

CE 353

Principles of Transportation and Traffic Engineering

PART 1

**INTRODUCTION TO TRANSPORTATION
SYSTEMS**

Basic Definitions

Transportation: “The services provided for the movement of people and goods (freight) from one place to another to create time and space utility.”

Transportation engineering deals with,

- planning,
- design,
- construction,
- operation and
- maintenance of all kinds of transportation facilities.



Basic Definitions

A more technical definition of **Transportation Engineering**:

“The application of technological and scientific principles to the planning, functional design, operation and management of facilities or any mode of transportation in order to provide for the safe, rapid comfortable, convenient, economical and environmentally compatible movement of people and goods.”

Basic Definitions

Traffic engineering is defined as:

“That phase of transportation engineering which deals with the planning, geometric design and traffic operations of roads, streets and highways, their network, terminals, abutting lands and relationship with other modes of transportation.”



Ideal Transportation

An ideal transportation system should be:

- dependable
- safe
- rapid
- economical
- environmentally compatible

Additionally, it should minimize noise, minimize air and water pollution, and be energy efficient.

Main Attributes of Transportation Systems

- **Efficiency and suitability:** The transport modes should be chosen by considering type of terrain, distance, demand and properties of commodities to be transported.
- **Economy:** High benefits with low investment should be achieved.
- **Speed:** Higher speed increase productivity.
- **Safety:** Safety is essential in transportation. Safety increases benefits both in monetary and intangible benefits.

Classification of Transportation Systems

1- Overland Transportation Systems

2- Water Transportation Systems

3- Air Transportation Systems

Classification of Transportation Systems

1- Overland Transportation Systems

- a) Highway transportation
- b) Rail transportation
- c) Continuous flow systems

2- Water Transportation Systems

- a) Sea transport
- b) Inland water transport systems

3- Air Transportation Systems

- c) Air carriers
- d) General Aviation



Highway Transportation



Railway Station- Amsterdam Central Station



Railways (Amsterdam Central Station)



Air Transportation- Atatürk Airport-Istanbul



Antalya Airport



3rd Istanbul Airport (project)



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Sea Transportation



Sea Transportation



Danube River (Tuna Nehri) Inland Water Transportation

Highway Transportation

The main goals of highway transportation are:

- i) The provision of high level of service with continuous flow, without interruption (i.e. minimize travel time and delay).
- ii) The provision of comfortable, convenient and safe movement (i.e. high standards).

Classification of Highways and Their Functions

Classification according to Design Type: Geometry and access conditions are the parameters used for the classification.

- 1) Freeways or motorways
(2x2, 3x3, 4x4 or 2x3, 3x4 etc. → figures indicates number of lanes in each direction)
- 2) Multilane divided highways
(2x2, 3x3, 4x4 or 2x3, 3x4 etc. figures indicates number of lanes in each direction)
- 3) Multilane undivided highways
(2x2, 3x3, 4x4 etc. figures indicates number of lanes in each direction)
- 4) Two lane highways, and three lane highway segments



Classification of Highways and Their Functions

Classification according to Administration: This will vary from country to country since administrative units are not the same in different countries.

In Turkey:

<u>Class</u>	<u>Authority</u>
Motorways	General Directorate of Highways (GDH)
State Highways	General Directorate of Highways (GDH)
Municipal roads	Municipalities
Village roads	Ministry
Forest Roads	Ministry

Classification of Highways and Their Functions

Classification by Function: This groups the streets and highways according to service they are intended to provide. The main grouping is as follows:

- a) Primary movement (Freeways, main arterials)
- b) Transition (Highway ramps)
- c) Distribution (Secondary arterials)
- d) Collection (Collector)
- e) Access (Local access roads)
- f) Terminals (parking facilities)

Classification of Highways and Their Functions

Access and mobility are two major considerations in classifying highways and streets.

- Regulated limitation of access is necessary on arterials to enhance their primary function of mobility.
- Conversely on the other extreme, the primary function of local roads and streets is to provide access which consequently causes limitation in mobility.
- The extent of degree of access control is thus a significant factor in defining the functional category of a street or a highway.

Classification of Highways and Their Functions

Figure 1 Change of priority of access and mobility in different road hierarchy

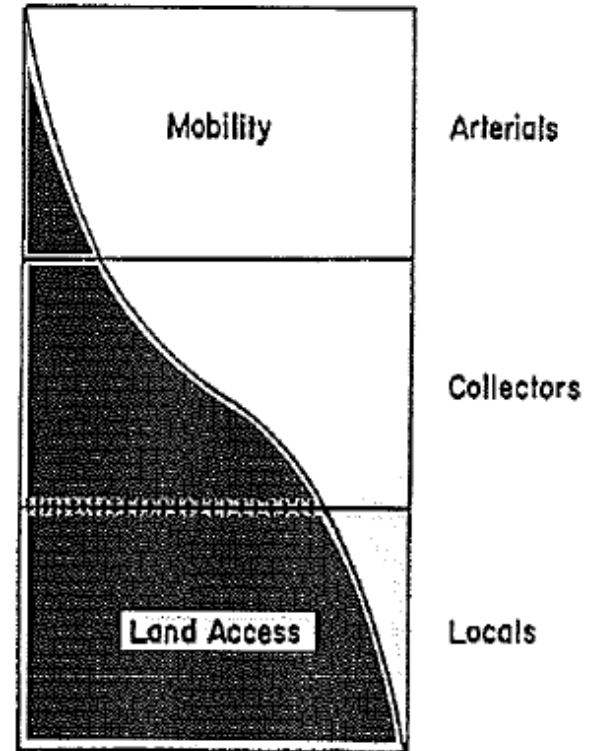


Table 1.1 Highway Functions and Classification

Subcategory	Rural	Urban
Freeways		
Freeways (Motorways)	High standard divided multilane highways with full control of access	High standard divided multilane highways with full control of access
Expressways	Facilities with substantial control of access, but having some at-grade crossings or entrances.	Facilities with substantial control of access, but having some at-grade crossings or entrances.
Arterials		
Major or Principal Arterials	Serving significant corridor movements, often between areas with populations over 25,000 to 50,000.	Principal service for through movements, with very limited land-access functions that are incidental to the mobility function.
	High-type design and alignment prevail.	High-type design prevails.

Collectors		
Major Collectors	Serve generators of intra-county importance not served by arterials; provide connections to arterials and/or freeways	No subcategories usually used for urban collectors.
Minor Collectors	Link locally important generators with their rural hinterlands; provide connections to major collectors or arterials.	Provide land access and circulation service within residential neighborhoods and/or commercial/industrial areas; collect trips from local generators and channel them to nearby arterials; distribute trips from arterials to their ultimate destination.
Local Roads		
Residential	No subcategories generally used in rural classification schemes.	Provide land access and circulation within residential neighborhoods.
Commercial	Provide access to adjacent lands of all types; serve travel over relatively short distances.	Provide land access and circulation in areas of commercial development.
Industrial		Provide land access and circulation in areas of industrial development
Terminals		
	Services (Roadside parking and petrol stations).	Bus stations, curb parking, roadside pick-up points, other parking facilities.

GENERAL OVERVIEW OF TRANSPORTATION SYSTEMS

Motivation

To understand the size and the current trends in transportation sector today, we have to look at the development of the transportation systems and sector in the past, both in Turkey and in the world.

The chronological development of transportation systems and structures in the world can be summarized as follows:

Early Road Transportation

- First traces of road structures were met in Egypt.
- During the throne of Roman Empire, roads called as “Roman Roads” had been constructed in Greece and Anatolia.

Early Road Transportation

Roman Road Network
100 BC



Roman Road Network
200 AC



Early Road Transportation

- During the first half of the 19th century; new highway engineering techniques were developed by two British engineers Mac Adam and Telford and a French engineer Polonceau.
- Use of asphalt in pedestrian walk lanes and in roads was first seen in 1836 and 1838 in London and in Philadelphia respectively.

Railway Era

- Invention of steam power in early 1700s and design of locomotives in 1820s
→ this resulted in the rise of “railways” in 19th century.

- By 1920s, railways became popular;

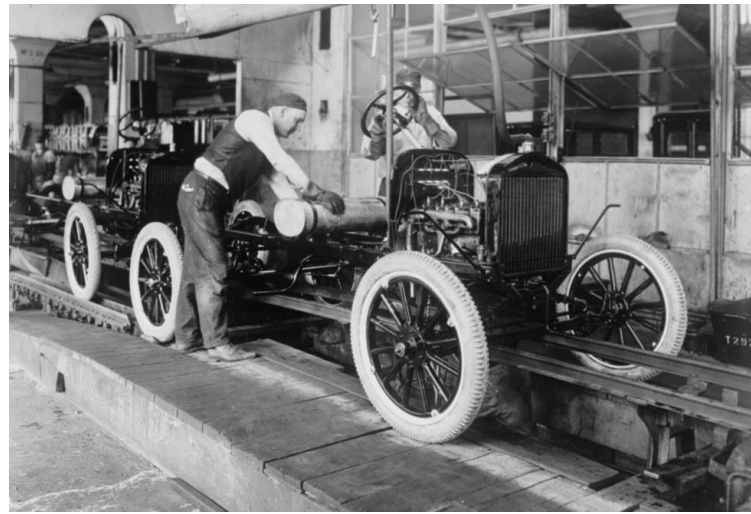
- Fast → 40 km/hr
- Easy to build → compared to canals and water transportation
- Great traction power → good for carrying freight



Pere Marquette #1034

Highway Transportation

- Beginning of 1900s
→ invention of personal vehicles (automobiles)
- 1920s
→ Mass production of automobiles
→ Ford's Assembly Line
 - personalized and “door-to-door” transportation system
 - became popular
 - railways lost popularity



Highway Transportation

- Today asphalt mixtures are used extensively in flexible pavement structures successfully for a safe, rapid and economical highway transportation to sustain heavy axle loads.



Transportation Systems in Turkey

- **Ottoman Times (1856-1922)**

→ 8619 km of railways were constructed under the inspection of foreign companies with the privileges granted to them

- **Post-Republic Period (1923-1950)**

→ “railroad intense” period focused on transporting such mass cargos (iron, steel, coal, etc.) in the cheapest way



Transportation Systems in Turkey

- 1950-2005 → golden age of land transportation
- 2005- today → Major changes in transportation systems:
 - High Speed Rail (HSR) lines, Ankara-Eskişehir, Ankara-Konya, Konya-Eskişehir, and new ones
 - The continuous planning and construction of divided limited access highways along major corridors and plans for increasing capacity of motorways.



Transportation Master Plans

- Major changes and infrastructure requires a very detailed and multi-perspective planning at the national level;
- These preparations are referred to as “master plans” for a region, let it be a city or a country.

Transportation Master Plans

1983-1993 Transport Master plan of Turkey → some aims listed as;

- To improve **safety in transportation**
- To increase **accessibility** of Turkish Transportation Network
- To **meet the future transport demands** properly
- To **minimize energy consumption** and to **decrease transport costs**
- To minimize the **dependency** of transportation sector to **an energy kind**
- To decrease the adverse effect of transportation on **environment**
- To improve the **efficiency** of transportation network
- To plan a transportation network for **national security**

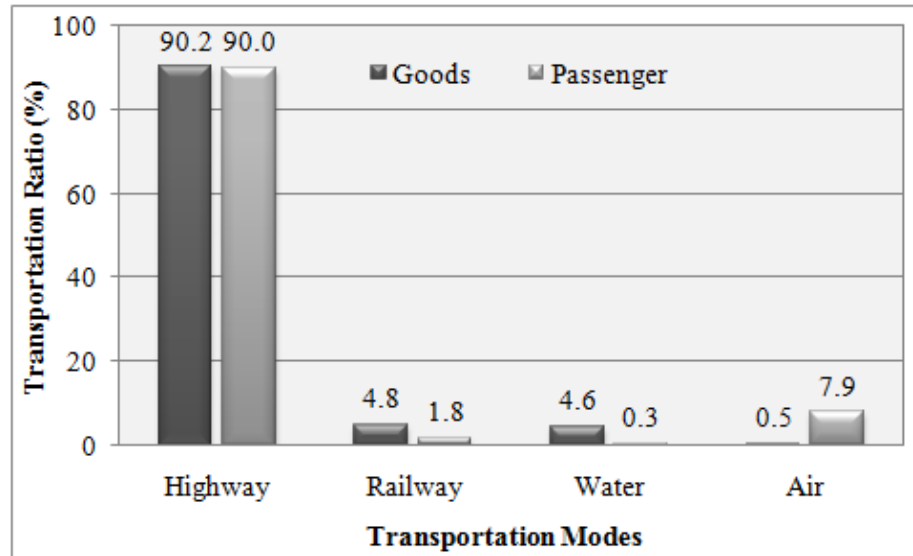
Transportation Master Plans

- No recently developed Transportation Master Plan, yet
- Strategy document prepared by İTÜ (2005) defined main objective of transportation in Turkey as
 - “....to give the necessary, necessity being determined by the development and social aims of the country, service to the user at the most appropriate quality, with the conditions that
 - it will be in conjunction with national security,
 - it will be **safe and environment friendly, cheap, technologically new,**
 - in harmony with **international rules and EU policies.**

Remember “ideal transportation” definition?

Current Status of Transportation Sector in Turkey

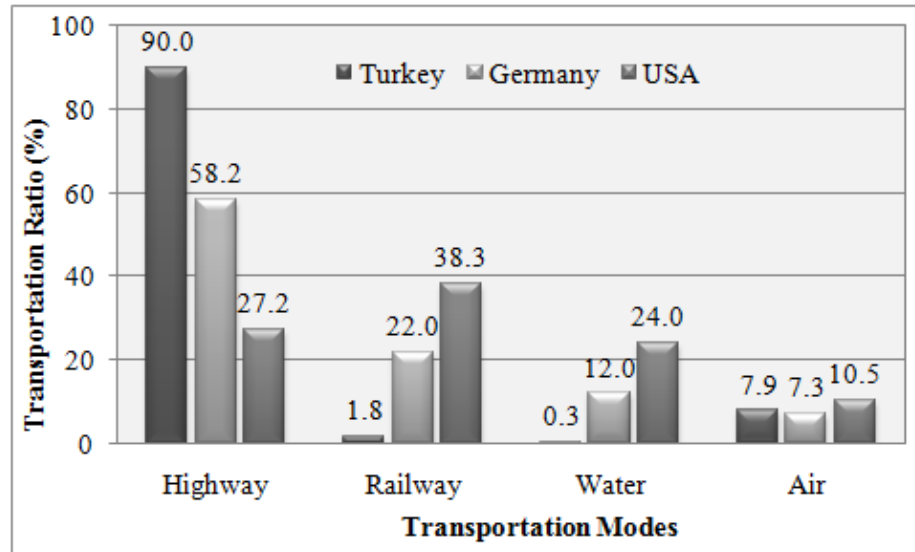
- Highway oriented



Transportation of Passengers and Goods per Mode in Turkey (%) (TurkStat, 2008)

Current Status of Transportation Sector in Turkey

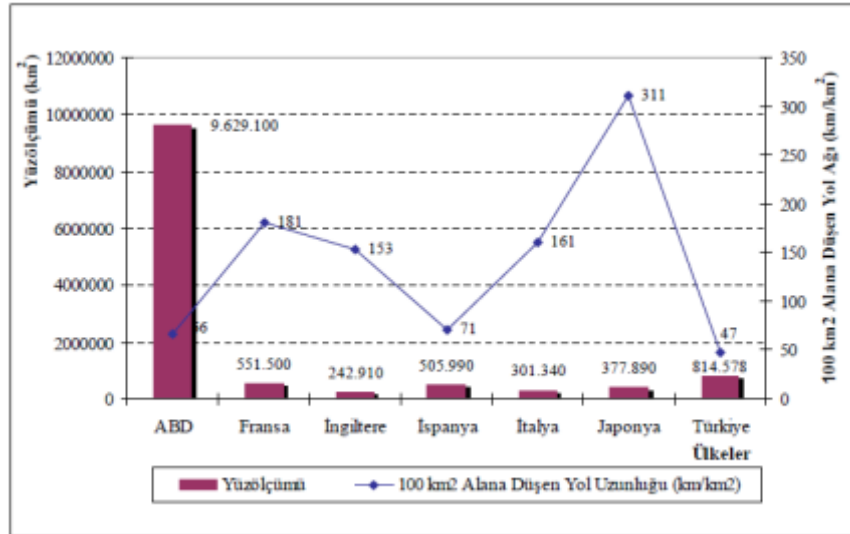
- Very unbalanced



Transportation of Passengers per Mode (%) in Turkey, United States and Germany (UNECE Transport Division, 2006)

Current Status of Transportation Sector in Turkey

- Road network not developed as much as developed countries



Length of Total Road Network in Some Countries per 100 km²

Current Status of Transportation Sector in Turkey

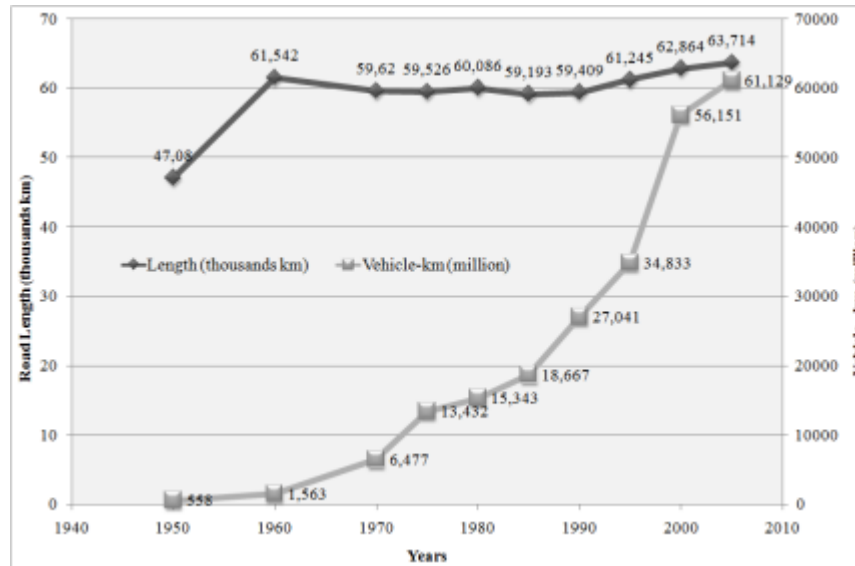
- **Capacity not increasing much!!!**

	2000	2009	% increase (2000-2009)
Motorways	1,773	2,036	14.8
State Roads (km)	31,397	31,271	-1.0
Provincial Roads (km)	29,693	30,948	1.0
Village Roads (km)	321,820	298,405	-9.0
Total	384,683	362,660	

Lengths of Motorways, State Highways, Provincial Roads and Village Roads (SIT, 2005; KGM 2005)

Current Status of Transportation Sector in Turkey

- Demand is increasing rapidly!!!



Length of Highway Road Network per Year (Motorways, Highways and State Roads) (GDH, 2004)

Current Status of Transportation Sector in Turkey

- **More drivers!!!**

Year	Total Drivers	Increase (%)	Male (%)	Female (%)
2000	13,859,449		11,988,154 86.5	1,871,295 13.5
2009	20,460,739	44.9	16,871,100 82.5	3,589,639 17.5

Number of Male and Female Drivers between 2000 and 2009

- **More vehicles!!!**

Year	Car	Minibus	Bus	Small Truck	Truck	Motorcycle	Special Use	Tractor	Total	Increase
2000	4,855,421	289,422	129,924	789,524	593,361	984,592	21,822	1,131,626	8,795,692	
2009	7,093,964	384,053	201,033	2,204,951	727,302	2,303,261	34,104	1,368,032	14,316,700	63%

Current Status of Transportation Sector in Turkey

- **Traffic Safety Problem!!!**

More than 4,000 people die at crash site every year!!

YEAR	ACCIDENTS INVOLVING			PEOPLE	
	TOTAL	FATALITY	INJURY	KILLED	INJURED
2000	500,664	2,994	62,295	5,566	136,406
2001	442,960	2,312	52,848	4,386	116,202
2002	439,958	2,221	52,525	4,169	116,045
2003	455,637	2,120	53,983	3,959	117,551
2004	537,352	2,354	61,239	4,427	136,437
2005	620,789	2,535	69,659	4,505	154,086
2006	728,755	2,586	76,591	4,633	169,080
2007	825,561	2,671	84,295	5,007	189,057
2008	950,120	2,258	82,361	4,236	184,468
2009	1,034,435	2,310	89,204	4,300	200,405

This is not sustainable...

Something must be changed in the current conditions!

**More information in fourth year technical electives
courses:**

**CE407 Special Studies in Transportation Systems
and Modes**

**and
CE 452 Traffic Safety and Accident Investigation**