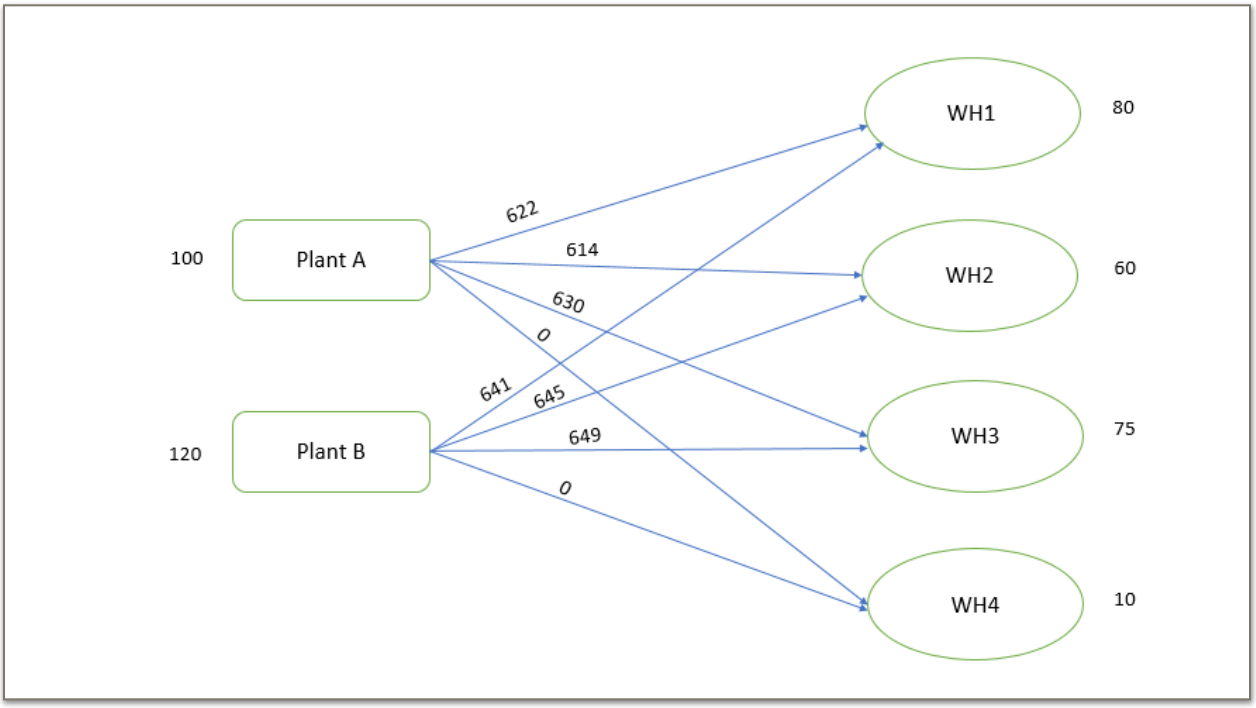
1. **Heart Start Problem:**

	Shipping and Production Cost				
	Warehouse 1	**Warehouse 2**	**Warehouse 3**	**Warehouse 4**	**Capacity**
Plant A	622	614	630	0	100
Plant B	641	645	649	0	120
Demand	80	60	70	Dummy = 10	100+120 = 220

I created Dummy Variable Warehouse 4 to match both supply and Demand.

Network Diagram:



Formulation:

Let, Z represent total shipping and production cost

1. X_{ij} represents the total shipping and production cost from Plant i to Warehouse j

2. We are choosing the values of 8 decision variables X_{ij} to minimize Z

Minimize $Z = 622X_{11} + 614X_{12} + 630X_{13} + 0X_{14} + 641X_{21} + 645X_{22} + 649X_{23} + 0X_{24}$

Constraints:

$X_{11} + X_{12} + X_{13} + X_{14} = 100$

$X_{21} + X_{22} + X_{23} + X_{24} = 120$

$X_{11} + X_{21} = 80$

$X_{12} + X_{22} = 60$

$X_{13} + X_{23} = 70$

$X_{14} + X_{24} = 10$

And $X_{ij} >= 0$

2. **Oil Distribution Problem:**

Capacity:

Well 1 has a capacity of 93 thousand barrels per day (TBD),

Well 2 can produce 88 TBD, and

Well 3 can produce 95 TBD

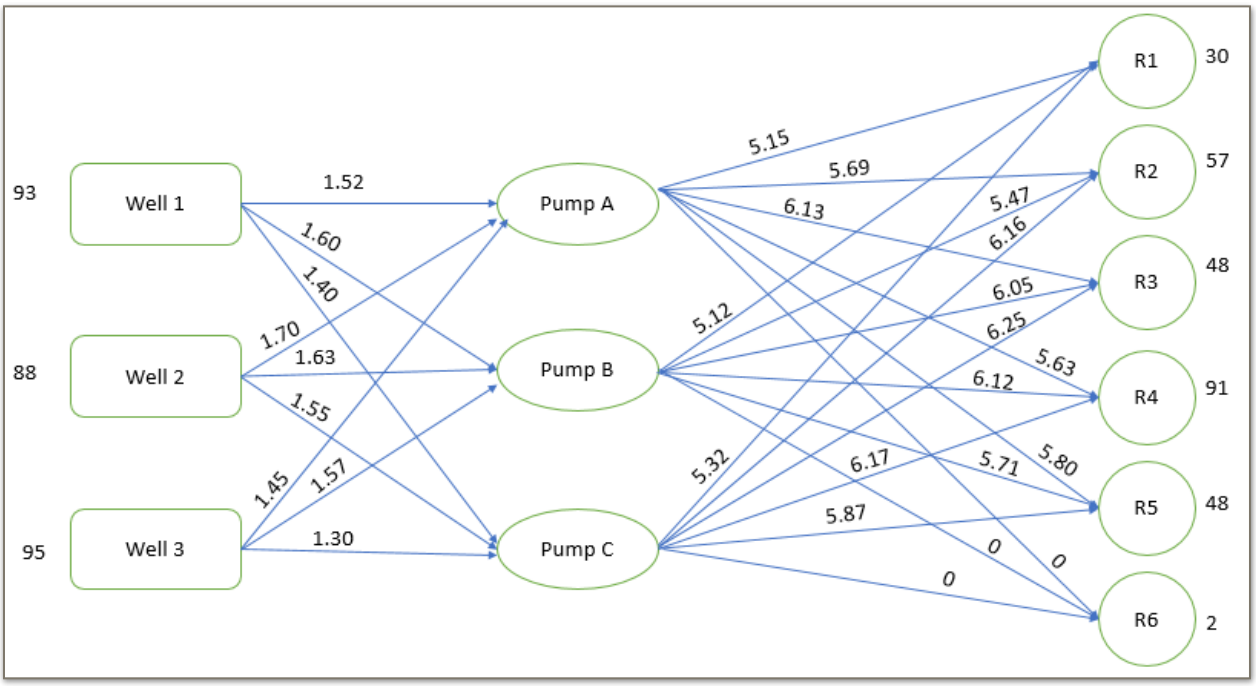
A total of 93 + 88 + 95 = 276 TBD

Demand:

Here the requirement = R1 + R2 + R3 + R4 + R5 = 30 + 57 + 48 + 91 + 48 = 274

Capacity is not matching with the demand. Hence, a dummy variable for requirement is created with value 2.

Network Diagram:



Formulation:

Let Z be the minimum cost of providing oil to the refineries

1. W_iPj represents the cost of providing from Well to Pump

2. P_jR_k represents the cost of providing from pump to refinery

Minimum Cost Z =

$1.52W_1P_1 + 1.60\ W_1P_2 + 1.40\ W_1P_3 + 1.70\ W_2P_1 + 1.63\ W_2P_2 + 1.55W_2P_3 + 1.45\ W_3P_1 + 1.57\ W_3P_2 + 1.30\ W_3P_3 + 5.15P_1R_1 + 5.69P_1R_2 + 6.13P_1R_3 + 5.63P_1R_4 + 5.80P_1R_5 + 0P_1R_6 + 5.12P_2R_1 + 5.47P_2R_2 + 6.05P_2R_3 + 6.12P_2R_4 + 5.71P_2R_5 + 0P_2R_6 + 5.32P_3R_1 + 6.16P_3R_2 + 6.25P_3R_3 + 6.17P_3R_4 + 5.87P3R_5 + 0P_3R_6;$

Constraints:

$W_1P_1 + W_1P_2 + W_1P_3 = 93$

$W_2P_1 + W_2P_2 + W_2P_3 = 88$

$W_3P_1 + W_3P_2 + W_3P_3 = 95$

$P_1R_1 + P_2R_1 + P_3R_1 = 30$

$P_1R_2 + P_2R_2 + P_3R_2 = 57$

$P_1R_3 + P_2R_3 + P_3R_3 = 48$

$P_1R_4 + P_2R_4 + P_3R_4 = 91$

$P_1R_5 + P_2R_5 + P_3R_5 = 48$

$P_1R_6 + P_2R_6 + P_3R_6 = 2$

$W_iP_j >= 0$ and $P_jR_k >= 0$