Choosing a Transportation Mode

A wine producer ships bottled wine from a winery in Cape Town, South Africa to a distribution center in Savannah, Georgia. We want to determine if it is more economical to ship in 20 ft containers or in 40 ft containers by ocean carriers. A 20 ft container can hold 13,000 bottles, and shipment of a 20 ft container from Cape Town to Savannah costs $5000, including the cost of trucking to and from the ports, the port fees, document processing fees, customs fees, and ocean carrier costs. A 40 ft container can hold 26,000 bottles, and shipment of a 40 ft container from Cape Town to Savannah costs $7000, including the same cost items as for the 20 ft container. The journey takes 20 days on average (door to door).

The forecasted demand is 100,000 bottles for the next year. The safety stock at the winery is not affected by the choice of container size. The safety stock at the distribution center is chosen to be 15,000 bottles if a 20 ft container is used, and 20,000 bottles if a 40 ft container is used (the safety stock is greater if a larger container is used, because the time between successive container shipments is greater if a larger container is used). A bottle is valued at $15 at the winery and $20 at the distribution center. The inventory holding cost rate is estimated at 20% of value per year, including cost of storage, funds tied up in inventory, breakage, spoilage, and loss.

Assume that the shipper may ship containers that are only partially full. Determine the lowest cost number of bottles to put in each container. Then determine the more economical transportation service to use. Show all calculations, and clearly show the cost components. Report the total annual cost of each option in your answer.

**Answer:** 20 ft containers:

Optimal shipment size

\[
q_{20} = \sqrt{\frac{(2)(5000)(100,000)}{(0.2)(20)}} = 15,811
\]

Thus each 20 ft container is shipped full with 13,000 bottles.

\[
\text{Total annual cost} = (0.2)(20) \left(15,000 + \frac{13,000}{2}\right) + (5000) \frac{100,000}{13,000} = \$124,462
\]
40 ft containers:
Optimal shipment size

\[ q_{40} = \sqrt{\frac{(2)(7000)(100,000)}{(0.2)(20)}} = 18,708 \]

Thus each 40 ft container is shipped with 18,708 bottles.

Total annual cost = (0.2)(20) \left( 20,000 + \frac{18,708}{2} \right) + (7000) \frac{100,000}{18,708} = $154,833