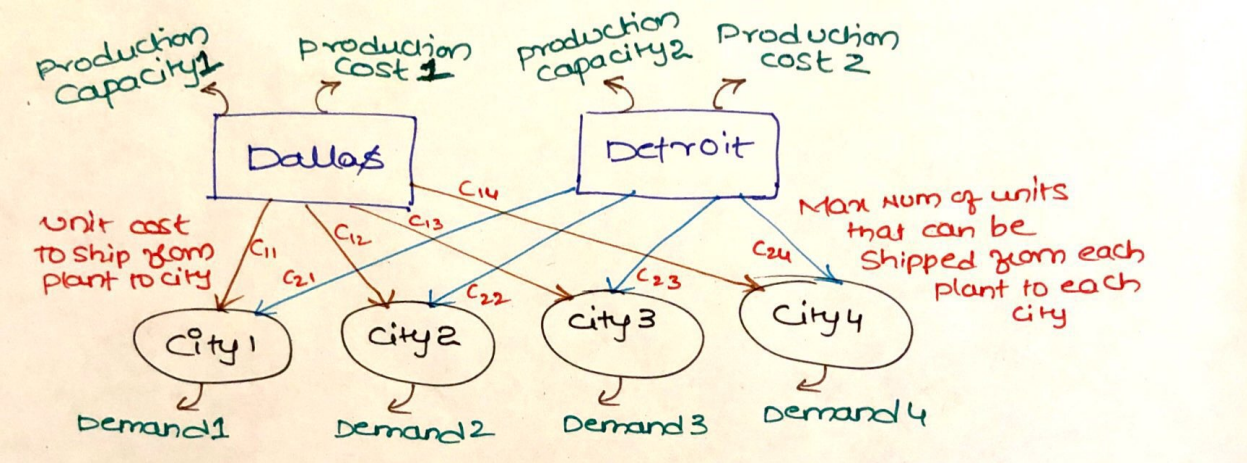
(Edsel Motors) Edsel Motors produces cars in Detroit and Dallas. The Detroit plant can produce up to 8500 cars, and the Dallas plant can produce up to 4000 cars. Producing a car costs $2000 in Detroit and $1800 in Dallas. Cars must be shipped to 12 cities. The costs of shipping a car from each plant to each city and the city requirements are given in the file **P05_57.xlsx**. At most 1000 cars can be sent from a given plant to a given city. Determine how to minimize the cost of meeting all demands.

Edsel Motors data														
Unit shipping costs														
		To												
		Atlanta	Boston	Chicago	Denver	Houston	Indianapolis	Los Angeles	New York	Philadelphia	Pittsburgh	San Francisco	Seattle	
From	Detroit	$800	$600	$300	$800	$1,000	$300	$1,500	$500	$600	$300	$1,400	$1,300	
	Dallas	$600	$1,300	$800	$600	$200	$700	$900	$900	$800	$800	$1,000	$1,400	
Requirements		1120	890	970	980	1060	930	1320	1050	960	850	900	950	

WinstonAlbright_6e_P05_57.xlsx

Discussion: -

Below picture gives you how the production of each plant is planned, and shipping is done from each plant to each city. Our objective in this problem is to minimize the cost. As per the given problem, cost is dependent on the production cost and shipping cost between a plant and city. If we know the number of cars shipped from each plant to each city, we will be able to calculate the total cost. Hence our decision variable will be the number of cars shipped from each plant to each city.



Mathematical Model: -

Parameters (Inputs):

$i \in 1,2 \quad (i: Index\ for\ production\ plants)$
$j \in 1,2,3..12 \quad (j: Index\ for\ cities)$
A_{ij} : $Unit\ cost\ to\ ship\ a\ car\ from\ plant\ i\ to\ city\ j$
C_i : $Production\ cost\ at\ plant\ i$
D_j : $Demand\ in\ city\ j$
M : $Maximum\ number\ of\ cars\ that\ can\ be\ shipped\ from\ each\ plant\ to\ each\ city; M = 1000$
P_i : $Production\ capacity\ at\ plant\ i$

Decision Variables:

x_{ij} : *Number of units shipped from plant i to city j*

Objective:

$$Minimize\ total\ cost = \sum_{j=1}^{12}\sum_{i=1}^{2}(x_{ij} * A_{ij}) + \sum_{j=1}^{12}\sum_{i=1}^{2}(x_{ij} * C_i\ )$$

Constraints:

$x_{ij} \geq 0;$ (1) *Non Negative constraint*

$\sum_{j=1}^{12} x_{ij} \leq P_i\ ;\quad for\ i\ \epsilon\{1,2\}$ (2) *Production capacity constraint*

$\sum_{i=1}^{2} x_{ij} \geq D_j\ ;\quad for\ j\ \epsilon\{1,2,..12\}$ (3) *Demand Constraint*

$x_{ij} \leq M;$ (4) *Plant to city supply constraint*

Constraint 2 will make sure that supply of each plant will not exceed the plant capacity. Constraint 3 will make sure that optimal solution meets the demand of each city. Constraint 4 helps in making sure that each plant can supply at max only 1000 vehicles to each city.

Excel Implementation:

Please find the attached spreadsheet for solution.

30[RA].xlsx

Inputs																	
Decision variables																	
Calculated Variables																	
Constraints																	
Objective																	
				Car Cost				Production Cost	$23,160,000								
			Detroit	$ 2,000				Shipping Cost	$ 7,725,000								
			Dallas	$ 1,800				Total Cost	**$30,885,000**								
Unit shipping costs	**To**	**Atlanta**	**Boston**	**Chicago**	**Denver**	**Houston**	**Indianapolis**	**Los Angeles**	**New York**	**Philadelphia**	**Pittsburgh**	**San Francisco**	**Seattle**				
From	**Detroit**	$800	$600	$300	$800	$1,000	$300	$1,500	$500	$600	$300	$1,400	$1,300				
	Dallas	$600	$1,300	$800	$600	$200	$700	$900	$900	$800	$800	$1,000	$1,400				
	To	**Atlanta**	**Boston**	**Chicago**	**Denver**	**Houston**	**Indianapolis**	**Los Angeles**	**New York**	**Philadelphia**	**Pittsburgh**	**San Francisco**	**Seattle**				Capacity
	Detroit	1000	890	970	50	60	930	320	1000	960	850	0	950	7980	<=		8500
	Dallas	120	0	0	930	1000	0	1000	50	0	0	900	0	4000	<=		4000
		1120	890	970	980	1060	930	1320	1050	960	850	900	950				
		>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	>=	**Decision variables**	<=		1000
	Demand	1120	890	970	980	1060	930	1320	1050	960	850	900	950				