Section II

LEGAL REGULATION OF INTERNATIONAL TRANSPORTATION

Topic 8. International legal regulation of road transportation

1. Definition and Description of the road transportation and road transport system
2. The History of road transportation
3. International classification and legislation of the road transportation
4. Advantages and Disadvantages of Road Transport

1. Definition and Description of road transportation

Road transport (British English) or **road transportation** (American English) is the transport of passengers or goods on roads.

Definition: Road transport means transportation of goods and personnel from one place to the other on roads. Road is a route between two destinations, which has been either paved or worked on to enable transportation by way of motorised and non-motorised carriages. There are many advantages of road transport in comparison to other means of transport. The investment required in road transport is very less compared to other modes of transport such as railways and air transport. The cost of construction, operating cost and maintaining roads is cheaper than that of the railways.

Description: Road transport can be classified as transporting either goods and materials or transporting people. The major advantage of road transport is that it can enable door-to-door delivery of goods and materials and can provide a very cost-effective means of cartage, loading and unloading. Sometimes road transport is the only way for carrying goods and people to and from rural areas which are not catered to by rail, water or air transport. Delivery of goods between cities, towns and small villages is made possible only through road transport. However, in spite of various merits, road transport has some major limitations. For instance, there are more chances of accidents and breakdowns in case of road transport. So, motor transport is not as safe as other means of transport. Road transport is also quite less organised in comparison with other modes. It is irregular and undependable. Rates for road transportation are also unstable and unequal, while the speed in road transport is slow and limited, which is a major drawback. Transporting bulky goods over long distances is also unsuitable and costly. In modern days, road transport has a serious negative impact on the environment. Building roads requires melting of tar or formulation of concrete, which may harm the associated environment. Since roads have been a major enabler of motorised transport, these vehicles also emit a lot of pollution in the form of Nitrogen dioxide, volatile organic compounds, carbon monoxide and various harmful air pollutants, including benzene, which have an adverse respiratory health effects and a serious threat to global warming. While improvisation of roads is a serious topic of research, road transport of the future includes aspects like solar panel roads and cars where solar cells have replaced asphalt or tar, and there are vehicles with electric motors reducing emission. Road transport of the future aims to work on these negativities and turn them around.

Vehicle

A **vehicle** (from Latin: *vehiculum)* is a mobile machine that transports people or cargo. Typical vehicles include wagons, bicycles, motor vehicles (motorcycles, cars, trucks, buses), railed vehicles (trains, trams), watercraft (ships, boats), aircraft and spacecraft.

Land vehicles are classified broadly by what is used to apply steering and drive forces against the ground: wheeled, tracked, railed or skied. ISO 3833-1977 is the standard, also internationally used in legislation, for road vehicles types, terms and definitions.

- 1769 Nicolas-Joseph Cugnot is often credited with building the first self-propelled mechanical vehicle or automobile in 1769.
- In Russia, in the 1780s, Ivan Kulibin developed a human-pedalled, three-wheeled carriage with modern features such as a flywheel, brake, gear box and bearings; however, it was not developed further.
- 1783 Montgolfier brothers first Balloon vehicle

- 1801 Richard Trevithick built and demonstrated his *Puffing Devil* road locomotive, which many believe was the first demonstration of a steam-powered road vehicle, though it could not maintain sufficient steam pressure for long periods and was of little practical use.
- 1817 Push bikes, draisines or hobby horses were the first human means of transport to make use of the two-wheeler principle, the draisine (or *Laufmaschine*, "running machine"), invented by the German Baron Karl von Drais, is regarded as the forerunner of the modern bicycle (and motorcycle). It was introduced by Drais to the public in Mannheim in summer 1817.
- 1885 Karl Benz built (and subsequently patented) the first automobile, powered by his own four-stroke cycle gasoline engine in Mannheim, Germany
- 1885 Otto Lilienthal began experimental gliding and achieved the first sustained, controlled, reproducible flights.
- 1903 Wright brothers flew the first controlled, powered aircraft
- 1907 First helicopters Gyroplane no.1 (tethered) and Cornu helicopter (free flight)
- 1928 Opel RAK.1 rocket car
- 1929 Opel RAK.1 rocket glider
- 1961 Vostok vehicle carried first man, Yuri Gagarin, into space
- 1969 Apollo Program first manned vehicle landed on the moon
- 2010 The number of road motor vehicles in operation worldwide surpassed the 1 billion mark – roughly one for every seven people.

Most popular vehicles. There are over 1 billion bicycles in use worldwide. In 2002 there were an estimated 590 million cars and 205 million motorcycles in service in the world. At least 500 million Chinese Flying Pigeon bicycles have been made, more than an other single model of vehicle. The most-produced model of motor vehicle is the Honda Super Cub motorcycle, having passed 60 million units in 2008. The most-produced car model is the Toyota Corolla, with at least 35 million made by 2010.

Locomotion. Locomotion consists of a means that allows displacement with little opposition, a power source to provide the required kinetic energy and a means to control the motion, such as a brake and steering system. By far, most vehicles use wheels which employ the principle of rolling to enable displacement with very little rolling friction.

Energy source. It is essential that a vehicle have a source of energy to drive it. Energy can be extracted from the surrounding environment, as in the case of a sailboat, a solar-powered car or a streetcar. Energy can also be stored, in any form, provided it can be converted on demand and the storing medium's energy density and power density are sufficient to meet the vehicle's needs.

The most common type of energy source is fuel. External combustion engines can use almost anything that burns as fuel whilst internal combustion engines and rocket engines are tailor built to burn a specific fuel, typically gasoline, diesel or ethanol.

Another common medium for storing energy are batteries, which have the advantage of being responsive, useful in a wide range of power levels, environmentally friendly, efficient, simple to install and easy to maintain. Batteries also facilitate the use of electric motors, which have their own advantages. On the other hand, batteries have low energy densities, short service life, poor performance at extreme temperatures, long charging times and difficulties with disposal (although they can usually be recycled). Like fuel, batteries store chemical energy and can cause burns and poisoning in event of an accident. Batteries also lose effectiveness with time. The issue of charge time can be resolved by swapping discharged batteries with charged ones, however this incurs additional hardware cost and may be impractical for larger batteries. Moreover, there must be standard batteries for battery swapping to work at a gas station. Fuel cells are similar to batteries in that they convert from chemical to electrical energy, but have their own set of advantages and disadvantages.

Electrified rails and overhead cables are a common source of electrical energy on subways, railways, trams, and trolleybuses. Solar energy is a more modern development, and several solar vehicles have been successfully built and tested, including Helios, a solar-powered aircraft.

Nuclear power is a more exclusive form of energy storage, currently reserved for large ships and submarines, mostly military. Nuclear energy can be released by a nuclear reactor, nuclear battery or by repeatedly detonating nuclear bombs. There have been two experiments with nuclear-powered aircraft, the Tupolev Tu-119 and the Convair X-6.

Mechanical strain is another method of storing energy, where an elastic band or metal spring is deformed and releases energy as it is allowed to return to its ground state. Systems employing elastic materials suffer from hysteresis, and metal springs are too dense to be useful in many cases.

Flywheels store energy in a spinning mass. Because a light and fast rotor is energetically favorable, flywheels can pose a significant safety hazard. Moreover, flywheels leak energy fairly quickly and effect a vehicle's steering due to the gyroscopic effect. They have been used experimentally in gyrobuses.

Wind energy is used by sailboats and land yachts as the primary source of energy. It is very cheap and fairly easy to use, the main issues being dependence on weather and upwind performance. Balloons also rely on the wind to move horizontally. Aircraft flying in the jet stream may get a boost from high altitude winds.

Compressed gas is currently an experimental method of storing energy. In this case, compressed gas is simply stored in a tank and released when necessary. Like elastics, they have hysteresis losses when gas heats up during compression.

Gravitational potential energy is a form of energy used in gliders, skis, bobsleds and numerous other vehicles that go down hill. Regenerative braking is an example of capturing kinetic energy where the brakes of a vehicle are augmented with a generator or other means of extracting energy.

Human power is a simple source of energy that requires nothing more than humans. Despite the fact that humans cannot exceed 500 W (0.67 hp) for meaningful amounts of time, the land speed record for human-powered vehicles (unpaced) is 133 km/h (83 mph), as of 2009.

Motors and engines. When needed, the energy is taken from the source and consumed by one or more motors or engines. Sometimes there is an intermediate medium, such as the batteries of a diesel submarine.

Most motor vehicles have internal combustion engines. They are fairly cheap, easy to maintain, reliable, safe and small. Since IC engines burn fuel, they have long ranges but pollute the environment. A related engine is the external combustion engine. An example of this are steam engines. Aside from fuel, steam engines also need water, making them impractical for some purposes. Steam engines also need time to warm up, whereas IC engines can usually run right after being started, although this is not recommended in cold conditions. Steam engines burning coal release sulfur into the air causing harmful acid rain.

While intermittent internal combustion engines were once the primary means of aircraft propulsion, they have been largely superseded by continuous internal combustion engines: gas turbines. Turbine engines are light and, particularly when used on aircraft, efficient.

On the other hand, they cost more and require careful maintenance. They also get damaged from ingesting foreign objects and produce a hot exhaust. Trains using turbines are called gas turbine-electric locomotives. Examples of surface vehicles using turbines include M1 Abrams, MTT Turbine SUPERBIKE and the Millennium. Pulse jet engines are similar in many ways to turbojets, but have almost no moving parts. For this reason, they were very appealing to vehicle designers in the past, however their noise, heat and inefficiency has lend their abandonment. A historical example of a pulse jet in use was the V-1 flying bomb. Pulse jets are still occasionally used in amateur experiments. With the advent of modern technology, the pulse detonation engine has become practical and was successfully tested on a Rutan VariEze. While the pulse detonation engine is much more efficient that the pulse jet and even turbine engines, it still suffers from extreme noise and vibration levels. Ramjets also have few moving parts, but they only work at high speed meaning that their use is restricted to tip jet helicopters and high speed aircraft such as the Lockheed SR-71 Blackbird.

Rocket engines are primarily used on rockets, rocket sleds and experimental aircraft. Rocket engines are extremely powerful. The heaviest vehicle to ever leave the ground, the Saturn V rocket, was powered by five F-1 rocket engines generating a combined 180 million horsepower (134.2 gigawatt). Rocket engines also don't need to "push off" of anything, a fact that the New York Times denied in error. Rocket engines can be particularly simple, sometimes consisting of nothing more than a catalyst, as in the case of a hydrogen peroxide rocket. This makes them an attractive option for vehicles such as jet packs. Despite their simplicity, rocket engines are often dangerous and susceptible to explosions. The fuel they run off may be flammable, poisonous, corrosive or cryogenic. They also suffer from poor efficiency. For these reasons, rocket engines are only used when absolutely necessary.

Electric motors are used in electric vehicles such as electric bicycles, electric scooters, small boats, subways, trains, trolleybuses, trams and experimental aircraft. Electric motors can be very efficient, over 90% efficiency is common. Electric motors can also be built powerful, reliable, low-maintenance and of arbitrary size. Electric motors can deliver a range of speeds and torques without necessarily using a gearbox (although it may be more economic to use one). Electric motors are limited in their use chiefly by the difficulty of supplying electricity.

Compressed gas motors have been used on some vehicles experimentally. They are simple, efficient, safe, cheap, reliable and operate in a variety of conditions. One of the difficulties encountered when using gas motors is the cooling effect of expanding gas. These engines are limited by how quickly they absorb heat from their surroundings. The cooling effect can, however, double as air conditioning. Compressed gas motors also lose effectiveness with falling gas pressure.

Ion thrusters are used on some satellites and spacecraft. They are only effective in a vacuum, which limits their use to spaceborne vehicles. Ion thrusters run primarily off electricity but they also need a propellant such as caesium or more recently xenon. Ion thrusters can achieve extremely high speeds and use little propellant however they are power hungry too.

Converting energy to work. The mechanical energy that motors and engines produce must be converted to work by wheels, propellers, nozzles, or similar means. Aside from converting mechanical energy into motions, wheels allow a vehicle to roll along a surface and, with the exception of railed vehicles, to steer/ Wheels are ancient technology, with specimens being discovered from over 5000 years ago. Wheels are used in a plethora of vehicles, including motor vehicles, armoured personnel carriers, amphibious vehicles, airplanes, trains, skateboards and wheelbarrows.

Nozzles are used in conjunction with almost all reaction engines. Vehicles using nozzles include jet aircraft, rockets and personal watercraft. While most nozzles take the shape of a cone or bell, some unorthodox designs have been created such as the aerospike. Some nozzles are intangible, such as the electromagnetic field nozzle of a vectored ion thruster.

Continuous tracks are sometimes used instead of wheels to power land vehicles. Continuous tracks have the advantage of a larger contact area, easy repairs on small damage and high maneuverability. Examples of vehicles using continuous tracks include tanks, snowmobiles and excavators. Two continuous tracks used together allow for steering. The largest vehicle in the world, the Bagger 288 is propelled by continuous tracks.

Propellers (as well as screws, fans and rotors) are used to move through a fluid. Propellers have been used as toys since ancient times, however it was Leonardo da Vinci who devised what was one of the earliest propeller driven vehicles, the "aerial-screw".

In 1661, Toogood & Hays adopted the screw for use as a ship propeller. Since then, the propeller has been tested on many terrestrial vehicles, including the

Schienenzeppelin train and numerous cars. In modern times, propellers are most prevalent on watercraft and aircraft, as well as some amphibious vehicles such as hovercraft and ground effect vehicles. Intuitively, propellers cannot work in space as there is no working fluid, however some sources have suggested that since space is never empty, a propeller could be made to work in space.

Similarly to propellered vehicles, some vehicles use wings for propulsion. Sailboats and sailplanes are propelled by the forward component of lift generated by their sails/wings. Ornithopters also produce thrust aerodynamically. Ornithopters with large rounded leading edges produce lift by leading-edge suction forces.

Paddle wheels are used on some older watercraft and their reconstructions. These ships were known as paddle steamers. Because paddle wheels simply push off the water, their design and construction is very simple. The oldest such ship in scheduled service is the Skibladner. Many pedalo boats also use paddle wheels for propulsion.

Screw-propelled vehicles are propelled by auger-like cylinders fitted with helical flanges. Because they can produce thrust on both land and water, they are commonly used on all-terrain vehicles. The ZiL-2906 was a Soviet-designed screw-propelled vehicle that was meant to retrieve cosmonauts from the Siberian wilderness.

Friction. All or almost all of the energy added by the engine is usually lost as friction; so minimising frictional losses are very important in many vehicles. The main sources of friction are rolling friction and fluid drag (air drag or water drag).

Wheels have low bearing friction and pneumatic tyres give low rolling friction. Steel wheels on steel tracks are lower still. Air drag can be minimised with aerodynamic features.

Description of the road transport system

Road transport services are carried out throughout the world with vehicles spanning from small distribution vans to long road trains. The loading capacity is either fixed on the vehicle or a swap body that can be transferred to another mode of transport, typically rail or sea. The advantages of road transportation are its flexibility and ability to reach far out to customers and the security of goods as there is always a driver involved.

The size of a shipment can vary between a parcel up to a whole truck load. The limitations are the loading capacity, based on road weight carrying capacity and a maximised size of vehicles, and dependence upon drivers. Furthermore, increasing congestion problems is a drawback in some areas.

Road transport as covered by NTM includes different types of lorries/trucks designed exclusively for cargo transport on public roads. NTM distinguishes between the following transport situations involving road vehicles:

Shared (Integrated) transport systems

A network of different vehicles and terminals engaged in the transport of the cargo. The idea is to obtain high capacity utilisation by integrating several shipments, this at the expense of higher transit time and longer actual transported distance. It is often transport services with re-loadings at integrating terminals. This often includes less than truck load and parcel and mail distribution.

Dedicated (Direct) transport – single shipment

The transport is carried out once by a vehicle travelling directly from the shipper to the consignee. Positioning before and after the transport will decrease the total capacity utilisation. This often includes a truck load.

Dedicated (Direct) transport – frequent shipments

The transport is carried out repeatedly by a vehicle travelling back and forth between the shipper to the consignee. If the vehicle is specially adapted to the cargo, the vehicle is often used as a shuttle, i.e. returned empty. Trucks with normal cargo hold structures might carry goods on the return trip. This often includes a truck load.

Delimitations. NTM data excludes at present other types of road transports such as cargo transported by long distance buses, vehicles designed for special purpose transport services (heavy, wide or long cargo) or trailers pulled by farm tractors, military equipment or construction machinery.

2. The History of road transportation

The Setting of Road Transport Systems

Two major modes are composing the land transport system, roads and railways. Obviously, roads were established first, as rail technology only became available by the 18th century, in the midst on the industrial revolution. Historical considerations are important in assessing the structure of current land transportation networks. Modern roads tend to follow the structure established by previous roads, as it was the case for the modern European road network (especially in Italy, France and Britain) that follows the structure established by the Roman road network centuries before.

Early roads. The first methods of road transport were horses, oxen or even humans carrying goods over dirt tracks that often followed game trail. The Persians later built a network of Royal Roads across their empire.

The first land roads took their origins from trails which were generally used to move from one hunting territory to another. With the emergence of the first forms of nation-states trails started to be used for commercial purposes as trade expanded and some became roads, especially through the domestication of animals such as horses, mules and camels. The use of wheeled vehicles encouraged construction of better roads to support the additional weight. However, a road transport system requires a level of labor organization and administrative control that could only be provided by a form of governmental oversight offering some military protection over trade routes.

By 3,000 BC the first paved road systems appeared in Mesopotamia and asphalt was used to pave roads in Babylon by 625 BC. The Persian Empire had a road of 2,300 km in the 5th century BC. However, the first major road system was established by the Roman Empire from 300 BC and onwards, mainly for economic, military and administrative reasons. It relied on solid road engineering methods, including the laying of foundations and the construction of bridges. This was also linked with the establishment of pan-continental trading routes, such as the Silk Road, linking Europe and Asia by 100 BC.

With the advent of the Roman Empire, there was a need for armies to be able to travel quickly from one area to another, and the roads that existed were often muddy, which greatly delayed the movement of large masses of troops. To resolve this issue, the Romans built great roads. The Roman roads used deep roadbeds of crushed stone as an underlying layer to ensure that they kept dry, as the water would flow out from the crushed stone, instead of becoming mud in clay soils. The Islamic Caliphate later built tar-paved roads in Baghdad.

Following the fall of the Roman Empire in the 5th century, integrated road transportation fell out of favor as most roads were locally constructed and maintained. Because of the lack of maintenance of many road segments, land transport became a very hazardous activity. It is not until the creation of modern nation-states in the 17th century that national road transportation systems were formally established.

New road networks. As states developed and became richer, especially with the Renaissance, new roads and bridges began to be built, often based on Roman designs. Although there were attempts to rediscover Roman methods, there was little useful innovation in road building before the 18th century.

Starting in the early 18th century, the British Parliament began to pass a series of acts that gave the local justices powers to erect toll-gates on the roads, in exchange for professional upkeep. The toll-gate erected at Wades mill became the first effective toll-gate in England. The first scheme that had trustees who were not justices was established through a Turnpike Act in 1707, for a section of the London-Chester road between Foothill and Stony Stafford. The basic principle was that the trustees would manage resources from the several parishes through which the highway passed, augment this with tolls from users from outside the parishes and apply the whole to the maintenance of the main highway. This became the pattern for the turn piking of a growing number of highways, sought by those who wished to improve flow of commerce through their part of a county.

The quality of early turnpike roads was varied. Although turn piking did result in some improvement to each highway, the technologies used to deal with geological features, drainage, and the effects of weather, were all in their infancy. Road construction improved slowly, initially through the efforts of individual surveyors such as John Metcalf in Yorkshire in the 1760s. British turnpike builders began to realize the importance of selecting clean stones for surfacing, and excluding vegetable material and clay to make better lasting roads.

Industrial civil engineering. By the late 18th and early 19th centuries, new methods of highway construction had been pioneered by the work of three British engineers, John Metcalf, Thomas Telford and John Loudon McAdam, and by the French road engineer Pierre-Marie-Jérôme Trésaguet.

The first professional road builder to emerge during the Industrial Revolution was John Metcalf, who constructed about 180 miles (290 km) of turnpike road, mainly in the north of England, from 1765. He believed a good road should have good foundations, be well drained and have a smooth convex surface to allow rainwater to drain quickly into ditches at the side. He understood the importance of good drainage, knowing it was rain that caused most problems on the roads.

Pierre-Marie-Jérôme Trésaguet established the first scientific approach to road building in France at the same time. He wrote a memorandum on his method in 1775, which became general practice in France. It involved a layer of large rocks, covered by a layer of smaller gravel. The lower layer improved on Roman practice in that it was based on the understanding that the purpose of this layer (the sub-base or base course) is to transfer the weight of the road and its traffic to the ground, while protecting the ground from deformation by spreading the weight evenly. Therefore, the sub-base did not have to be a self-supporting structure. The upper running surface provided a smooth surface for vehicles, while protecting the large stones of the sub-base.

The surveyor and engineer Thomas Telford also made substantial advances in the engineering of new roads and the construction of bridges. His method of road building involved the digging of a large trench in which a foundation of heavy rock was set. He also designed his roads so that they sloped downwards from the centre, allowing drainage to take place, a major improvement on the work of Trésaguet. The surface of his roads consisted of broken stone. He also improved on methods for the building of roads by improving the selection of stone based on thickness, taking into account traffic, alignment and slopes. During his later years, Telford was responsible for rebuilding sections of the London to Holyhead road, a task completed by his assistant of ten years, John MacNeill.

It was another Scottish engineer, John Loudon McAdam, who designed the first modern roads. He developed an inexpensive paving material of soil and stone aggregate (known as macadam). His road building method was simpler than Telford's, yet more effective at protecting roadways: he discovered that massive foundations of rock upon rock were unnecessary, and asserted that native soil alone would support the road and traffic upon it, as long as it was covered by a road crust that would protect the soil underneath from water and wear.

Also unlike Telford and other road builders, McAdam laid his roads as level as possible. His 30-foot-wide (9.1 m) road required only a rise of three inches from the edges to the center. Cambering and elevation of the road above the water table enabled rain water to run off into ditches on either side. Size of stones was central to the McAdam's road building theory. The lower 200-millimetre (7.9 in) road thickness was restricted to stones no larger than 75 millimetres (3.0 in). The upper 50-millimetre (2.0 in) layer of stones was limited to 20 millimetres (0.79 in) size and stones were checked by supervisors who carried scales. A workman could check the stone size himself by seeing if the stone would fit into his mouth. The importance of the 20 mm stone size was that the stones needed to be much smaller than the 100 mm width of the iron carriage tyres that traveled on the road. Macadam roads were being built widely in the United States and Australia in the 1820s and in Europe in the 1830s and 1840s.

In the 18th century, the French, through central government efforts, build their Royal Roads system spanning 24,000 km, over which a public transport service of stage-coaches carrying passengers and mail was established. The British, mainly through private efforts, built a 32,000 km system of turnpikes where tolls have to be paid for road usage.

A similar initiative was undertaken in the United States in the 19th century and by the early

20th Century. Macadam roads were adequate for use by horses and carriages or coaches, but they were very dusty and subject to erosion with heavy rain. The Good Roads Movement occurred in the United States between the late 1870s and the 1920s. Advocates for improved roads led by bicyclists turned local agitation into a national political movement.

Outside cities, roads were dirt or gravel; mud in the winter and dust in the summer. Early organizers cited Europe where road construction and maintenance was supported by national and local governments. In its early years, the main goal of the movement was education for road building in rural areas between cities and to help rural populations gain the social and economic benefits enjoyed by cities where citizens benefited from railroads, trolleys and paved streets. Even more than traditional vehicles, the newly invented bicycles could benefit from good country roads.Later on, they did not hold up to higher-speed motor vehicle use. Methods to stabilise macadam roads with tar date back to at least 1834 when John Henry Cassell, operating from *Cassell's Patent Lava Stone Works* in Millwall, patented "Pitch Macadam".

This method involved spreading tar on the subgrade, placing a typical macadam layer, and finally sealing the macadam with a mixture of tar and sand. Tar-grouted macadam was in use well before 1900, and involved scarifying the surface of an existing macadam pavement, spreading tar, and re-compacting. Although the use of tar in road construction was known in the 19th century, it was little used and was not introduced on a large scale until the motorcar arrived on the scene in the early 20th century.

Modern tarmac was patented by British civil engineer Edgar Purnell Hooley, who noticed that spilled tar on the roadway kept the tar down and created a smooth surface. He took out a patent in 1901 for tarmac.

The post-World War Two era represented a period of rapid expansion of road transportation networks worldwide.

The most remarkable road transport achievement is without doubt the setting of the American Interstate highway system initiated in 1956. Its strategic purpose was to provide a national road system servicing the American economy and also able to support troop movements and act as air strips in case of an emergency. About 56,000 km were built from the 1950s to the 1970s, but between 1975 and 2006 only 15,000 km were added to the system, underlining growing construction costs and diminishing returns. Overall, about 70,000 km of four-lane and six-lane highways were constructed, linking all major American cities, coast to coast. A similar project took place in Canada with the Trans-Canada highway completed in 1962.

By the 1970s, every modern nation has constructed a national highway system, which in the case of Western Europe resulted in a pan-European system. This trend now takes place in many industrializing countries. For instance, China is building a national highway system that expanded to 104,000 km in 2013, with construction taking place at a pace of about 2,000 km per year.

Modern roads. Today, roadways are primarily asphalt or concrete. Both are based on McAdam's concept of stone aggregate in a binder, asphalt cement or Portland cement respectively. Asphalt is known as a flexible pavement, one which slowly will "flow" under the pounding of traffic. Concrete is a rigid pavement, which can take heavier loads but is more expensive and requires more carefully prepared subbase. So, generally, major roads are concrete and local roads are asphalt. Concrete roads are often covered with a thin layer of asphalt to create a wearing surface.

Modern pavements are designed for heavier vehicle loads and faster speeds, requiring thicker slabs and deeper subbase. Subbase is the layer or successive layers of stone, gravel and sand supporting the pavement. It is needed to spread out the slab load bearing on the underlying soil and to conduct away any water getting under the slabs. Water will undermine a pavement over time, so much of pavement and pavement joint design are meant to minimize the amount of water getting and staying under the slabs.

Shoulders are also an integral part of highway design. They are multipurpose; they can provide a margin of side clearance, a refuge for incapacitated vehicles, an emergency lane, and parking space. They also serve a design purpose, and that is to prevent water from percolating into the soil near the main pavement's edge. Shoulder pavement is designed to a lower standard than the pavement in the traveled way and won't hold up as well to traffic, so driving on the shoulder is generally prohibited.

Pavement technology is still evolving, albeit in not easily noticed increments. For instance, chemical additives in the pavement mix make the pavement more weather resistant, grooving and other surface treatments improve resistance to skidding and hydroplaning, and joint seals which were once tar are now made of low maintenance neoprene.

3. International classification and legislation of the road transportation

Motor vehicle and trailer categories are defined according to the following international classification:

- Category M: passenger vehicles.
- Category N: motor vehicles for the carriage of goods.
- Category O: trailers and semi-trailers.

European Union.

In the European Union the classifications for vehicle types are defined by:

- Commission Directive 2001/116/EC of 20 December 2001, adapting to technical progress Council Directive 70/156/EEC on the approximation of the laws of the Member States relating to the type-approval of motor vehicles and their trailers

- Directive 2002/24/EC of the European Parliament and of the Council of 18 March 2002 relating to the type-approval of two or three wheeled motor vehicles and repealing Council Directive 92/61/EEC

European Community, is based on the Community's WVTA (whole vehicle type-approval) system. Under this system, manufacturers can obtain certification for a vehicle type in one Member State if it meets the EC technical requirements and then market it EU-wide with no need for further tests. Total technical harmonization already has been achieved in three vehicle categories (passenger cars, motorcycles, and tractors) and soon will extend to other vehicle categories (coaches and utility vehicles). It is essential that European car manufacturers be ensured access to as large a market as possible.

While the Community type-approval system allows manufacturers to benefit fully from internal market opportunities, worldwide technical harmonization in the context of the United Nations Economic Commission for Europe (UNECE) offers a market beyond European borders.

Licensing. In many cases, it is unlawful to operate a vehicle without a license or certification. The least strict form of regulation usually limits what passengers the driver may carry or prohibits them completely (e.g., a Canadian ultra-light license without endorsements). The next level of licensing may allow passengers, but without any form of compensation or payment. A private driver's license usually has these conditions. Commercial licenses that allow the transport of passengers and cargo are more tightly regulated. The most strict form of licensing is generally reserved for school buses, hazardous materials transports and emergency vehicles.

The driver of a motor vehicle is typically required to hold a valid driver's license while driving on public lands, whereas the pilot of an aircraft must have a license at all times, regardless of where in the jurisdiction the aircraft is flying.

Registration. Vehicles are often required to be registered. Registration may be for purely legal reasons, for insurance reasons or to help law enforcement recover stolen vehicles. Toronto Police Service, for example, offers free and optional bicycle registration online. On motor vehicles, registration often takes the form of a vehicle registration plate, which makes it easy to identify a vehicle. In Russia, trucks and buses have their licence plate numbers repeated in large black letters on the back. On aircraft, a similar system is used where a tail number is painted on various surfaces. Like motor vehicles and aircraft, watercraft also have registration numbers in most jurisdictions, however the vessel name is still the primary means of identification as has been the case since ancient times. For this reason, duplicate registration names are generally rejected. In Canada, boats with an engine power of 10 hp (7.5 kW) or greater require registration, leading to the ubiquitous "9.9 hp (7.4 kW)" engine.

Registration may be conditional on the vehicle being approved for use on public highways, as in the case of the UK and Ontario. Many US states also have requirements for vehicles operating on public highways. Aircraft have more stringent requirements, as they pose a high risk of damage to people and property in event of an accident. In the US, the FAA requires aircraft to have an airworthiness certificate. Because US aircraft must be flown for some time before they are certified, there is a provision for an experimental airworthiness certificate. FAA experimental aircraft are restricted in operation, including no overflights of populated areas, in busy airspace or with unessential passengers. Materials and parts used in FAA certified aircraft must meet the criteria set forth by the *technical standard orders*.

Mandatory safety equipment. In many jurisdictions, the operator of a vehicle is legally obligated to carry safety equipment with or on them. Common examples include seat belts in cars, helmets on motorcycles and bicycles, fire extinguishers on boats, buses and airplanes and life jackets on boats and commercial aircraft. Passenger aircraft carry a great deal of safety equipment including inflatable slides are rafts, oxygen masks, oxygen tanks, life jackets, satellite beacons and first aid kits. Some equipment such as life jackets has led to debate regarding their usefulness. In the case of Ethiopian Airlines Flight 961, the life jackets saved many people but also led to many deaths when passengers inflated their vests prematurely.

Right-of-way.

There are specific real-estate arrangements made to allow vehicles to travel from one place to another. The most common such arrangements are public highways, where appropriately licensed vehicles can navigate without hindrance. These highways are on public land and are maintained by the government. Similarly, toll routes are open to the public after paying a toll. These routes and the land they rest on may be government or privately owned or a combination of both. Some routes are privately owned but grant access to the public. These routes often have a warning sign stating that the government does not maintain the way. An example of this are byways in England and Wales. In Scotland, land is open to un-motorised vehicles if the land meets certain criteria. Public land is sometimes open to use by off-road vehicles.

On US public land, the Bureau of Land Management (BLM) decides where vehicles may be used. Railways often pass over land not owned by the railway company. The right to this land is granted to the railway company through mechanisms such as easement. Watercraft are generally allowed to navigate public waters without restriction as long as they do not cause a disturbance. Passing through a lock, however, may require paying a toll.

Despite the common law tradition *Cuius est solum, eius est usque ad coelum et ad inferos* of owning all the air above one's property, the US supreme court ruled that aircraft in the US have the right to use air above someone else's property without their consent. While the same rule generally applies in all jurisdictions, some countries such as Cuba and Russia have taken advantage of air rights on a national level to earn money. There are some areas that aircraft are barred from overflying. This is called prohibited airspace. Prohibited airspace is usually strictly enforced due to potential damage from espionage or attack. In the case of Korean

Air Lines Flight 007, the airliner entered prohibited airspace over Soviet territory and was shot down as it was leaving.

Safety. Several different metrics used to compare and evaluate the safety of different vehicles. The main three are *deaths per billion passenger-journeys*, *deaths per billion passenger-hours* and *deaths per billion passenger-kilometers*.

Trucking and haulage

Trucking companies (AE) or haulage companies / hauliers (BE) accept cargo for road transport. Truck drivers operate either independently – working directly for the client – or through freight carriers or shipping agents. Some big companies (e.g. grocery store chains) operate their own internal trucking operations. The market size for general freight trucking was nearly $125 billion in 2010.

In the U.S. many truckers own their truck (rig), and are known as owner-operators. Some road transportation is done on regular routes or for only one consignee per run, while others transport goods from many different loading stations/shippers to various consignees. On some long runs only cargo for one leg of the route (to) is known when the cargo is loaded. Truckers may have to wait at the destination for the return cargo (from).

A bill of lading issued by the shipper provides the basic document for road freight. On cross-border transportation the trucker will present the cargo and documentation provided by the shipper to customs for inspection (for EC see also Schengen Agreement). This also applies to shipments that are transported out of a free port.

To avoid accidents caused by fatigue, truckers have to keep to strict rules for drivetime and required rest periods. In the United States and Canada, these regulations are known as hours of service, and in the European Union as drivers working hours. One such regulation is the Hours of Work and Rest Periods (Road Transport) Convention, 1979. Tachographs record the times the vehicle is in motion and stopped. Some companies use two drivers per truck to ensure uninterrupted transportation; with one driver resting or sleeping in a bunk in the back of the cab while the other is driving.

Truck drivers often need special licences to drive, known in the U.S. as a commercial driver's license. In the U.K. a Large Goods Vehicle licence is required.

For transport of hazardous materials (see dangerous goods) truckers need a licence, which usually requires them to pass an exam (e.g. in the EU). They have to make sure they affix proper labels for the respective hazard(s) to their vehicle. Liquid goods are transported by road in tank trucks (AE) or tanker lorries (BE) (also road-tankers) or special tankcontainers for intermodal transport. For unpackaged goods and liquids weigh stations confirm weight after loading and before delivery. For transportation of live animals special requirements have to be met in many countries to prevent cruelty to animals (see animal rights). For fresh and frozen goods refrigerator trucks or reefer (container)s are used.

In Australia road trains replace rail transport for goods on routes throughout the center of the country. B-doubles and semi-trailers are used in urban areas because of their smaller size. Low-loader or flat-bed trailers are used to haul containers, see containerization, in intermodal transport.

Traffic control

Nearly all roadways are built with devices meant to control traffic. Most notable to the motorist are those meant to communicate directly with the driver. Broadly, these fall into three categories: signs, signals or pavement markings. They help the driver navigate; they assign the right-of-way at intersections; they indicate laws such as speed limits and parking regulations; they advise of potential hazards; they indicate passing and no passing zones; and otherwise deliver information and to assure traffic is orderly and safe.

Two hundred years ago these devices were signs, nearly all informal. In the late 19th century signals began to appear in the biggest cities at a few highly congested intersections. They were manually operated, and consisted of semaphores, flags or paddles, or in some cases colored electric lights, all modeled on railroad signals. In the 20th century signals were automated, at first with electromechanical devices and later with computers. Signals can be quite sophisticated: with vehicle sensors embedded in the pavement, the signal can control and choreograph the turning movements of heavy traffic in the most complex of intersections. In the 1920s traffic engineers learned how to coordinate signals along a thoroughfare to increase its speeds and volumes. In the 1980s, with computers, similar coordination of whole networks became possible.

In the 1920s pavement markings were introduced. Initially they were used to indicate the road's centerline. Soon after they were coded with information to aid motorists in passing safely. Later, with multi-lane roads they were used to define lanes. Other uses, such as indicating permitted turning movements and pedestrian crossings soon followed.

In the 20th century traffic control devices were standardized. Before then every locality decided on what its devices would look like and where they would be applied. This could be confusing, especially to traffic from outside the locality. In the United States standardization was first taken at the state level, and late in the century at the federal level. Each country has a Manual of Uniform Traffic Control Devices (MUTCD) and there are efforts to blend them into a worldwide standard.

Besides signals, signs, and markings, other forms of traffic control are designed and built into the roadway. For instance, curbs and rumble strips can be used to keep traffic in a given lane and median barriers can prevent left turns and even U-turns.

Toll roads

Early toll roads were usually built by private companies under a government franchise. They typically paralleled or replaced routes already with some volume of commerce, hoping the improved road would divert enough traffic to make the enterprise profitable. Plank roads were particularly attractive as they greatly reduced rolling resistance and mitigated the problem of getting mired in mud. Another improvement, better grading to lessen the steepness of the worst stretches, allowed draft animals to haul heavier loads.

A *toll road* in the United States is often called a *turnpike*. The term *turnpike* probably originated from the gate, often a simple pike, which blocked passage until the fare was paid at a *toll house* (or *toll booth* in current terminology). When the toll was paid the pike, which was mounted on a swivel, was turned to allow the vehicle to pass. Tolls were usually based on the type of cargo being transported, not the type of vehicle. The practice of selecting routes so as to avoid tolls is called shunpiking. This may be simply to avoid the expense, as a form of economic protest (or boycott), or simply to seek a road less traveled as a bucolic interlude.

Companies were formed to build, improve, and maintain a particular section of roadway, and tolls were collected from users to finance the enterprise. The enterprise was usually named to indicate the locale of its roadway, often including the name of one of both of the termini. The word *turnpike* came into common use in the names of these roadways and companies, and is essentially used interchangeably with *toll road* in current terminology.

In the United States, toll roads began with the Lancaster Turnpike in the 1790s, within Pennsylvania, connecting Philadelphia and Lancaster. In the state of New York, the Great Western Turnpike was started in Albany in 1799 and eventually extended, by several alternate routes, to near what is now Syracuse, New York.

Toll roads peaked in the mid 19th century, and by the turn of the twentieth century most toll roads were taken over by state highway departments. The demise of this early toll road era was due to the rise of canals and railroads, which were more efficient (and thus cheaper) in moving freight over long distances. Roads wouldn't again be competitive with rails and barges until the first half of the 20th century when the internal combustion engine replaces draft animals as the source of motive power.

With the development, mass production, and popular embrace of the automobile, faster and higher capacity roads were needed. In the 1920s limited access highways appeared. Their main characteristics were dual roadways with access points limited to (but not always) grade-separated interchanges. Their dual roadways allowed high volumes of traffic, the need for no or few traffic lights along with relatively gentle grades and curves allowed higher speeds.

The first limited access highways were *Parkways*, so called because of their often park-like landscaping and, in the metropolitan New York City area, they connected the region's system of parks. When the German autobahns built in the 1930s introduced higher design standards and speeds, road planners and road-builders in the United States started developing and building toll roads to similar high standards. The Pennsylvania Turnpike, which largely followed the path of a partially built railroad, was the first, opening in 1940.

After 1940 with the Pennsylvania Turnpike, toll roads saw a resurgence, this time to fund limited access highways. In the late 1940s and early 1950s, after World War II interrupted the evolution of the highway, the US resumed building toll roads. They were to still higher standards and one road, the New York State Thruway, had standards that became the prototype for the U.S. Interstate Highway System. Several other major toll-roads which connected with the Pennsylvania Turnpike were established before the creation of the Interstate Highway System. These were the Indiana Toll Road, Ohio Turnpike, and New Jersey Turnpike.

Interstate Highway System

In the United States, beginning in 1956, Dwight D. Eisenhower National System of Interstate and Defense Highways, commonly called the Interstate Highway System was built. It uses 12 foot (3.65m) lanes, wide medians, a maximum of 4% grade, and full access control, though many sections don't meet these standards due to older construction or constraints. This system created a continental-sized network meant to connect every population center of 50,000 people or more.

By 1956, most limited access highways in the eastern United States were toll roads. In that year, the federal Interstate highway program was established, funding non-toll roads with 90% federal dollars and 10% state match, giving little incentive for states to expand their turnpike system. Funding rules initially restricted collections of tolls on newly funded roadways, bridges, and tunnels. In some situations, expansion or rebuilding of a toll facility using Interstate Highway Program funding resulted in the removal of existing tolls. This occurred in Virginia on Interstate 64 at the Hampton Roads Bridge-Tunnel when a second parallel roadway to the regional 1958 bridge-tunnel was completed in 1976.

Since the completion of the initial portion of the interstate highway system, regulations were changed, and portions of toll facilities have been added to the system. Some states are again looking at toll financing for new roads and maintenance, to supplement limited federal funding. In some areas, new road projects have been completed with public-private partnerships funded by tolls, such as the Pocahontas Parkway (I-895) near Richmond, Virginia.

The newest policy passed by Congress and the Obama Administration regarding highways is the Surface and Air Transportation Programs Extension Act of 2011.

Pneumatic tires

As the horse-drawn carriage was replaced by the car and lorry or truck, and speeds increased, the need for smoother roads and less vertical displacement became more apparent, and pneumatic tires were developed to decrease the apparent roughness. Wagon and carriage wheels, made of wood, had a tire in the form of an iron strip that kept the wheel from wearing out quickly. Pneumatic tires, which had a larger footprint than iron tires, also were less likely to get bogged down in the mud on unpaved roads.

The Spatial Impacts of Road Transportation

Road transportation is the mode that has expanded the most over the last 50 years, both for passengers and freight transportation. This represents a dramatic change in the built environment with the massive addition of road infrastructures. The spatial cover of road transportation is extensive. Growth in road freight transport has been fueled largely by trade liberalization as modal shares of trade within the European Union and NAFTA suggest. This is the result of growth of the loading capacity of vehicle and an adaptation of vehicle to freight (e.g. perishables, fuel, construction materials, etc.) or passengers (e.g. school bus) demand for speed, autonomy and flexibility.

Problems, such as a significant growth of fuel consumption, increasing environmental externalities, traffic congestion and a safety (accidents) have also emerged.

Roads have a functional hierarchy depending on the role they play in the network. At the top of the hierarchy are freeways (highways), which are limited access roads with no intersections. There are also arterials that are roads that have traffic signals at intersection, forcing vehicles to stop. These arterials are fed by collectors and local roads, which have the main purpose to connect specific activities (residences, retail stores, industries).

Put together, this network enables point to point services, a notable advantage the road transport has over other transport modes. Road transport modes have limited potential to achieve economies of scale. This is due to size and weight constraints imposed by governments and also by the technical and economic limits of engines. In most jurisdictions, trucks and busses have specific weight and length restrictions which are imposed for safety reasons. While in the United States, the maximum gross vehicle weight is 36 metric tons (80,000 pounds), while in Europe and China these figures are 40 (88,000 pounds) and 49 (100,000 pounds) metric tons respectively. In addition, there are serious limits on the traction capacities of cars, buses and trucks because of the considerable growth in energy consumption that accompany increases in the vehicle weight. For these reasons the carrying capacities of individual road vehicles are limited.

Road transportation is characterized by acute geographical disparities in traffic. It is not uncommon that 20% of the road network supports 60 to 80% of the traffic. This observation is expanded by the fact that developed and developing countries have important differences in terms of the density, capacity and the quality of road transport infrastructures. Acute geographical variations of the inventory are therefore the norm.

Technological evolution of road transport vehicles was a continuous trend since the first automobiles were built. The basic technology is however very similar, as road transportation massively relies on the internal combustion engine.

In the future new materials (ceramic, plastic, aluminum, composite materials etc...), fuels (electricity, hydrogen, natural gas, etc...) and information technologies (vehicle control, location, navigation and toll collection) are expected to be included in cars and improve the efficiency of road transport systems. There are however signs that a peak mobility can be achieved for road transportation when the car has been diffused to some optimum level and that countervailing forces are at play such as congestion, the aging of the population or a decline in income. A similar pattern of peaking truck circulation is emerging in large metropolitan areas.

The urban population has increased considerably over the last 50 years and about 50% of the global population was urbanized by 2010 (about 3.5 billion people). It is challenging for developing countries to have a rates of individual vehicle ownership similar to those of developed countries, especially compared with the United States, not because of a lack of income, but the physical lack of space to accommodate a high level of car ownership. This will impose new or alternative methods to transport freight and passengers over urban roads.

The reduction of vehicle emissions and the impacts of infrastructures on the environment are mandatory to promote a sustainable environment. Under such circumstances cycling is thus to be considered an alternative to the automobile in urban areas, widely adopted in developing countries, although more for economic reasons. However, the potential of cycling is related to its substitution for existing public transit users. There is limited potential to substitute car trips by bicycle trips since most car trips cover longer distances that are not easily substitutable by other modes, including the bicycle. Bicycle parking schemes at urban transit stations are a strategy that can be used as a strategy to incite a substitution.

Road transport, however, possesses significant advantages over other modes:

- The capital cost of vehicles is relatively small, which makes it comparatively easy for new users to gain entry. This helps ensure that the trucking industry, for example, is highly competitive. Low capital costs also ensure that innovations and new technologies can diffuse quickly through the industry.

- Another advantage of road transport is the high relative speed of vehicles, the major constraint being government-imposed speed limits.
- One of its most important attributes is the flexibility of route choice, once a network of roads is provided. Road transport has the unique opportunity of providing door to door service for both passengers and freight.

These multiple advantages have made cars, buses and trucks the modes of choice for a large number of trip purposes, and have led to their market dominance for short distance trips. The success of cars and trucks has given rise to a number of serious problems. Road congestion has become a feature of most urban areas around the world. In addition, the mode is behind many of the major environmental externalities linked to transportation. Addressing these issues is becoming an important policy challenge at all levels of jurisdiction, from the local to the global. A symbiosis between types of roads and types of traffic with specialization (reserved lanes and hours) is to be expected.

Infrastructures and Investments

Road infrastructures are moderately expensive to provide, but there is a wide divergence of costs, from a gravel road to a multi-lane urban expressway. Because vehicles have the means to climb moderate slopes, physical obstacles are less important than for some other land modes, namely rail. Most roads are provided as a public good by governments, while the vast majority of vehicles are owned privately. Capital costs, therefore, are generally assumed by the society, and do not fall as heavily on one source as is the case for other modes. Unlike many transport infrastructures where the network is paid for by the user through a pricing mechanism, 95% of the financing of road infrastructure is covered by the public sector, leaving the reminder covered by tolls. Road transportation thus has a unique characteristic where several costs are externalized. This is an indirect form of mobility subsidy.

The public offering of free road infrastructure conveys several advantages to the private sector, but can also lead to serious problems. The main advantage is clear; the users of roads commonly do not bear the full operating costs implying that road transportation tends to be below real market price. For road freight transportation, this can be seen as a subsidy as road maintenance is not part of the operating costs, but is indirectly present with taxes and tolls. As long as there is spare road capacity this situation works for the benefit of the users. However, when congestion starts to arise, users have limited, if any, influence on the construction of new and improved infrastructure to mitigate the problem since they do not own the infrastructure and are using it for free. Lobbying public entities to receive public road infrastructure investments can be a very long process, subject to constant delays and changes. Road users thus become trapped in a situation they can do little to change since it is provided free of charge. This can be labeled as the "free roads curse". An entity owning and operating its own network, such as a rail company in North America, has the advantage of directly implementing improvements with its own capital if congestion arise on a segment of its network. It is thus better placed to cope with congestion. Governments can expropriate the necessary land for road construction since a private enterprise may have difficulties to expropriate without government support. Another important aspect about roads is their economies of scale and their indivisibility, underlining that the construction and maintenance of roads is cheaper when the system is extensive, but to a limit. However, all road transport modes have limited abilities to achieve scale economies. This is due to the size constraints imposed by governments and also by the technical and economic limits of the power sources and what infrastructures can bear weight-wise. In most jurisdictions, trucks and busses have specific weight and length restrictions which are imposed for safety reasons. In addition, there are serious limits on the traction capacities of cars, busses and trucks because of the considerable increases in energy consumption that accompany increases in the weight of the unit. For these reasons the carrying capacities of individual road vehicles are limited. Roads are thus costly infrastructures, but also sources of revenue:

- **Costs**. They include rights of way, development costs (planning), construction costs, maintenance and administration costs, losses in land taxes (urban environment), expropriation costs (money and time), and external costs (accidents and pollution).

- **Revenue**. They include registration, gas (taxes), purchases of vehicles (taxes), tolls, parking, and insurance fees. Another form of indirect income concerns traffic violations (e.g. speeding) that are using the pretext of public safety to hide revenue generation practices by local governments.

In many cases governments have been inefficient custodians of road infrastructure as it is tempting to delay road maintenance or improvements because of the high costs involved. Budgetary problems are also inciting selling assets to increase revenue and reduce expenses. Consequently, a growing number of roads have been **privatized** and companies specializing in road management have emerged, particularly in Europe and North America. This is only possible on specific trunks that have an important and stable traffic. Private enterprises usually have vested interests to see that the road segments they manage are maintained and improved since the quality of the road will be directly linked with revenue generation. The majority of toll roads are highways linking large cities or bridges and tunnels where there is a convergence of traffic. Most roads are not economically profitable but **must be socially present** as they are essential to service populations. It can thus be expected that roads will remain dominantly publically funded in the future.

Transport on roads can be roughly grouped into the transportation of goods and transportation of people. In many countries licensing requirements and safety regulations ensure a separation of the two industries.

The nature of road transportation of goods depends, apart from the degree of development of the local infrastructure, on the distance the goods are transported by road, the weight and volume of the individual shipment, and the type of goods transported. For short distances and light, small shipments a van or pickup truck may be used. For large shipments even if less than a full truckload a truck is more appropriate. (Also see Trucking and Hauling below). In some countries cargo is transported by road in horse-drawn carriages, donkey carts or other non-motorized mode. Delivery services are sometimes considered a separate category from cargo transport. In many places fast food is transported on roads by various types of vehicles. For inner city delivery of small packages and documents bike couriers are quite common.

People are transported on roads either in individual cars or in mass transit by bus or coach. Special modes of individual transport by road such as cycle rickshaws may also be locally available. There are also specialist modes of road transport for particular situations, such as ambulances.

4. Advantages and Disadvantages of Road Transport

There are numerous advantages of road transport in comparison to other modes of transport:

Advantages:

1. Less Capital Outlay:

Road transport required much less capital Investment as compared to other modes of transport such as railways and air transport. The cost of constructing, operating and maintaining roads is cheaper than that of the railways. Roads are generally constructed by the government and local authorities and only a small revenue is charged for the use of roads.

2. Door to Door Service:

The outstanding advantage of road transport is that it provides door to door or warehouse to warehouse service. This reduces cartage, loading and unloading expenses.

3. Service in Rural Areas:

Road transport is most suited for carrying goods and people to and from rural areas which are not served by rail, water or air transport. Exchange of goods, between large towns and small villages is made possible only through road transport.

4. Flexible Service:

Road transport has a great advantage over other modes of transport for its flexible service, its routes and timings can be adjusted and changed to individual requirements without much inconvenience.

5. Suitable for Short Distance:

It is more economic and quicker for carrying goods and people over short distances. Delays in transit of goods on account of intermediate loading and handling are avoided. Goods can be loaded direct into a road vehicle and transported straight to their place of destination.

6. Lesser Risk of Damage in Transit:

As the intermediate loading and handling is avoided, there is lesser risk of damage, breakage etc. of the goods in transit. Thus, road transport is most suited for transporting delicate goods like chinaware and glassware, which are likely to be damaged in the process of loading and unloading.

7. Saving in Packing Cost:

As compared to other modes of transport, the process of packing in motor transport is less complicated. Goods transported by motor transport require less packing or no packing in several cases.

8. Rapid Speed:

If the goods are to be sent immediately or quickly, motor transport is more suited than the railways or water transport. Water transport is very slow. Also much time is wasted in booking the goods and taking delivery of the goods in case of railway and water transport.

9. Less Cost:

Road transport not only requires less initial capital investment, the cost of operation and maintenance is also comparatively less. Even if the rate charged by motor transport is a little higher than that by the railways, the actual effective cost of transporting goods by motor transport is less. The actual cost is less because the motor transport saves in packing costs and the expenses of intermediate loading, unloading and handling charges.

10. Private Owned Vehicles:

Another advantage of road transport is that big businessmen can afford to have their own motor vehicles and initiate their own road services to market their products without causing any delay.

11. Feeder to other Modes of Transport:

The movement of goods begins and ultimately ends by making use of roads. Road and motor transport act as a feeder to the other modes of transport such as railways, ships and airways.

Disadvantages:

In spite of various merits, road/motor has some serious limitations:

1. Seasonal Nature:

Motor transport is not as reliable as rail transport. During rainy or flood season, roads become unfit and unsafe for use.

2. Accidents and Breakdowns:

There are more chances of accidents and breakdowns in case of motor transport. Thus, motor transport is not as safe as rail transport.

3. Unsuitable for Long Distance and Bulky Traffic:

This mode of transport is unsuitable and costly for transporting cheap and bulky goods over long distances.

4. Slow Speed:

The speed of motor transport is comparatively slow and limited.

5. Lack of Organisation:

The road transport is comparatively less organised. More often, it is irregular and undependable. The rates charged for transportation are also unstable and unequal.