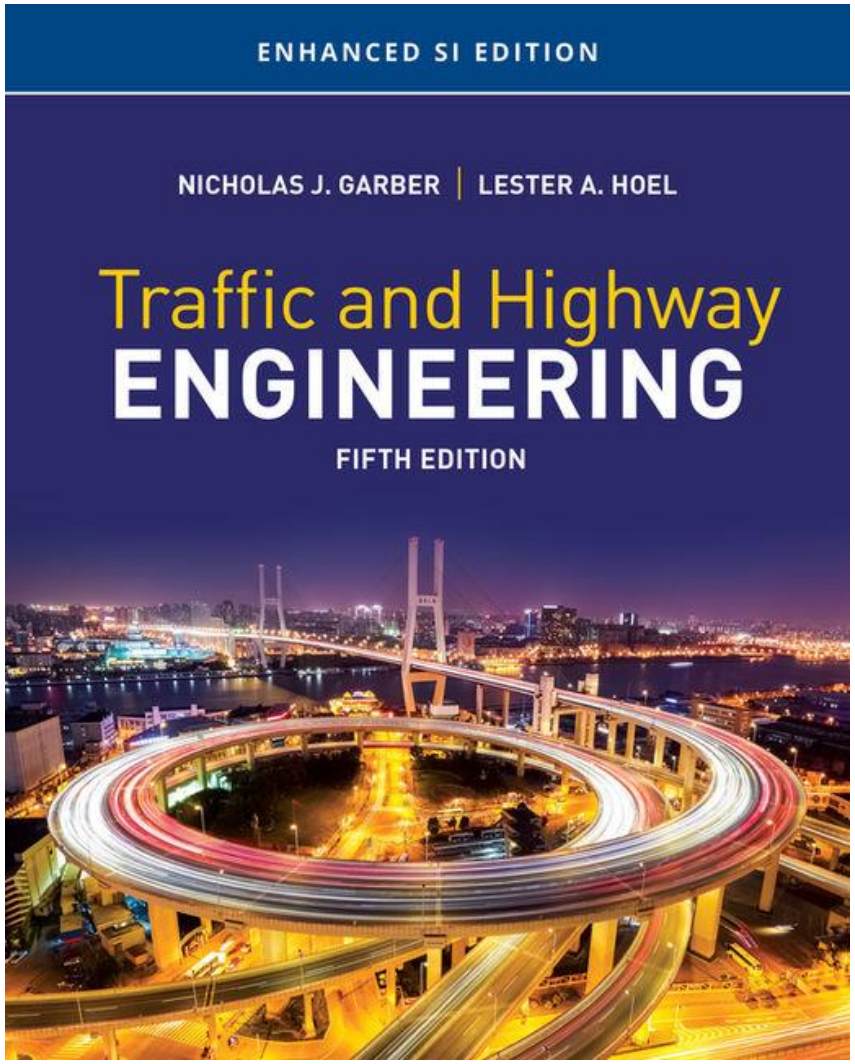

Chapter 2

Transportation Systems and Organizations

Interaction of Supply and Demand

- Transportation system is the product of two factors that act on each other:
  - State of economy (produces demand)
  - Extent and quality of the current system (constitutes the supply)

- Example: High unemployment and/or rising fuel costs lead to decrease in transportation
- Current COVID 19 pandemic crisis

Interaction of Supply and Demand

- Figure 2.1 shows how demand in terms of traffic volume could vary with cost (e.g. a new bridge with toll):

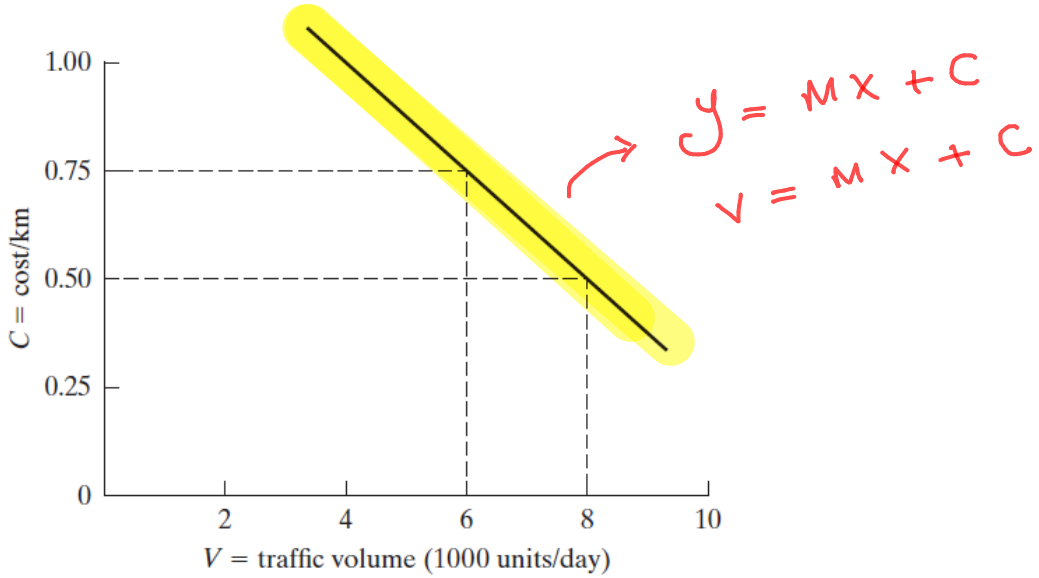

Figure 2.1 Relationship between Transportation Demand and Cost

Interaction of Supply and Demand

- Figure 2.3 shows how the cost of a transportation system could increase as the traffic volume increases:

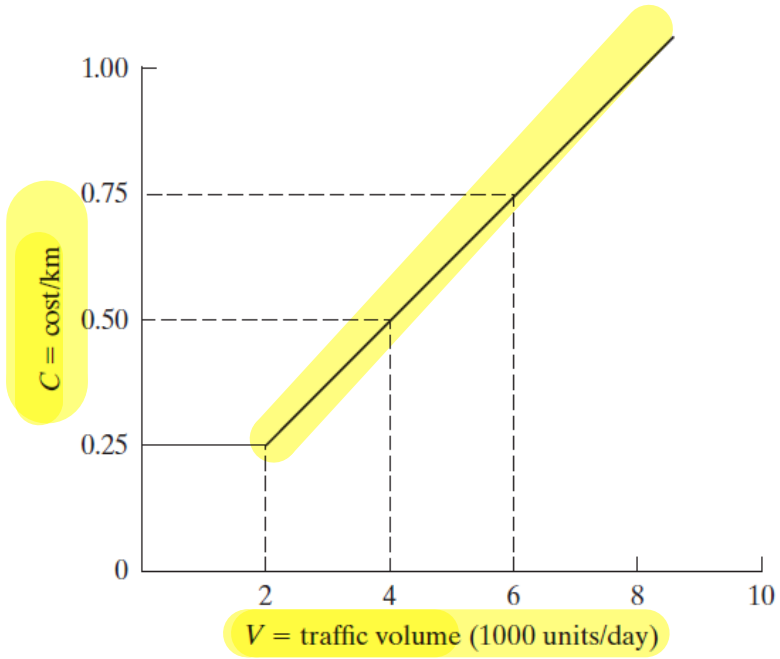

Figure 2.3 Relationship between Transportation Supply and Cost

Interaction of Supply and Demand

- The two curves (2.1 and 2.3) determine what volume (V) can be expected for a transportation system
- The figure below shows the equilibrium point V. Going beyond this point would make the cost go up and the demand drop
- Likewise, if V dropped below equilibrium, the cost goes down and demand increases

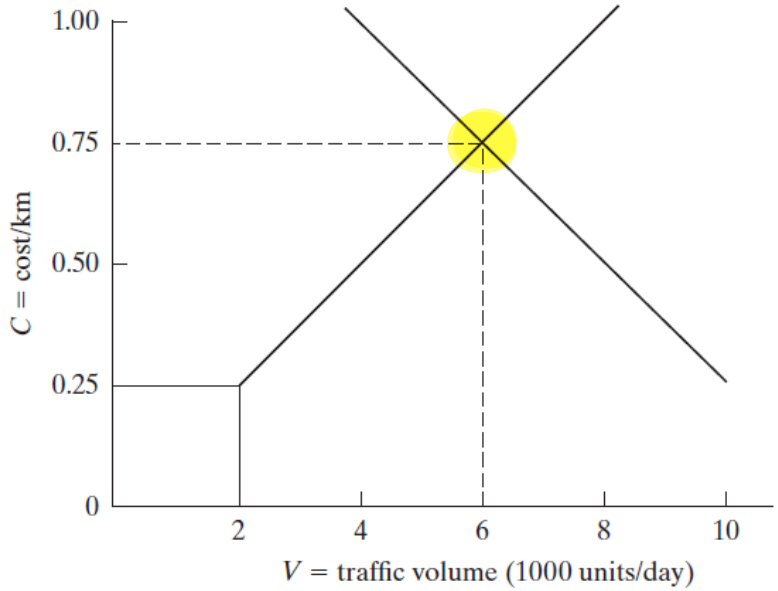

Figure 2.4 Equilibrium Volume for Traffic Crossing a Bridge

Example 2.2 Using a Supply-Demand Curve to Compute the Bridge Cost/Vehicle (Toll) That Will Maximize Total Revenue

A toll bridge carries 5000 veh/day. The current cost (toll) is 150 cents. When the cost (toll) is increased by 25 cents, traffic volume decreases by 500 veh/day. Determine the cost/veh (new toll) that should be charged such that revenue is maximized. How much additional revenue will be received?

$x \Rightarrow$ additive Revenue/vehicle

5000 veh/day → 4500 ; 150 Cents → 175 Cents

$x = 0 \rightarrow x = 25$

$V = qx + b$ (slope, y-int)

$$\text{Slope } (q) = \frac{\Delta V}{\Delta x} = \frac{5000 - 4500}{0 - 25} = \frac{-500}{25}$$

$$= -20$$

$$V = -20x + b$$

$$4500 = -20(25) + b$$

$$b = 5000$$

$$V = -20x + 5000$$

$$\text{new Cost/vehicle} = T = 150 + x$$

$$R = VT$$

$$= (-20x + 5000)(150 + x)$$

$$R = -3000x - 20x^2 + 750000 + 5000x$$

$$R = 750000 + 2000x - 20x^2$$

$$\frac{dR}{dx} = 2000 - 40x = 0$$

$$x = \frac{2000}{40} = 50 \text{ Cents}$$

$$T_{Max} = 150 + 50 = 200$$

$$V_{Max} = -20(50) + 5000 = 4000$$

$$AR = V_{Max} T_{Max} - V_{Current} T_{Curr}$$

$$= (4000)\left(\frac{200}{100}\right) - (5000)\left(\frac{150}{100}\right)$$

$$= 500\ \$$$