Introduction to Logistics and SCM

– Distribution Logistics –

Distribution Network Design – Case Study

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1 INTRODUCTION

The following case study challenges you to apply certain logistic methods to solve a real world scenario. In order to be able to solve this case study you have to read carefully through the provided material and to understand the explained methods. This includes both logistics and spreadsheet related methods and calculations. You will read the case description, but the required data to conduct the analysis will not be provided beforehand. On the day of the case study you will have a short introduction to fresh up the required methods and to explain the case. Then you will work through the case step by step in groups and present your findings in a one-page report.

2 CASE DESCRIPTION

Your group is a part of a logistics consultant company, and you have been given the task to analyze the distribution network of XYZ Company. Your group visited the CEO of the company, and receveid the following information.

Currently, XYZ has a decentralized distribution network with two warehouses - one in Bremen, Germany, and another one in Valencia, Spain. Both are serving a fixed number of retailers in certain locations of Europe. The product is brought from Shanghai, China via ship to Bremerhaven port in Germany, and to the Port of Santander in Spain. From Bremerhaven it is transported via truck to Bremen and from Santander it is transported via railway to Valencia. However, the management board has a plan to build a centralized warehouse in Paris, France. Your group is responsible to analyze a centralized warehouse network compared to the actual given situation and present a conclusion.

The warehouse in Bremen serves retailers in Bremen, Hamburg, Berlin, Paris and Munich. The warehouse in Valencia serves retailers in Valencia, Madrid, Marseilles, Lisbon, and Bordeaux (cf. Figure 1). For the new distribution network consider that the incoming goods will be shipped to the port of Le Havre, and then be brought to Paris via train (cf. Figure 2).

DATA PROVIDED BY XYZ COMPANY INCLUDES:

1. Average Incoming Transportation cost per unit to different locations.
2. Distances for Incoming Transportation.
3. Orders for the last twelve months.
4. Weights and purchase value of different item.
5. Transportation cost list from different warehouses to different customers.
6. Distances list from different warehouses to different customers.
7. Lead time for delivery to different locations from different warehouses.
8. Data involving redesign.
9. Average CO_2 Emission rates per Transport Type.

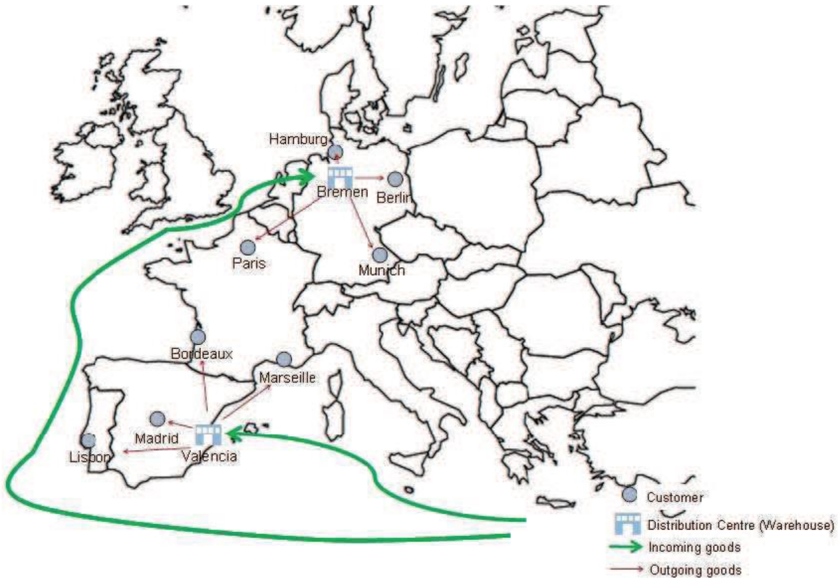

FIGURE 1. DECENTRALIZED DISTRIBUTION NETWORK (EXISTING)

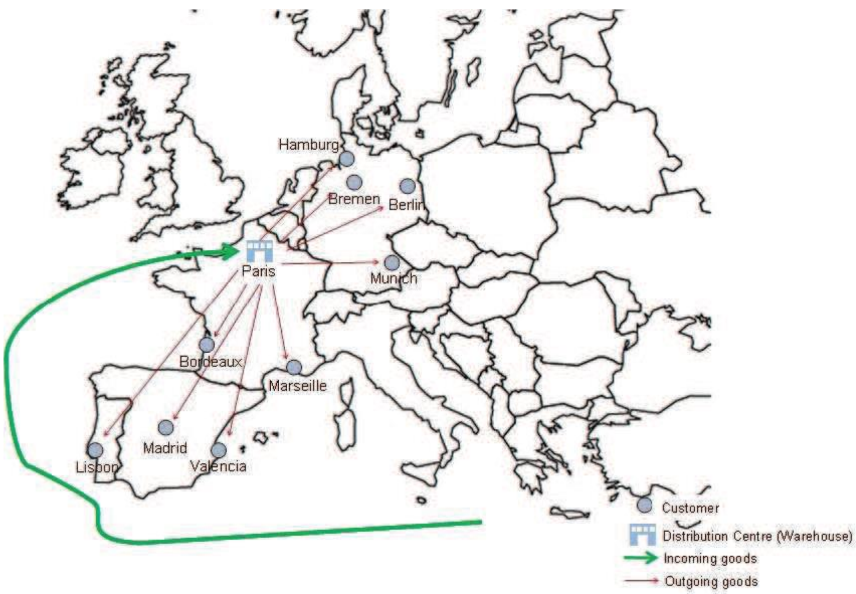

FIGURE 2. CENTRALIZED DISTRIBUTION NETWORK (PLANNED)

YOUR CONCLUSION SHOULD INCLUDE:

1. Is it profitable to change the current decentralized distribution network to one with a centralized warehouse (without considering the redesign costs)?

2. If so, considering the redesign costs, what is the breakeven point?

3. What is your conclusion regarding the logistics performance (delivery time, costs, and total CO_2 emissions) of the distribution network scenarios?

4. Considering the trade-off of logistics targets, what will your answer to XYZ Company? Which distribution network should XYZ utilize?

3 ANALYSIS

3.1 STORAGE COSTS

Storage costs are the expenses associated with maintaining inventory. Standard accounting practice is to value inventory at purchase or standard manufacturing costs rather than at selling price. Determining the storage costs percentage rate requires assignment of inventory related costs. These can be divided into inventory holding costs and warehouse operation costs:

Inventory holding costs consist of capital tied-up costs, the appropriate charge to place on capital invested in inventory. The logic behind this is that the capital invested in inventory can be invested in the money market to gain return (opportunity costs). The costs of capital must be clearly specified since it has significant impact on system design and performance.

Warehouse operation costs include costs that are affected by storage and operation of the inventory. They consist of labour costs, space costs (e.g. rent), capital costs and depreciation of equipment, consumption and maintenance costs, overhead costs (e.g. electricity, taxes) and/or payment to external service providers.

According to Schönsleben the storage costs can be estimated to be 20% of the value of the average stock level:

$$Storage\ Costs = \left(\sum_{i=1}^{N}\left(\left(\frac{lot\ stock_i}{2} + safety\ stock_i\right) x\ purchase\ value_i\right)\right) x\ 0.2$$

- $lot\ stock_i$ – lot stock for product i
- $safety\ stock_i$ – safety stock for product i
- $purchase\ value_i$ – purchase value for product i

In order to calculate the storage costs it is necessary to know the lot stock, safety stock and purchase value of each type of product. There are many different ways to calculate lot stock and safety stock. In the following you will find simple but often used formulas for each.

3.1.1 ECONOMIC ORDER QUANTITY (EOQ)

The EOQ model is one of the earliest models used to determine the economic lot size so as to strike up the balance between ordering costs when purchased (setup costs tied with the start of each production process) and the costs tied up with the inventory. Since ordering costs (or overall costs of production if produced) is reduced with large lot size while low inventory level can be achieved with the smaller lot size, EOQ model can be used to determine the economic lot size.

To derive the economic lot size formula, the following assumptions are made:

1. Production is instantaneous.
2. Delivery is immediate.
3. Demand is deterministic.
4. Demand is constant over time.
5. An ordering cost is fixed per order.
6. Products can be analyzed individually.

With this assumption, we can derive the formula for the economic lot size by using following notions:

D demand rate in units per year

c unit production costs in euro per year

A fixed ordering costs to purchase a lot in euro

h holding costs in euro per unit per year

Q lot size in units that is to be determined

i annual interest rate

In EOQ, both time and product are represented as continuous. Since demand is assumed to be constant and Q units are ordered each time the inventory reaches zero, the average inventory level is thus $\frac{Q}{2}$ (cf. figure 4).

- Hence, holding cost associated with the inventory is $\frac{hQ}{2}$ per year
- The ordering cost is $\frac{AD}{Q}$ per year as $\frac{D}{Q}$ orders are placed per year
- The production cost is $c \ x \ D$ per year

Thus, the total cost per year can be expressed as:

$$Y\ (Q)\ =\frac{hQ}{2}+\frac{AD}{Q}+cD$$

The first derivative of $Y\ (Q)$ is:

$$\frac{dY(Q)}{dQ}=\frac{h}{2}-\frac{AD}{Q^2}$$

And the second derivative of $Y\ (Q)$ is:

$$\frac{d^2Y(Q)}{dQ^2} = \frac{2AD}{Q^3}$$

As the second derivative of $Y\ Q)$ is positive, the first derivative has minimum value when it is zero. Thus the lot size that minimizes $Y(Q)$ in the above costs function is Q^*:

$$Q^* = \sqrt{\frac{2AD}{h}}$$

If the holding costs consist entirely of interest on money tied up in the inventory $h = i\ x\ c$, where i is the annual interest rate, the lot size that minimizes $Y(Q)$ is:

$$Q^* = \sqrt{\frac{2AD}{ic}}$$

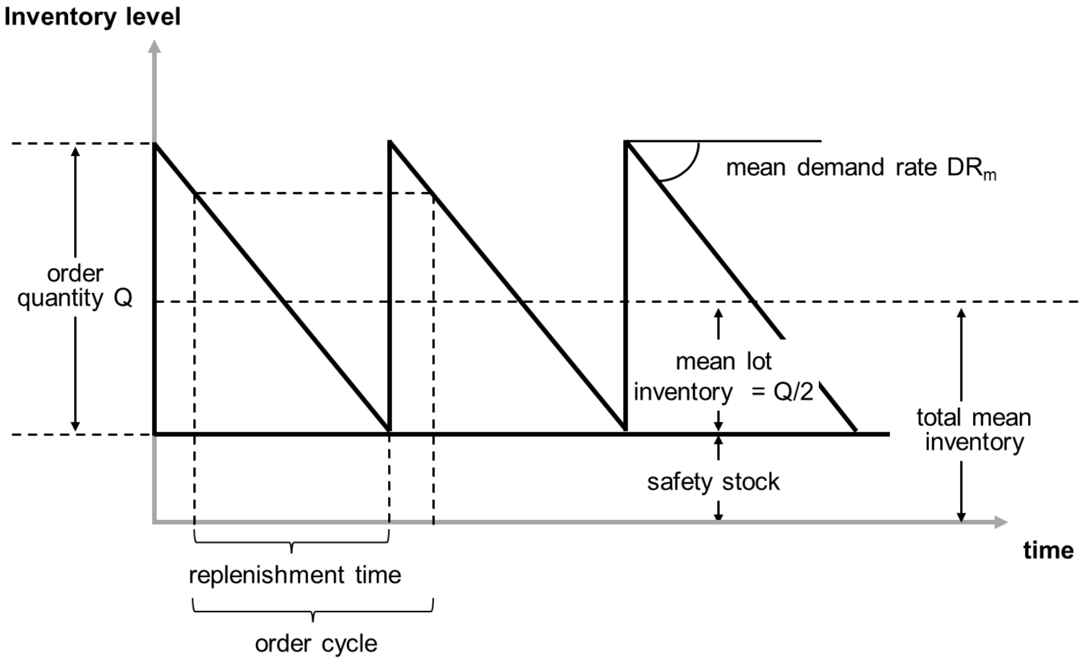

FIGURE 3. GENERAL STORAGE MODEL

If we assume that the order cycle and replenishment time are equal, we can find the replenishment time RT for our incoming lots, by divide the order quantity Q by the demand rate (Q is the Economic Order Quantity and the demand rate given by the slope in the storage model):

$$RT = \frac{Q}{D} \times 365 \text{ (or 366 for a leap year)}^1$$

[1] As the demand rate (D) is given per year, the calculated replenishment time will also be expressed in terms of year. To convert the RT into days (needed for further calculations) please multiply it by 365 (366 for leap year).

3.1.2 SAFETY STOCK

Safety stock is required to tackle various deviations, e.g. deviation in delivery due date, deviation in delivery quantity, or deviation in demand. For the present case deviation in delivery due date and delivery quantity is considered to be zero. Thus, we will rather focus on the deviation of demand during the safety stock calculation. A simple way of calculating safety stock is based on the following formula:

$$SS = (DR_{max} - DR_m) \times RT$$

SS	safety stock [units]
DR_{max}	maximum demand rate [units/SCD]
DR_m	mean demand rate per item [units/SCD]
RT	replenishment time [SCD]

Naturally, you need to calculate the safety stock for each type of product individually, due to the fact that offering product X instead of Y will not satisfy the customer.

In addition, in order to limit the effect of outliers in the data on your safety stock levels, you need to use the average daily demand for each month (the total number of products ordered within a month divided by the number of days in that month). You can then use the average daily demand from the 12 months to calculate DR_{max} (the maximum of the average daily demands from the 12 months) and N_0 (the mean of the average daily demands from the 12 months).

3.2 TRANSPORTATION COSTS

Transportation costs include multiple directly and indirectly related costs, such as drivers' wages, overhead, parking, environmental costs, congestion, etc., as well as distance of travel. Another factor affecting the transportation costs are the goods' characteristics, namely weight and volume.

In this case you have to consider two types of transportation during your analysis - incoming and outgoing shipments (cf. Figure 4).

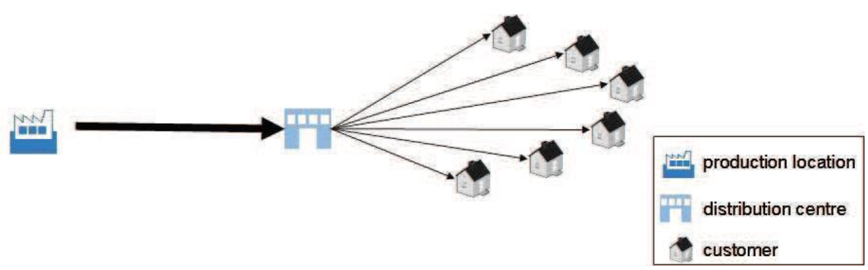

FIGURE 4. TRANSPORTATION

3.2.1 INCOMING SHIPMENTS

Incoming shipment includes transportation during procurement of goods. In our case, different items are procured from different manufacturers in China. Each item is shipped to different warehouses. This cost depends on ordering costs and the weight of the shipment charged by the shipper. To determine the number ofincoming shipments (orders to supplier) made in a year you have to divide the annual demand by the economic order quantity (EOQ).

$$\text{Number of Orders to Supplier} = \frac{D}{Q}$$

NOTE: Make sure to round up the outcome to the nearest integer.

Furtehr, the weight of shipment affects the rate of transport. The cost for incoming shipments that includes ordering cost per shipment and rate per weight will be given. From this you should be able to calculate incoming transportation cost.

3.2.2 OUTGOING SHIPMENTS

Outgoing shipments include shipments during the distribution of goods from the warehouse. Their cost can be calculated from the cost table provided by the forwarding company (see Table 1).

The weight of the shipments affects the total costs of the shipment. The costs for first 100 kg is fixed, as can be seen from the freight forwarder, if the weight exceeds 100 kg then the shipment is charged per kg with a different shipment rate. The different per kg charges for different range of weights is also provided (see Table 1).

TABLE 1. FREIGHT COSTS TABLE EXAMPLE

Weight		Zones				Unit
from (<)	up to (≤)	1	2	3	4	
0	100	27.30	23.17	31.07	30.35	price per shipment
100	300	0.443	0.375	0.521	0.494	price per KG
300	500	0.341	0.289	0.401	0.383	price per KG
500	1,000	0.248	0.295	0.339	0.330	price per KG
1,000	1,500	0,224	0.204	0.264	0.270	price per KG
1,500	2,000	0.121	0.153	0.212	0.236	price per KG
2,000	3,000	0.113	0.140	0.197	0.220	price per KG

3.3 REDESIGN COST

In case of the analysis of distribution networks, the redesign cost includes all modifications in the layout of the supply network. These modifications are targeted towards a distribution center or existing facilities. The cost is primarily affected by two decisions:

1. Building a new distribution center (DC) or enlargement of existing DC facility.
2. Decrease or shutdown of an existing DC.

When a new DC is to be built or the existing one is to be expanded with the addition of new facilities, the cost of redesigning is influenced by various factors, such as the new infrastructure, slow warehouse utilization, ramp up costs, etc. Downsizing or shutting an existing DC down also influence redesign costs. Performing either of the two actions will cause unemployment, call for employee and partner compensations, incur maintenance costs and run out costs.

In our case, the construction of a distribution center can be estimated based on the following assumptions:

- $1m^3$ stock volume is calculated for 150 kg
- additional 50% of the stock volume is required for corridors
- additional 50% of the stock volume is required for loading and unloading area
- additional 100% of the stock volume is required for testing, painting, packing area
- $1\ m^3$ = 90 Euro (costs for the building and instalations)

For the shutdown of the warehouse, the costs of selling the equipment are positive. However, the other costs that are to be borne, for example breaking of the contract, run out costs, etc., are negative. This shutdown costs will be given as provided by XYZ Company.

3.4 COST COMPARISON

After calculating the different kinds of costs your team has to come up with a final conclusion for the costs analysis. Therefore, a second look at the calculated costs is necessary. You can differentiate between periodical costs and one-time costs. Transportation costs and storage costs are periodical costs that occur over and over. Redesign costs on the other hand are an investment. In case the periodical costs of a future scenario are lower than the current periodical costs the amortization time of the investment must be determined. Payback Period is the period until the investment pays off. To determine the length of this period in years one has to divide the investment costs by the annual savings:

$$Payback\ Period = \frac{\sum investment\ costs}{annual\ savings}$$

3.5 DELIVERY TIME

All the above-mentioned methods are cost-based analysis. However, delivery performance also plays a very important role during the analysis. Hence, your analysis should also be based on delivery time, which is one of the key indicators of logistics performance. It can be seen from Figure 5 that delivery time covers time for order preparation and material handling process as well as the transportation time. Delivery time basically is the period between the order placement by the customer and receiving of the goods.

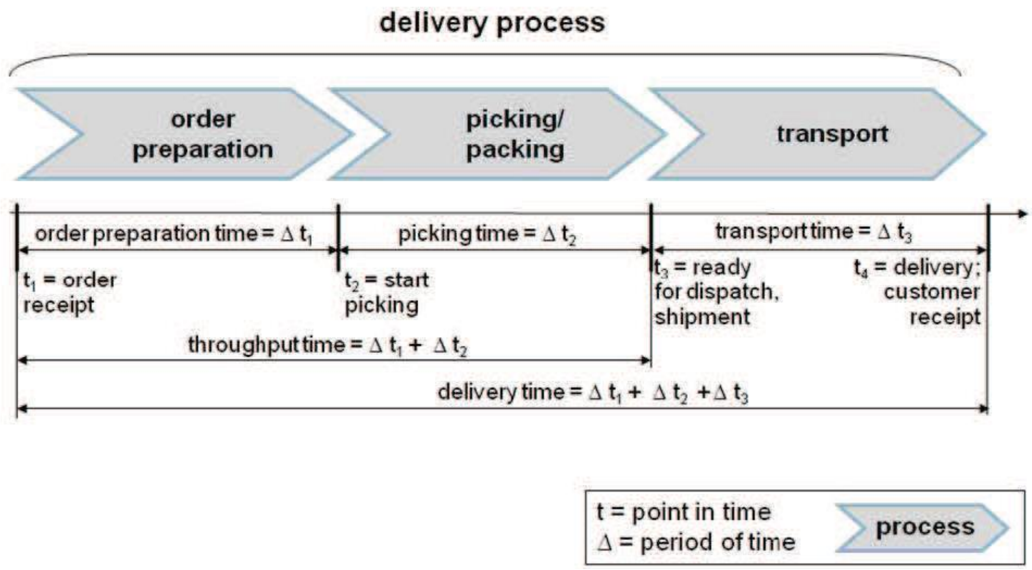

FIGURE 5. DELIVERY TIME

The order preparation and picking/packing time combined give the Throughput time and this is affected by processes involved during these operations. In our case, the existing warehouses take two days for order preparation and picking/packing. However, the new warehouse to be built in Paris will take only one day for the same processes because of the increased automation. The transport time from warehouses to different locations are provided. The average transportation time per warehouse needs to be calculated. The delivery time is derived as shown in Table 2.

TABLE 2. DELIVERY TIME

	Decentralized	Centralized
Throughput Time	2	1
Average Transportation Time	X (to be calculated)	Y (to be calculated)
Delivery time	2+X	1+Y

3.6 CARBON FOOTPRINT

As an additional factor, it is also important to consider the carbon footrpint of a given scenario. Thus, your analysis should also include the total CO_2 emission as another key performance indicator. Different transportation types have different emission rates, dependent on the weight of the good and the transport type. In this case you have to calculate the total emissions for both incoming and outgoing shipments. The incoming shipments involve different transporation types (see Table 3). All outgoing goods are transported by trucks from the warehouse to the customer. The distances from each location are already calculated for you.

TABLE 3. FREIGHT TYPE FOR INCOMING SHIPMENTS

Bremen	Shanghai to Bremerhaven	Ship freight
	Bremerhaven to Bremen	Truck freight
Valencia	Shanghai to Santander	Ship freight
	Santander to Valencia	Train freight
Paris	Shanghai to Le Havre	Ship freight
	Le Havre to Paris	Train freight

The different emission rates by freight type are also included:

- Ship freight: 7.7 g CO_2/km*tonnes = 0.0077 g CO_2/km*kg
- Train freight: 23 g CO_2/km*tonnes = 0.0230 g CO_2/km*kg
- Truck freight: 54.5 g CO_2/km*tonnes = 0.0545 g CO_2/km*kg

4 LITERATURE

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Entwicklung und Anwendung einer Methode zur Planung von Distributionsnetzwerke Philipp, T.; Teucke, M.; Jeken, O.; Scholz-Reiter, B.; Windt, K. In: PPS Management Nr.3, Jahrgang 13 (2008), GITO-Verlag, Berlin, S. 42-46.

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5 SPREADSHEET CALCULATION

It is now your job to use a spreadsheet (MS Office Excel or Open Office) to calculate the transportation costs of each order. The functions that are helpful in the calculation are given here. You will find similar functions in any spreadsheet program.[4]

VLOOKUP

This function is a vertical search with reference to adjacent cells to the right. This function checks if a specific value is contained in the first column of an array. The function then returns the value in the same row of the column named by index. If the Sort order parameter is omitted or set to TRUE, it is assumed that the data is sorted in ascending order. In this case, if the exact search criterion is not found, the next value will be returned. If Sort order is set to FALSE or zero, an exact match must be found, otherwise the error: Error Value Not Available will be the result. Thus with the value of zero the data does not need to be sorted in ascending order.
Syntax VLOOKUP (search criterion; array; index; sort order)

- **Search criterion** from the first column of the array.
- **Array** is to comprise at least two columns.
- **Index** is the number of the column in the array that contains the value to be returned (first column has the value of 1).
- **Sort order** is an optional parameter that indicates whether the first column in the array is sorted in ascending order. Enter the Boolean value FALSE if the first column is not sorted in ascending order. Sorted columns can be searched much faster and the function always returns a value, even if the search value was not matched exactly, if it is between the lowest and highest value of the sorted list. In unsorted lists, the search value must be matched exactly. Otherwise the function will return this message: Error: Value Not Available.

IF

This function specifies a logical test to be performed.
Syntax IF(Test; Then_value; Otherwise_value)

- **Test** is any value or expression that can be TRUE or FALSE
- **Then_value** (optional) is the value that is returned if the logical test is TRUE.
- **Otherwise_value** (optional) is the value that is returned if the logical test is FALSE.

[4] The following information is copied from the Excel Help tool

6 DATA SHEET EXPLANATION

TABLE 4. CONTENT OF EXCEL SHEET

Sheet	Content
Bremen	Bremen: List of Orders and space for calculations.
Valencia	Valencia: List of Orders and space for calculations.
Paris	France: Orders of Bremen and Valencia combined and space for calculations.
General Data	Principle data of Weight and value of different items, annual interest rate, ordering costs, and shutdown costs, basic fee per incoming shipment order, and cost per weight of the incoming shipment
Tariff for Outgoing Transport	Outgoing Transport Tariff Rates from Bremen, Valencia, and Paris to all customer locations served.
Data for CO2 Calculation	Data with distances to different customer location from three warehouse scenarios, distances between ports and warehouses, and CO_2 emission rates by transport type.
Transport Time	Data with Transport Time to different customer location from three warehouse scenarios.
Analysis	Table for final calculations and comparisons.

BREMEN

SHEET Bremen contains the List of Orders that are fulfilled by Bremen Warehouse.

The List of Orders includes

- Order Reference Number
- Date of Order
- Customer ID for each order (to give information about the customer who placed the order)
- Number of different items

Storege Costs: The following calculations are required:

Calculating the EOQ:

1. **FIND: Total annual demand for individual items.**
   USE: SUM function

2. **FIND: EOQ**
   NOTE: EOQ refers to Economic Order Quantity and is different for each individual item. Refer to the Manual for the formula and concept behind the formula. Ordering costs which is fixed is provided in SHEET General Data. Demand rate of each individual item has been calculated previously. Holding costs is calculated by using Interest rate and unit costs of production (which refers to value in Euro) as provided in SHEET General Data.

3. **FIND**: **Replenishment Time**
   NOTE: RT refers to Replenishment Time. Refer to the Manual for the formula and concept behind the formula. Required parameters have been calculated previously.

4. **FIND: Average Daily Demand for each month**
   USE: SUMIFs function
   NOTE: Use the SUMIFs function to calculate the average daily demand for each month which is equal to the total number of products ordered within a month divided by the number of days in that month (e.g. 31 days for January). The MAXIMUM function can be used to determine the maximum of the average daily demands from the 12 different months. The AVERAGE function can be used to calculate the mean of the average daily demands from the 12 different months.

5. **FIND**: **Safety stock**
   USE: AVERAGE and MAX function
   NOTE: For safety stock refer to the Manual for the formula and concept behind the formula. All the required parameters have been calculated.
   MAXIMUM function can be used to select maximum of the average daily demand. AVERAGE function can be used to calculate the mean of the average daily demands for 12 different months.

6. **FIND**: **Storage costs**
   NOTE: For storage costs refer to the Manual for the formula and concept behind the formula. Lot Stock or EOQ and Safety Stock have been calculated. For Purchase value, use values for different items as provided in SHEET General Data.

Incoming transportation costs:

7. **FIND**: **Total weight of shipment**
   USE: Weight of individual type of item and then use the sum function for the weight (SHEET Master_Data_1)

8. **FIND**: **Transportation costs**
   NOTE: The transportation costs of incoming goods in warehouse depend on the weight of goods that is delivered in each order and fixed ordering costs. Fixed ordering costs and costs per weight in Euro for incoming goods are given in the SHEET General Data. Total weight of incoming goods can be obtained by multiplying Total individual items orders with the weight of each item provided in SHEET General Data. Thus, the variable costs of transportation can be obtained by multiplying the total weight calculated with the costs per weight (provided in SHEET General Data).

9. **FIND**: **Incoming Transportation costs**
   NOTE: Fixed costs of ordering can be obtained by multiplying number of orders with basic fee in Euro per order (provided in SHEET General Data). Addition of the latter two costs gives the required Incoming Transportation costs for each individual item

10. **FIND**: **Total Incoming Transportation costs**
    USE: SUM function
    NOTE: Addition of Incoming Transportation costs of all the individual items gives the Total Incoming Transportation costs.

Outgoing transportation costs:

As we have already found the total weight of the shipment we can now proceed to calculate the cost of outbound transport which depends on the tariffs and the weight.

11. **FIND**: **Tariff to be charged by the transportation firm**
    USE: VLOOKUP and the tariff rates from SHEET Tarrif for Outgoing Transport

12. **FIND**: **Total cost of Transportation & Total cost for Shipment**
    NOTE: Tariff is charged according to the weight of the shipment. Thus, note that the total costs of shipment is fixed if the weight is less than 100kg.

13. **FIND: Total costs of Shipment (for all orders) & Total costs of Shipment (if from France) (for all orders)**
    USE: SUM function
    NOTE: Space is provided at the end of list of all the orders below each column

    Note that the same orders are to be considered as for the Planned Central Warehouse in France. Thus, the Tariff costs of Shipment "If from France" is to be calculated in this Sheet.

Transportation Time:

14. **FIND**: **Transportation Time of shipment of individual orders**
    USE: Customer ID and Table from SHEET Transport Time
    NOTE: Transportation Time is fixed for each customer based on their distance from Bremen.

    Note that the same orders are to be considered as for the Planned Central Warehouse in France. Thus, the Transportation Time of Shipment "If from France" is to be calculated in this Sheet.

CO_2 Emissions of incoming transportation:

15. **FIND**: **Total weight of each item transported to warehouse**
    NOTE: To find the total weight multiply the total number items needed by each item's weight for each of the five item types.

16. **FIND**: **Emissions of incoming transportation for each item**
    USE: Emission Rate by Transport Type and Distance for Incoming Transportation tables from SHEET Data for CO_2 Calculation.
    NOTE: Be mindful of the different transportation types being used at different stages of transportation, as well as between different warehouse locations (i.e. Port of Santander to Valencia is delivered by train while Port of Bremerhaven to Bremen is delivered by truck).

CO_2 Emissions of outgoing transportation:

17. **FIND: Distance from warehouse to customer for each order**
    USE: VLOOKUP and distances from SHEET Master_Data_8

18. **FIND**: **Emmissions of outgoing transport for each order**
    USE: Emission rate by transport type from SHEET Data for CO_2 Calculation
    NOTE: To find Emissions multiply emission rate by distance and weight of shipment.

19. **FIND: Total Outgoing Emissions (for all orders) & Total Outgoing Emissions (if from France) (for all orders)**
    USE: SUM function
    NOTE: Space is provided at the end of list of all the orders below each column

VALENCIA

Information provided and Calculations required are for Orders fulfilled from the warehouse in Valencia. Repeat the calculation procedures described above for SHEET Bremen.

PARIS

Information provided: Orders fulfilled from the warehouse in Paris.

Calculations required:

- Repeat the necessary part of the calculation procedures for SHEET Bremen.
- Storage Volume Required (Only for goods): To calculate Storage Volume Required, weight of maximum amount of goods stored in the warehouse is necessary (refer to the manual: volume dependent of weight.)
- Additional Volume: Storage Volume for goods + Additional Volume
- Redesign costs: Dependent on Total volume required.

GENERAL DATA

Information provided:

- Weight and Value of each of the five items.
- Ordering costs
- Annual interest rate
- Shutdown costs
- Basic order processing fee for incoming transportation
- Costs per kg for incoming transportation

Calculation required: none

DATA FOR CO2 CALCULATION

Information provided:

- Average emission rates of different transport types in g of CO_2/km*kg
- Distances between ports and cities for incoming transportation
- Table providing information regarding the distances to different customers from Bremen
- Table providing information regarding the distances to different customers from Valencia
- Table providing information regarding the distances to different customers from Paris

Calculation required: None

TRANSPORT TIME

Information provided:

- Table providing information regarding the transportation time of different customers from Bremen
- Table providing information regarding the transportation time of different customers from Valencia
- Table providing information regarding the transportation time of different customers from Paris

Calculation required: None

SHEET ANALYSIS

Information provided: Throughput time for centralized and decentralized scenarios

Calculation required:

- Storage costs for Centralized and Decentralized scenarios
- Outgoing Transportation costs for Centralized and Decentralized scenarios
- Incoming Transportation costs for Centralized and Decentralized scenarios
- SUM of Storage and Transportation costs for two scenarios
- Build Up, Shutdown and Total Redesign costs
- Average Transportation Time for Bremen, Valencia, and the average of the two for decentralized scenario
- Average Transportation Time for Paris
- Total Delivery Time for the two scenarios
- Average Stock: Refer to general storage model 4. As $Avg\ Stock = \frac{Lot\ size}{2} + Safety\ stock$, individual average stock for different items should be added to calculate the average stock for the warehouse
- Emissions of Incoming Transportation for Centralized and Decentralized scenarios
- Emissions of Outgoing Transportation for Centralized and Decentralized scenarios
- Sum of Total Emissions