lead_time)

# Calculate Order-Up-To Level (OUL) for the National distribution center
OUL_national = d_national * (review_interval + lead_time) + SS_national

# Calculate Average Order Quantity for the National distribution center
average_order_quantity_national = d_national * review_interval

# Calculate Average Cycle Stock for the National distribution center
average_cycle_stock_national = average_order_quantity_national / 2

# Calculate Average Inventory for the National distribution center
average_inventory_national = average_cycle_stock_national + SS_national

# Calculate Daily Average Inventory Holding Cost for the National distribution center
```

```
daily_average_inventory_holding_cost_national = average_inventory_national * holding_cost_per

# Calculate Daily Average Transportation Cost for the National distribution center
daily_average_transportation_cost_national = (national_inbound_transportation_cost_per_unit +

# Calculate Total Daily Average Cost for the National distribution center
total_daily_average_cost_national = daily_average_inventory_holding_cost_national + daily_ave

# Store the results in a dictionary
national_results = {
    'Metric': ['OUL', 'Average Order Quantity', 'Average Cycle Stock', 'Average Safety Stock
    'Value': [OUL_national, average_order_quantity_national, average_cycle_stock_national, SS
}

# Convert results to DataFrame for better readability
national_results_df = pd.DataFrame(national_results)
national_results_df
```

	Metric	Value
0	OUL	1353.023838
1	Average Order Quantity	717.186233
2	Average Cycle Stock	358.593116
3	Average Safety Stock	38.182411
4	Average Inventory	396.775528
5	Daily Average Inventory Holding Cost	59.516329
6	Daily Average Transportation Cost	34.664001
7	Total Daily Average Cost	94.180330

- Regional Total Daily Cost: $87.56
- National Total Daily Cost: $94.18

For Product 1, the regional distribution centers have a lower total daily cost compared to the national distribution center. Therefore, the regional distribution center model is recommended for Product 1.

Product 2

Regional distribution center

	Region	OUL	Average Order Quantity	Average Cycle Stock	Average Safety Stock	Average In
0	Region1	124.014636	61.734266	30.867133	10.835148	41.702281
1	Region2	122.857925	61.005165	30.502582	11.015123	41.517705
2	Region3	119.554199	59.348324	29.674162	10.748938	40.423100
3	Region4	124.218983	62.012635	31.006318	10.529152	41.535470

National distribution center

	Metric	Value
0	OUL	469.171861
1	Average Order Quantity	244.100391
2	Average Cycle Stock	122.050195
3	Average Safety Stock	21.654478
4	Average Inventory	143.704674
5	Daily Average Inventory Holding Cost	21.555701
6	Daily Average Transportation Cost	11.798186
7	Total Daily Average Cost	33.353887

Product 3

Regional distribution center

	Region	OUL	Average Order Quantity	Average Cycle Stock	Average Safety Stock	Average In
0	Region1	119.031673	58.687131	29.343566	11.438599	40.782165
1	Region2	117.700347	58.050420	29.025210	11.274577	40.299787
2	Region3	120.443877	58.874310	29.437155	12.507642	41.944797
3	Region4	120.529564	59.336476	29.668238	11.746025	41.414263

National distribution center

	Metric	Value
0	OUL	468.569137
1	Average Order Quantity	234.948337
2	Average Cycle Stock	117.474168
3	Average Safety Stock	37.830519
4	Average Inventory	155.304688
5	Daily Average Inventory Holding Cost	23.295703

	Metric	Value
6	Daily Average Transportation Cost	11.355836
7	Total Daily Average Cost	34.651539

- Regional Total Daily Cost(Products 2): $32.51
- National Total Daily Cost(Products 2): $33.35
- Regional Total Daily Cost(Products 3): $32.11
- National Total Daily Cost(Products 3): $34.65

For Products 2 and 3, the regional distribution centers also have a lower total daily cost compared to the national distribution center. Hence, the regional distribution center model is preferable for these products as well.