

Transportation Problem

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Use the solver in Excel to find the number of units to ship from each factory to each customer that minimizes the total cost.

Formulate the Model

The model we are going to solve looks as follows in Excel.

	A	B	C	D	E	F	G	H	I	J
1										
2										
3		Unit Cost	Customer 1	Customer 2	Customer 3					
4		Factory 1	40	47	80					
5		Factory 2	72	36	58					
6		Factory 3	24	61	71					
7										
8										
9		Shipments	Customer 1	Customer 2	Customer 3	Total Out		Supply		
10		Factory 1	0	0	0	0	=	100		
11		Factory 2	0	0	0	0	=	200		
12		Factory 3	0	0	0	0	=	300		
13										
14		Total In	0	0	0					
15			=	=	=				Total Cost	
16		Demand	200	200	200				0	
17										

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Transportation Problem

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Sensitivity Analysis

System of Linear Equations

Download Excel File

transportation-problem.xlsx

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300 Examples

1. To formulate this transportation problem, answer the following three questions.

a) What are the decisions to be made? For this problem, we need Excel to find out how many units to ship from each factory to each customer.

b) What are the constraints on these decisions? Each factory has a fixed supply and each customer has a fixed demand.

c) What is the overall measure of performance for these decisions? The overall measure of performance is the total cost of the shipments, so the objective is to minimize this quantity.

2. To make the model easier to understand, create the following [named ranges](#).

Range Name	Cells
UnitCost	C4:E6
Shipments	C10:E12
TotalIn	C14:E14
Demand	C16:E16
TotalOut	G10:I12
Supply	I10:I12
TotalCost	I16

3. Insert the following functions.

	C	D	E	F	G	H	I
	Customer 1	Customer 2	Customer 3				
40	47	80					
72	36	58					
24	61	71					
	Customer 1	Customer 2	Customer 3	Total Out		Supply	
0	0	0		=SUM(C10:E10)	=100		
0	0	0		=SUM(C11:E11)	=200		
0	0	0		=SUM(C12:E12)	=300		
	=SUM(C10:C12)	=SUM(D10:D12)	=SUM(E10:E12)				
	=	=	=			Total Cost	
200	200	200				=SUMPRODUCT(UnitCost,Shipments)	

Explanation: The SUM functions calculate the total shipped from each factory (Total Out) to each customer (Total In). Total Cost equals the [sumproduct](#) of UnitCost and Shipments.

Trial and Error

With this formulation, it becomes easy to analyze any trial solution.

For example, if we ship 100 units from Factory 1 to Customer 1, 200 units from Factory 2 to Customer 2, 100 units from Factory 3 to Customer 1 and 200 units from Factory 3 to Customer 3, Total Out equals Supply and Total In equals Demand. This solution has a total cost of 27800.

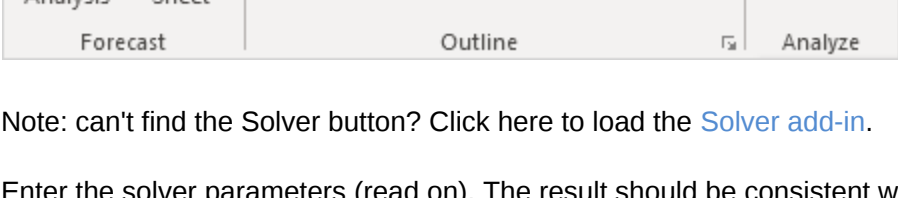
	A	B	C	D	E	F	G	H	I	J
1										
2										
3		Unit Cost	Customer 1	Customer 2	Customer 3					
4		Factory 1	40	47	80					
5		Factory 2	72	36	58					
6		Factory 3	24	61	71					
7										
8										
9		Shipments	Customer 1	Customer 2	Customer 3	Total Out		Supply		
10		Factory 1	100	0	0	100	=	100		
11		Factory 2	0	200	0	200	=	200		
12		Factory 3	100	0	200	300	=	300		
13										
14		Total In	200	200	200					
15			=	=	=				Total Cost	
16		Demand	200	200	200				27800	
17										

It is not necessary to use trial and error. We shall describe next how the Excel Solver can be used to quickly find the optimal solution.

Solve the Model

To find the optimal solution, execute the following steps.

1. On the Data tab, in the Analyze group, click Solver.



Note: can't find the Solver button? Click [here](#) to load the [Solver add-in](#).

Enter the solver parameters (read on). The result should be consistent with the picture below.

Solver Parameters

Set Objective:

TotalCost

To:

☐ Max

☒ Min

☐ Value Of:

0

By Changing Variable Cells:

Shipments

Subject to the Constraints:

TotalIn = Demand
TotalOut = Supply

Add

Change

Delete

Reset All

Load/Save

☒ Make Unconstrained Variables Non-Negative

Select a Solving Method:

Simplex LP

Options

Solving Method

Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Help

Solve

Close

You have the choice of typing the range names or clicking on the cells in the spreadsheet.

2. Enter TotalCost for the Objective.

3. Click Min.

4. Enter Shipments for the Changing Variable Cells.

5. Click Add to enter the following constraint.

Add Constraint

Cell Reference:

TotalIn

Constraint:

=

Demand

OK

Add

Cancel

6. Click Add to enter the following constraint.

Add Constraint

Cell Reference:

TotalOut

Constraint:

=

Supply

OK

Add

Cancel

7. Check 'Make Unconstrained Variables Non-Negative' and select 'Simplex LP'.

8. Finally, click Solve.

Result:

Solver Results

Solver found a solution. All Constraints and optimality conditions are satisfied.

☒ Keep Solver Solution

☐ Restore Original Values

Return to Solver Parameters Dialog

Outline Reports

OK

Cancel

Save Scenario...

Solver found a solution. All Constraints and optimality conditions are satisfied.

When the GRG engine is used, Solver has found at least a local optimal solution. When Simplex LP is used, this means Solver has found a global optimal solution.

The optimal solution:

	A	B	C	D	E	F	G	H	I	J
1										
2										
3		Unit Cost	Customer 1	Customer 2	Customer 3					
4		Factory 1	40	47	80					
5		Factory 2	72	36	58					
6		Factory 3	24	61	71					
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8										
9		Shipments	Customer 1	Customer 2	Customer 3	Total Out		Supply		
10		Factory 1	0	100	0	100	=	100		
11		Factory 2	0	100	100	200	=	200		
12		Factory 3	200	0	100	300	=	300		
13										
14		Total In	200	200	200					
15			=	=	=				Total Cost	
16		Demand	200	200	200				26000	
17										

Conclusion: it is optimal to ship 100 units from Factory 1 to Customer 2, 100 units from Factory 2 to Customer 2, 100 units from Factory 2 to Customer 3, 200 units from Factory 3 to Customer 1 and 100 units from Factory 3 to Customer 3. This solution gives the minimum cost of 26000. All constraints are satisfied.

2/8 Completed! [Learn much more about the solver >](#)

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