Importance of Transportation

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Introduction

- Transportation has always played a significant role by facilitating trade, commerce, conquest, and social interaction, while consuming a considerable portion of time and resources.
- The primary need for transportation has been economic, involving personal travels in search of food or work, travel for the exchange of goods and commodities, exploration, personal fulfillment, and the improvement of a society or a nation.
- The movements of people and goods, which is the basis of transportation, always has been undertaken to accomplish those basic objectives or tasks that require transfer from one location to another.
- For example, a farmer must transport product to market, a doctor must see a patient in the office or in the hospital, and a salesman must visit clients located throughout a territory.

Importance of Transportation

- Making the most of natural resources and markets and maintaining a competitive edge over other regions and nations are linked closely to the quality of the transportation system.
- The speed, cost, and capacity of available transportation have a significant impact on the economic vitality of an area and the ability to make maximum use of its natural resources.
- Examination of most developed and industrialized societies indicates that they have been noted for high-quality transportation systems and services.
- Countries with advanced transportation systems have always been among leaders in industry and commerce.
- Without the ability to transport manufactured goods and raw materials, a country is unable to maximize the comparative advantage it may have in the form of natural or human resources.
- Countries that lack an abundance of natural resources rely heavily on transportation in order to import raw materials and export manufactured products.

Transportation and Economic Growth

- Good transportation is a necessary but insufficient condition for economic growth.
- However, the absence of supportive transportation services will serve to limit or hinder the potential for a nation or region to achieve its economic potential.
- Thus, if a society expects to develop and grow, it must have a strong internal transportation system consisting of good roads, rail systems, as well as excellent linkages to the rest of the world by sea and air.
- A healthy transportation system is a necessary condition for human interaction and economic competitiveness.
- Good transportation permits the specialization of industry or commerce, reduces costs for raw materials or manufactured goods, and increases competition between regions, thus resulting in reduced prices and greater choices for the consumer.
- Transportation is also a necessary element of government services, such as delivering mail, defense, and efficient mobilization in the event of national emergencies.

Social Costs and Benefits of Transportation

- The improvement of a region's economic position by virtue of improved transportation does not come without costs.
- Building vast transportation systems requires enormous resources of energy, material, and land.
- In major cities, transportation can consume as much as half of all the land area.
- An aerial view of any major metropolis will reveal vast acreage used for railroad terminals, airports, parking lots, and freeways.
- Transportation has other negative effects as well.
  - Every mode of transportation brings to mind some major disaster, such as the sinking of ships, the infrequent but dramatic passenger air crashes, and highway accidents that each year claim thousands of lives throughout the world.
  - In addition, transportation can create noise, spoil the natural beauty of an area, change the environment, pollute air and water, and consume energy resources.

Social Costs and Benefits of Transportation

- Society has shown a willingness to accept some risk and changes to the natural environment in order to gain the advantages that result from constructing new transportation systems.
- Society also values many social benefits brought about by good transportation.
  - Providing medical, commercial, financial and other services to rural areas are just a few examples of the benefits that transportation provides.
- A major task for the modern transportation engineer is to balance society's need for fast and efficient transportation with the costs involved.
- Thus, the most efficient and cost-effective system is created, while assuring that the environment is not compromised or destroyed.
- In carrying out this task, the transportation engineer must work closely with the public and elected officials and needs to be aware of modern engineering practices to ensure that the highest quality transportation systems are built consistent with available funds and accepted social policy.

Transportation in the United States

- Approximately 18 percent of U.S. household expenditure is related to transportation.
- Transportation accounts for about 28 percent of total energy consumption.
- Almost 100 percent of the energy utilized for propelling transport vehicles is derived from petroleum resources.
- Over 50 percent of all petroleum products consumed in the United States are for transportation purposes.
- Over 80 percent of eligible drivers are licensed to operate a motor vehicle.
- Each person in the Unites States travels an average of 12,000 miles each year.
- Over 10 percent of the work force is employed in a transportation-related activity.
- There are almost four million miles of paved roadway, of which 754,000 miles are used for intercity travel and 46,800 miles are interstate highways.
- There are approximately 140,300 miles of freight railroads, 5300 public use airports, 26,000 miles of navigable channels, and 359,000 miles of oil and gas pipelines.

Transportation Employment

Logistics and Supply-Chain Management

Vehicle Design and Transportation Services

Transportation Infrastructure Services

- The physical-distribution aspect of transportation.
- Known as business logistics or physical-distribution management.
- Concerned with the movement and storage of freight between the primary source of raw materials and the location of the finished manufactured product.
- Logistics is the process of planning, implementing, and controlling the efficient and effective flow and storage of goods, services, and related information from origination to consumption as required by the customer.
- An expansion of the logistics concept is called supply-chain management: A process that coordinates the product, information, and cash flows to maximize consumption satisfaction and minimize organization costs.

Transportation Employment

Logistics and Supply-Chain Management

Vehicle Design and Transportation Services

Transportation Infrastructure Services

- Vehicle design and manufacture is a major industry and involves the application of mechanical, electrical, and aerospace engineering skills as well as those of technically trained mechanics and workers in other trades.
- The service sector provides jobs for vehicle drivers, maintenance people, flight attendants, train conductors, and other necessary support personnel.
- Other professionals, such as lawyers, economists, social scientists, and ecologists, also work in the transportation fields when their skills are required to draft legislation, to facilitate right-of-way acquisition, or to study and measure the impacts of transportation on the economy, society, and the environment.

Transportation Employment

Logistics and Supply-Chain Management

Vehicle Design and Transportation Services

Transportation Infrastructure Services

- A wide variety of job opportunities exist in the area of transportation infrastructure: planning, design, construction, operation, and maintenance of the transportation system.
- Transportation professionals must make critical decisions about the system that will affect the thousands of people who use it.
- The work depends on the results of experience and research and is challenging and ever changing as new needs emerge and new technologies replace those of the past.
- The challenge of the transportation engineering profession is to assist society to ensure that the system functions efficiently from an economic point of view, and that it meets external requirements concerning energy, air quality, safety, congestion, noise, and land use.

Transportation Systems

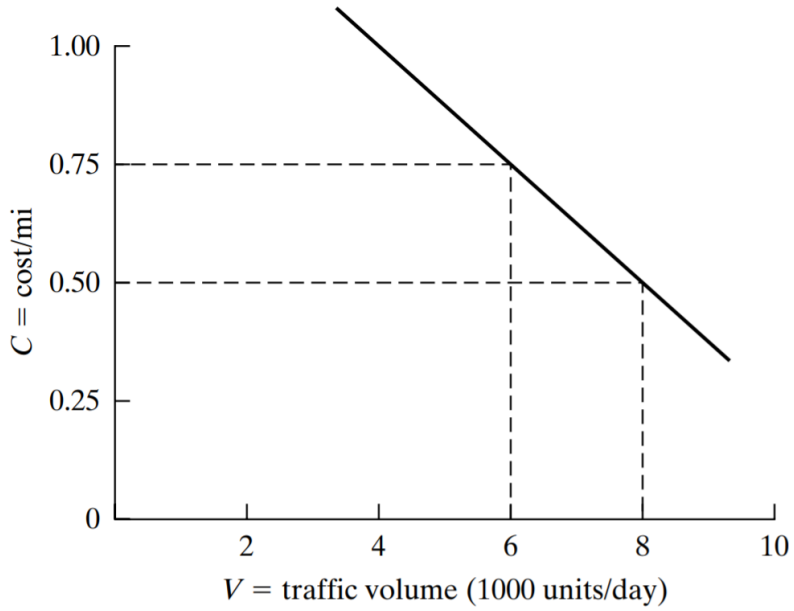
- The transportation system in a developed nation is an aggregation of vehicles, routes, terminal facilities, and control systems that move freight and passengers.
- These systems are usually operated according to established procedures and schedules in the air, on land, and on water.
- The set of physical facilities, control systems, and operating procedures referred to as the nation's transportation system is not a system in the sense that each of its components is part of a grand plan or was developed in a conscious manner to meet a set of specified regional or national goals and objectives.
- Rather, the system has evolved over a period of time and is the result of many independent actions taken by the private and public sectors, which act in their own or in the public's interest.

Interaction of Supply and Demand

- The transportation system that exists at any point in time is the product of two factors that act on each other.
- These are:
  1. The state of the economy, which produces the demand for transportation.
  2. The extent and quality of the system that is currently in place, which constitutes the supply of transportation facilities and services.
- In periods of high unemployment or rising fuel costs, the demand for transportation tends to decrease.
- On the other hand, if a new transportation mode is introduced that is significantly less costly when compared with existing modes, the demand for the new mode will increase, decreasing demand for the existing modes

Interaction of Supply and Demand

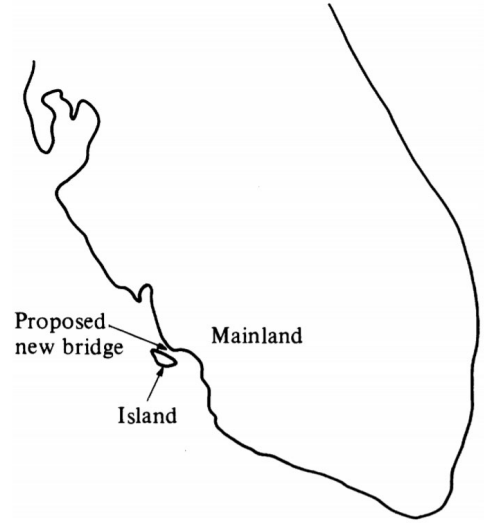
- The curve in Figure shows how demand in terms of traffic volume could vary with cost.
- The curve is representative of a given state of the economy and of the present population.
- As is evident, if the transportation cost per mile, C, decreases, then, since more people will use it at a lower cost, the volume, V, will increase.
- In other words, this curve provides an estimate of the demand for transportation under a given set of economic and social conditions.



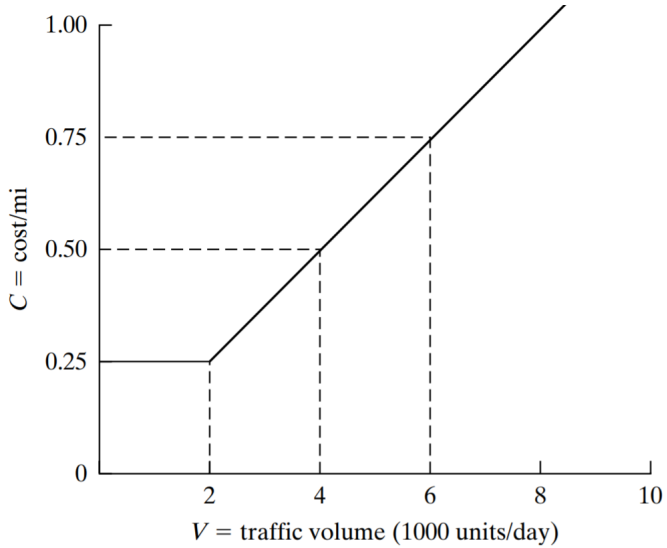
Relationship between Transportation Demand and Cost

Interaction of Supply and Demand

- Now, Consider a situation where the demand shown before represents the desire to travel between the mainland of Florida and an inaccessible island that is located off the coast, as shown in Figure.
- If a bridge is built, people will use it, but the amount of traffic will depend on cost.
- The cost to cross the bridge will depend on the travel time for cars and trucks.
- If only a few vehicles cross, little time is lost waiting, however, as more and more cars and trucks use the bridge, the time required to cross will increase due to traffic congestion.
- In this figure, if the volume is less than 2000 units/day, there is almost no delay due to traffic congestion. However, as traffic volumes increase beyond 2000 units/day, delays occur, and the travel time increases. Since "time is money," the increased time has been converted to $/mi (ex: if 4000 units/day use the bridge, the cost is $0.50/mi)



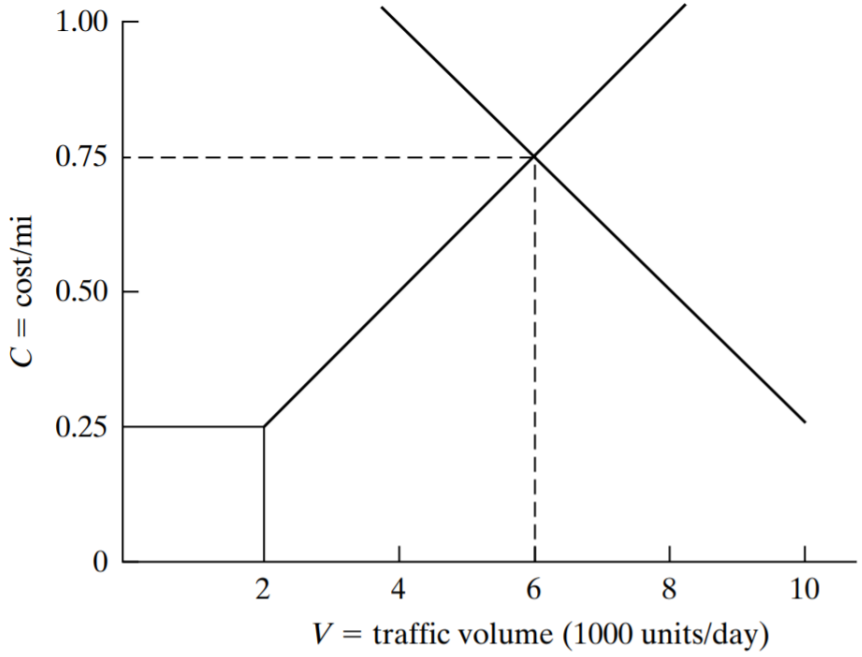
Location of a New Bridge Between the Mainland and an Island



Relationship between Transportation Supply and Cost

Interaction of Supply and Demand

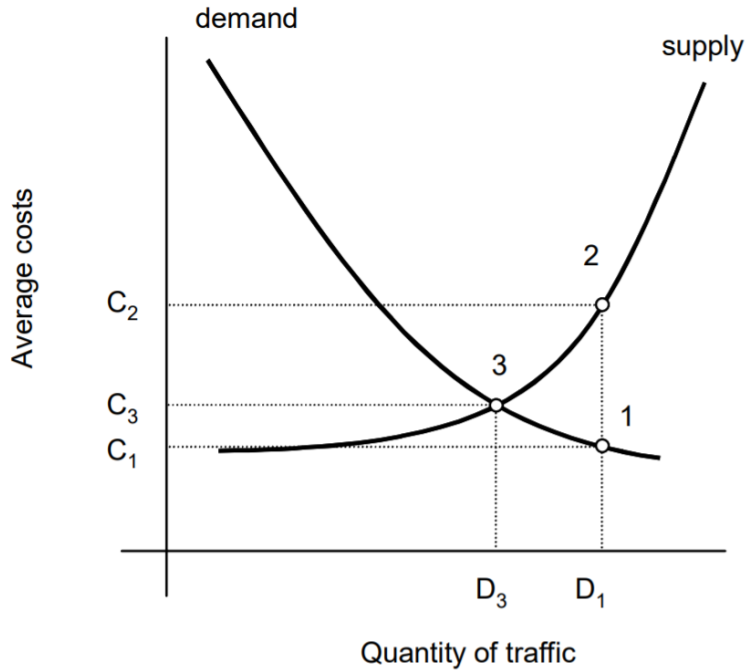
- The two previous curves determine what volume (V) can be expected to use the bridge.
- This value will be found where the demand curve intersects the supply curve as shown in figure, because any other value of V will create a shift in demand either upward or downward, until the equilibrium point is reached.
- If the volume increased beyond the equilibrium point, cost would go up and demand would drop. Likewise, if the volume dropped below equilibrium, cost would go down and demand would increase. Thus, in both instances equilibrium is achieved.
- In this example, the number of units crossing the bridge would be 6000 units/day.
- The traffic volume could be raised or lowered by changing the toll—an example of congestion pricing.



Equilibrium Volume for Traffic Crossing a Bridge

Interaction of Supply and Demand

- The objective of demand-supply analysis is to predict the performance of the traffic system from the viewpoint of the users and from the perspective of the system.
- The users will be interested in their travel times, incurred delays, queueing, comfort, risks, and energy consumption.
- The system manager will be concerned with system performance, level-of-service, air pollution, noise generation, accident rates, and total transport costs.
- The formulation often takes the form of a multi-objective function with a set of constraints.
  - Ex.: At an isolated signalized intersection the objective may be to minimize a combination of delays and stops with the constraint of a maximum delay.
- Generally, as the size and the complexity of the traffic system increases, the formulation becomes more comprehensive and more complex as well.



Demand-supply equilibrium

Interaction of Supply and Demand

- At any point in time, the nation's transportation system is in a state of equilibrium as expressed by the traffic carried (or market share) for each mode and the levels of service provided (expressed as travel attributes such as time, cost, frequency, and comfort).
- This equilibrium is the result of
  - Market forces: state of the economy, competition, costs, and prices of service
    - For example, if gasoline prices were to increase significantly, there could be a measurable shift of long-haul freight from truck to rail. In the long run, if petroleum prices remained high, there might be shifts to more fuel-efficient trucks and autos.
  - Government actions: regulation, subsidy, and promotion
    - For example, the federal government's decision to build a national interstate system affects the truck–rail balance in favor of truck transportation. It also encourages long distance travel by auto and is a factor in the decline of intercity bus service to small communities.
  - Transportation technology: speed, capacity, range, and reliability
    - A dramatic example is the introduction of jet aircrafts, which essentially eliminated long distance passenger train travels and passenger steamship transcontinental travel.

Interaction of Supply and Demand

- As these forces shift over time, the transportation system changes as well, creating a new set of market shares (levels of demand) and a revised transportation system.
- For this reason, the nation's transportation system is in a constant state of flux, causing short-term changes due to immediate revisions in levels of service (such as raising the tolls on a bridge or increasing the gasoline tax) and long-term changes in lifestyles and land-use patterns (such as moving to the suburbs after a highway is built or converting auto production from large to small cars).

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