

Assignment Instructions: Assignment 4

Purpose

The purpose of this assignment is to formulate and solve a transportation / transshipment problem.

Directions

1. Heart Start produces automated external defibrillators (AEDs) in each of two different plants (A and B). The unit production costs and monthly production capacity of the two plants are indicated in the table below. The AEDs are sold through three wholesalers. The shipping cost from each plant to the warehouse of each wholesaler along with the monthly demand from each wholesaler are also indicated in the table. How many AEDs should be produced in each plant, and how should they be distributed to each of the three wholesaler warehouses so as to minimize the combined cost of production and shipping?

	Unit Shipping Cost			Unit	Monthly
	Warehouse 1	Warehouse 2	Warehouse 3	Production Cost	Production Capacity
Plant A	\$22	\$14	\$30	\$600	100
Plant B	\$16	\$20	\$24	\$625	120
Monthly Demand	80	60	70		

Formulate and solve this transportation problem using *lp_solve*, or any other equivalent library in R.

Answer:

Let x_{1i} be product in plant A ($i=1,2,3,4$)

Let x_{2i} be product in plant B ($i=1,2,3,4$)

/* Objective function */ min : $622x_{11}+614x_{12}+630x_{13}+0x_{14}+641x_{21}+645x_{22}+649x_{23}+0x_{24}$;

/* Constraints */

$x_{11}+x_{12}+x_{13}+x_{14}=100$;

$x_{21}+x_{22}+x_{23}+x_{24}=120$;

$x_{11}+x_{21}=80$;

$$\begin{aligned}
 x_{12} + x_{22} &= 60; \\
 x_{13} + x_{23} &= 70; \\
 x_{14} + x_{24} &= 10; \\
 x_{1i}, x_{2i} &\geq 0
 \end{aligned}$$

2. **Oil Distribution** Texxon Oil Distributors, Inc., has three active oil wells in a west Texas oil field. 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. The company has five refineries along the Gulf Coast, all of which have been operating at stable demand levels. In addition, three pump stations have been built to move the oil along the pipelines from the wells to the refineries. Oil can flow from any one of the wells to any of the pump stations, and from any one of the pump stations to any of the refineries, and Texxon is looking for a minimum cost schedule. The refineries' requirements are as follows.

Refinery	R1	R2	R3	R4	R5
Requirement (TBD)	30	57	48	91	48

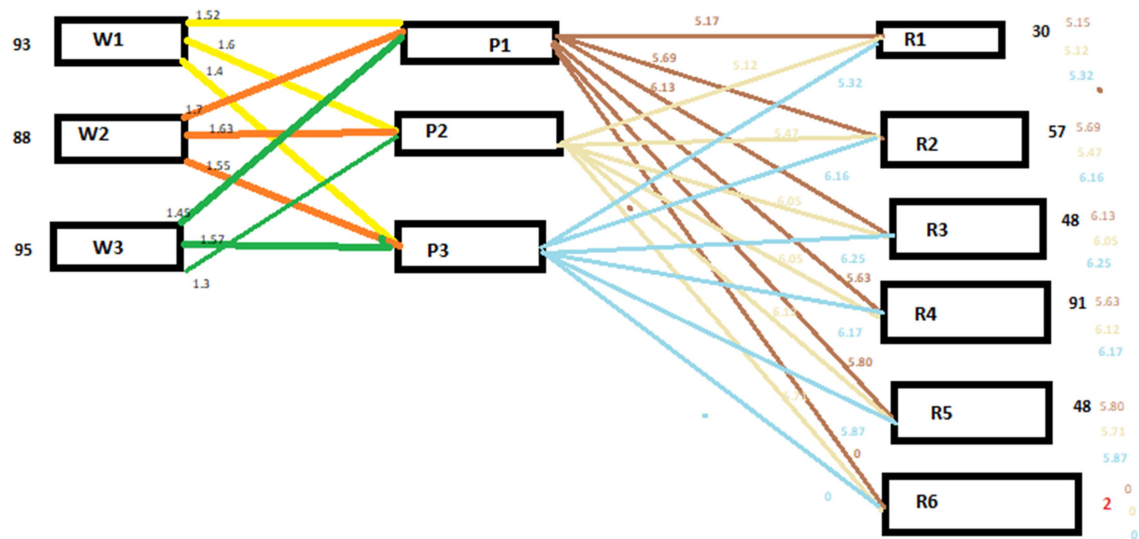
The company's cost accounting system recognizes charges by the segment of pipeline that is used. These daily costs are given in the tables below, in dollars per thousand barrels.

To		Pump A	Pump B	Pump C
From	Well 1	1.52	1.60	1.40
	Well 2	1.70	1.63	1.55
	Well 3	1.45	1.57	1.30

To		R1	R2	R3	R4	R5
From	Pump A	5.15	5.69	6.13	5.63	5.80
	Pump B	5.12	5.47	6.05	6.12	5.71
	Pump C	5.32	6.16	6.25	6.17	5.87

- 1) What is the minimum cost of providing oil to the refineries? Which wells are used to capacity in the optimal schedule? Formulation of the problem is enough.
- 2) Show the network diagram corresponding to the solution in (a). That is, label each of the arcs in the solution and verify that the flows are consistent with the given information.

Let z be the minimum cost of



Let z be the minimum cost providing oil to the refineries

- W_iP_j presents the cost of providing from wells to pumps
- P_iR_j presents the cost of providing from pumps to refineries

Minimum cost $Z =$

$$1.52W_1P_1 + 1.60W_1P_2 + 1.40W_1P_3 + 1.70W_2P_1 + 1.63W_2P_2 + 1.55W_2P_3 + 1.45W_3P_1 + 1.57W_3P_2 + 1.30W_3P_3 + 5.15P_1R_1 + 5.69P_1R_2 + 6.13P_1R_3 + 5.63P_1R_4 + 5.80P_1R_5 + 5.12P_2R_1 + 5.47P_2R_2 + 6.05P_2R_3 + 6.12P_2R_4 + 5.71P_2R_5 + 5.32P_3R_1 + 6.16P_3R_2 + 6.25P_3R_3 + 6.17P_3R_4 + 5.87P_3R_5;$$

Constraint

$$W_1P_1 + W_1P_2 + W_1P_3 = 93$$

$$W_2P_1 + W_2P_2 + W_2P_3 = 88$$

$$W_3P_1 + W_3P_2 + W_3P_3 = 95$$

$$P_1R_1 + P_2R_1 + P_3R_1 = 30$$

$$P_1R_2 + P_2R_2 + P_3R_2 = 57$$

$$P_1R_3 + P_2R_3 + P_3R_3 = 48$$

$$P_1R_4 + P_2R_4 + P_3R_4 = 91$$

$$P_1R_5 + P_2R_5 + P_3R_5 = 48$$

$$P_1R_6 + P_2R_6 + P_3R_6 = 2$$

Constraint from pump to refinery

$$W_1P_1 + W_2P_1 + W_3P_1 = P_1R_1 + P_1R_2 + P_1R_3 + P_1R_4 + P_1R_5 + P_1R_6$$

$$W_1P_2 + W_2P_2 + W_3P_2 = P_2R_1 + P_2R_2 + P_2R_3 + P_2R_4 + P_2R_5 + P_2R_6$$

$$W_1P_3 + W_2P_3 + W_3P_3 = P_3R_1 + P_3R_2 + P_3R_3 + P_3R_4 + P_3R_5 + P_3R_6$$

$$W_iP_j \geq 0, P_iR_j \geq 0$$