INTERNATIONAL AND INTERREGIONAL TRANSPORTATION

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Contents

Summary

Interregional including international transport plays a crucial role in the life support

system in terms of both personal travel and distribution of goods. This chapter first explains the brief histories of international/ interregional transportation systems, including road, rail, air, water, and pipeline transportations. Secondly, the role of international/ interregional transportation and the current situation in the world are identified. One function of interregional transport is trade. Inter-dependence between international trade and international products is discussed here. Interregional trade of agriculture products is essential for human life. The worldwide export of agriculture products is dominated by the United States, while Japan dominates their import. The United States, Japan, and China lead the world in maritime transport in terms of their trade value. The popularity of the automobile has drastically changed human life. Road transport modes, especially automobiles and trucks, play a major role in domestic transportation in all countries, except for the freight transportation by railway in the United States. The railway transport in Japan has a significant share in passenger travel. On the contrary, freight transportation by railway in the United States accounts for the greatest share. Airway is the most popular transportation mode for international travel. The United States, United Kingdom and Japan are the top three countries in terms of both air freight transportation and air passenger traffic. Airlines in the United States dominate in air transportation. This chapter also deals with tourism and its effects on the economy. A new challenge in interregional transportation and future prospects are discussed last.

1. Introduction

Before the nineteenth century, land transport by animal-drawn carriage and sea transport by ocean-going ships were the major systems of transportation. During the nineteenth century, rail transport became important in the international and domestic movement of passengers and distribution of bulk goods over long distances. Ports and container-related facilities have developed considerably in the twentieth century. In the latter half of the twentieth century, air transport played an important role in international transport and domestic transport in large countries, such as the USA and Russia, and in archipelagos like Indonesia.

The definition of interregional transport is quite vague because of the unclear definition of interregional. Antonyms of interregional must be intra-regional and regional. However, this article deals with the transportation beyond urban transport such as commuting traffic and the usual shopping trip. This article includes inter-city and international passenger travel and freight transportation together with the usage of different transport modes like the car, train, ship, airplane, and pipeline. The discussion also covers transportation travel of more than 100 kilometers, and explains the four major transportation subsystems; namely, land transportation, water transportation, air transportation, and pipeline transportation.

Interregional traffic grew drastically after World War II. The major reasons are summarized as follows:

1) Dramatic economic growth in the world contributed to the increase in world trade. Growth in the United States in the 1950s and 1960s and Japan in the 1970s, in particular, contributed to the rapid growth of the trans-Pacific traffic.
2) The relocation of factories and shops of multinational companies of the US, Europe

and Japan to Asia made the traffic between Asia and western countries increase in the 1970s-1980s.

3) The stimulation of economic growth in Asia in the 1980s due to large amounts of foreign investment from western countries. The newly industrialized countries, Korea, Taiwan, Hong Kong and Singapore, showed surprising economic development and contributed to the rapid growth of world trade and interregional transportation/traffic.
4) The emergence of Thailand, Malaysia, Indonesia and the Philippines, the so-called economic tigers, and China as a new economic power in Asia after 1985.
5) The German reunification on November 28, 1989 triggered changes in Eastern Europe. Changes in the political and economic systems in the European continent have also dramatically changed the interregional transportation in the European continent.

The driving forces of interregional transportation changes are the political situation/relationship changes, economic system/scale changes, and technological development of the transportation system and tools. In order to meet with the changes mentioned, transport technology, especially in the area of air transport and container transport, developed very fast. Transport technology is quite complex and is composed of many individual technologies. Ocean-going container transport, for example, needs improvement in the technologies of: 1) container yards, 2) container handling equipment, 3) container cranes, 4) container berths, 5) container vessel, 6) navigation aids and 7) communication. All these improvement and changes lead to an improved interregional transportation system that is beneficial for life and society in general.

The following sections are divided into 3 parts. The first section is about the brief history of interregional transport. The next is about the current situation and roles of interregional transport in the world. The last section is on the future prospects and the technological advances that enhance interregional transport, and then concludes.

2. Brief History of Interregional/ International Transportation

A brief history of transport modes and their related infrastructure facilities used in interregional/ international transportation are discussed in this section. The history of the transportation system will be sub-divided according to the three major subsystems; namely, Land Transportation, Air Transportation and Water Transportation. Land Transportation. Land transport can be divided into road and rail transportation. Besides three major transportation modes, the importance of pipeline transport is rapidly growing. The history of those systems is presented in this section.

2.1. Road Transportation

Roads and Pavements

The first large-scale road network was built by the Romans in 334 BC. It was expanded to 53,000 miles during the peak of the Roman Empire. The purpose of this extensive system of fully integrated roads is the efficiency of military/logistics, and administrative movements. Roads are not only built primarily for military purposes but also for trade and tourism. The Silk Road is an example of a road built for economic purposes. It is well known as a trade route between China and the West developed during the period

300 BC to 200 AD. Ancient roads were basically made of dirt, stone or logs strewn on the path. The Romans used concrete to develop their roads and other construction advances. However, these surface materials were inadequate for the demands of the automobile.

The development of the modern asphalt and concrete pavements in nineteenth century France led the way to an improved roadway. The modern freeway system, which is a divided highway with limited access, began in Germany. Adolf Hitler started the construction of the freeway in 1933 and completed nearly 6,500 kilometers by 1942. The development of railroads in the United States allowed the parochial road patterns to survive as these roads basically led to the nearest railroad depot. The toll road system with limited access started in the United States in 1937 as introduced by the Pennsylvania Turnpike Commission. In 1956, the US Congress adopted the Interstate Highway System, which was structured to meet two needs: the creation of a national system of automotive highways and to allow federal financing for the extremely costly stretches of urban mega-highways (which were beyond the resources of the increasingly impoverished cities). In Canada, the completion of a passable road from Cape Spear in Newfoundland to Rose Spit in the Queen Charlotte Islands of British Columbia, known as the Trans-Canada Highway, was achieved in the 1960s.

In other parts of the world, the advent of the automobile found a similarly primitive natural road system improved to the standard of automobile travel. From the improvement of infrastructure facilities, human beings have gained a level of mobility that has been an objective of human effort.

After World War II, motorization spread rapidly worldwide, while the railway passenger usage declined instead. In order to meet the growing demand for roads, a large portion of capital investment from the governments poured into road construction/improvement projects. Table 1 shows the current condition of roads in the world.

Country/Region	Road Length	Pavement	Country/Region	Road Length	Pavement
Asia			Italy	307,682	100
Japan	1,147,532	74.3	Austria	200,000	100
Israel	15,464	100	Netherlands	124,530	90
Iran			Greece	117,000	91.8
India	3,319,644	45.7	Swiss	71,048	...
Indonesia	342,700	46.3	Sweden	210,760	77.2
Korea	84,968	74	Spain	346,858	99
Saudi Arabia	162,000	42.7	Denmark	71,600	100
Thailand	64,600	97.5	Germany	656,074	99.1
China			Norway	91,180	74
Turkey	382,397	25	Finland	77,796	64
Philippines	161,313	0.2	France	892,900	100
Hong Kong	1,760	100	Belgium	145,774	79.7

Malaysia	94,500	75.1	Poland	377,048	65.7
Myanmar			Portugal	68,732	86.1
America			Russia		
United States	6,307,584	60.5	Africa/Oceania		
Canada	901,902	35.3	Egypt	64,000	78.1
Mexico	252,000	37.4	South Africa	331,265	41.5
Argentine	218,276	29.1	Morocco	57,810	51.8
Brazil	1,980,000	9.3	Australia	913,000	38.7
Europe			New Zealand	92,200	58.1
United Kingdom	369,887	100			

Table 1: Road and Road Pavement in the World
(Source: International Road Federation, World Road Statistics, 1999)

One of the most remarkable changes in interregional transportation is the emergence of the automobile, which became popular due to the invention of the internal combustion engine. In 1913, Henry Ford introduced an assembly line for mass production of the Model T automobile. The 1920s saw the emergence of the great European producers—Austin, Fiat, and Citroën, to name a few. It also saw the annual production level of Ford's Model T reach nearly 2 million in 1923. The 1920s to early 1940s saw the appearance of new small and large automobiles as well as the rise of luxurious fast cars. In the U.S., the size of the standard motorcar increased steadily from the late 1940s to the early 1960s thereby increasing the clamor for smaller cars and for comparatively uncluttered styling. The success of the German Volkswagen and other small cars eventually led the major U.S. producers to undertake the production of cars generally termed compact. The small car continued to dominate in Europe and Japan, though the number of larger cars also increased. Japan also became a major producer of vehicles in the 1960s. The production of the automobile allowed easy and efficient movement of people and goods within and between regions.

2.2. Rail Transportation

The Liverpool and Manchester railway, completed in 1830, can be said to be the first fully evolved railway. The railway system began from Britain, and then soon spread over to the European continent and the American continent in the 1840s. Interregional traveling by railway became popular in Europe in 1850. The railway became an instrument of geopolitics in Europe as seen in the forced unification of Germany by Prussia through building an extensive network of rail. In the United States, on the other hand, the transcontinental railway, which is 2860 kilometers long, was completed in 1869. Moreover, the American railway network was almost completed in 1910. The extent of the railway network in the world reached about 1.6 million kilometers in the twentieth century. One third were in North America. The geographical extent of railroads during the late twentieth century did not increase much but efforts to increase the speed have produced fundamental changes. The railroad system's advantages are its large geographical coverage and carrying capacity that improved interregional freight transport.

The evolution of the locomotive started with the steam locomotive. The first rails that were used were metal rails, which supported the steam locomotives. The usage of metal rails together with the steam locomotive led to the opening of the Stockton & Darlington Railway in 1825. Meanwhile, the improvement of rail tracks from metal rails to steel rails strengthened the operation of locomotives in the world.

Electrification spread over Europe and then North America in the early twentieth century. This led to the use of electric traction systems in several European railroads before World War II. The first successful diesel engine went into service in 1925 and in 1933; the diesel-electric train in Germany was able to run at an average speed of 124 kilometers per hour. In 1935, the Baltimore & Ohio Railroad first used passenger trains powered by diesel-electric locomotives while the first road freight locomotive was built in 1939. By the end of the 1960s, diesel had almost completely superseded steam as the standard railroad motive power.

After World War II, efforts to increase the speed of the train started in Europe and Japan. The Tokaido Shinkansen, which is called the bullet train, connected several cities in Japan, such as Tokyo, Osaka, Kyoto and Nagoya. It was inaugurated in 1964 to coincide with the opening of the Tokyo Olympic Games. The new railway operated at a speed of more than 250 km/h and extended to all areas of the main island in Japan within 30 years. The performance and economy of both electric and diesel traction units have been considerably advanced by the usage of microprocessors since 1980. In the latest very high-speed trains of Japan, France and Germany, microprocessors and fiber optics transmission system are used in the operation of the trains.

2.3. Air Transportation

Man has always been enthralled with the idea of flight. Early in the eighteenth and nineteenth centuries, experiments on balloons and dirigibles succeeded in producing the first manned flight. The balloon was primarily used for spying and warfare as in the Battle of Maubeuge in 1793. The improvement on the dirigible in the 1900s by Ferdinand von Zeppelin made it possible for it to become a practical air transport.

Wilbur and Orville Wright succeeded in developing the first engine-powered plane (Flyer I) on December 1903 in North Carolina, USA. The organization of operating the aircraft on a scheduled basis over a consistent route was undertaken in 1919. The first airline was formed in Germany in 1919, which began service from Berlin to Leipzig while three days after the French Farman Company made a trans-channel crossing from Paris to London. The oldest surviving airline, KLM, was organized in the Netherlands in 1919. Together with a British company, it began flying the Amsterdam-London route in 1920. Thus, the interregional travel by airplane began.

During the 1920s and 1930s, the routes of airplanes were limited within a country since the maximum distance that could be flown was about 800 kilometers. To be able to reach other countries, the airlines, mainly British, used bilateral agreements with other European countries to reach the other colonies. By 1930, the Pacific and the Atlantic remained unconquered by the airplane.

In the United States, commercial freight service by airplanes began in earnest in 1925 when the Post Office Department established contracts for carrying mail over assigned routes. Competition for the airmail routes brought about the formation of several large American aviation companies. The first airmail flight across the Pacific was achieved on November 22, 1935 and the passengers were added to the service in 1936. During this time, the dirigible was still in operation and it was also able to cross the Atlantic with passengers, but after the tragedy of the Hindenburg in 1937 the competition with the airplane ended.

William Boeing built the first modern commercial aircraft, the Boeing-247, in 1933. This was safer than other aircraft because it could be maneuvered more easily and could be flown on a single engine. The DC-3 of the Douglas Company could fly the existing ceiling of 5,000 feet on one engine, and with stressed aluminum sheathing was a strong plane with retractable landing gear. In the 10 years it was in production, the DC-3 became the unrivalled master airliner, carrying the majority of American traffic. Undoubtedly, its greatest contribution was that it showed with great clarity that flying could be safe, reliable, affordable, and profitable for the operator.

Capable of flying at 14,000 feet and at a speed of 200 mile/h, the Boeing Stratoliner had just begun service in 1940 when the war in Europe broke out. Its powerful supercharged engines could navigate not only above the weather but also over the mountains. The development of this pioneering four-engine plane was taken over by the government during the war.

By 1953, the DC-7 was put in service with a range of up to 3,000 miles and a speed reaching 300 miles/hour. The successful pure-jet Boeing 707 was put in service in 1958. Within a few years Boeing had developed specialized jets for nearly the full range of commercial flying. The Boeing 727 became an intermediate-range jet carrying more than 100 passengers, rivaling in size the largest piston planes. The Boeing Company began planning what came to be known as the “jumbo jet”, the 747. When placed in service in 1970, the 747 was capable of carrying up to 500 passengers, but most models were fitted out for about 400, with substantial space allocated for baggage, mail and freight.

Historically, air travel is the latest developed mode of transportation. Air travel is very important to interregional transportation because of the speed and convenience provided by this mode.

2.4. Water Transportation

Water transportation is the oldest form of mass freight transportation for inter-regional transportation. This section deals with ferry transportation across seas or oceans, mainly for freight. Traditionally, vibrant economic and industrial centers as well as population settlements were developed around ports, harbors, lakes and navigable rivers. Although inland water transport (rivers and lakes) for passenger is still popular in many parts of the world, the available data are quite limited. On the other hand, passenger transportation by ship in the developed countries nowadays is limited to recreational purposes.

2.4.1. Passenger Ferry Services

Oceanic navigation in the nineteenth century began with steam navigation. Even though the Savannah was unable to secure passenger or cargo in its transatlantic voyage it was still the first ship to employ steam in crossing the ocean on May 1819. The Great Western Steamship Company in the UK recorded its first long distance ferry service between Bristol and New York in 1838. This was called the "Atlantic Ferry". The ferry service has spread worldwide ever since. Until the emergence of the automobile, the ferry transported only passengers and cargo. The use of piston engines limited the speed of the ships so in 1906, with the introduction of the steam turbine engine on ships, the Mauretania was launched. It was the most popular ship ever launched with a speed of 27 knots.

The Olympic of 1911, which was commissioned by the British White Star Line, was the largest ship ever built at that time. The Titanic of 1912, so vast that it displaced 46,329 tons, was deemed to be unsinkable. The Titanic operated at only 21 knots but its maiden voyage was much anticipated. The ship collided with an iceberg off the coast of Newfoundland and sank within hours, with a loss of about 1,500 lives.

World War I severely cut civilian ship traffic, although ships were used for troop transport. During the prosperous years of the 1920s, tourist travel grew rapidly, so a new wave of ship construction began. But by the end of 1929, the Great Depression had begun; it made transatlantic passage a luxury that fewer and fewer could afford and rendered immigration to the United States impractical.
The Normandie was the first large ship to be built according to the 1929 Convention for Safety of Life at Sea. It was fitted with four-bladed propellers in 1937 permitting it to cross the Atlantic in only 3 days, 22 hours and 7 minutes, thereby earning a Blue Riband award from the Europa.

During World War II, civilian transportation was largely suspended but military transport was expanded. The Queen Elizabeth, which was the largest passenger ship ever built (at 83,673 tons) was launched in 1938 but it was used as a troopship when war broke out in 1939. It was completed as a luxury liner after 1945 and operated with the Queen Mary until the 1960s, when the jet airplane lured most of the passengers from the Atlantic Ferry.

2.4.2. Cargo Ships

The history of merchant marine activities is very similar to that of the great passenger liners. Freighter navigation, tanker navigation, naval ships and container ships must be understood as a similar ever-improving technology. Wood was the first material used for ships followed by iron and in turn by steel. After the 1900s, steam turbine engines were favored for passenger ship use while diesel engines were used for freighters. The Scandinavians used the diesel internal combustion engine because of its more economical fuel consumption while American shipping companies favored the steam turbine because of lower labor costs. The rapid rise in petroleum costs led to increased diesel-engine construction.

2.4.3. Bulk Cargo Transportation

Bulk cargo transportation can be divided into two types, dry and liquid. Liquid cargo like petroleum is transported using tankers while dry bulk cargo is transported using a dry-bulk ship and/or container ships. Tankers do not have cargo hatches or external handling gears. The inner arrangement of the tanker is the simplest compared to other ships, so this type of ship is produced more. Because of the limited crew requirements and the low cost per ton of initial building and outfitting, the tanker has led the way in the rapid expansion in the size of ships. The decline of crude oil prices after the petroleum crisis of 1979 led to a decline in preferred tanker size, but at that time a few ships had reached 1,300 feet (400 meters) in length, 80 feet in loaded draft, and a deadweight of 500,000 tons. Aside from oil, tankers have also specialized in carrying natural gas. For shipment, the gas is cooled and converted to liquid at -260º F (-162º C) and is then pumped aboard a tanker for transit in aluminum tanks that are surrounded by heavy insulation to prevent absorption of heat and to keep the liquid from evaporating during the voyage.

For transporting dry bulk cargo such as ore, coal, grain, and the like, modern dry-bulk ships have no cargo handling gear and have large cargo hatches. The absence of containers on deck is a decisive indicator that a vessel is a dry-bulk ship. The emergence of this type of dry bulk cargo vessel, such as iron ore carriers, and coal carriers, has changed the trade and industrialization patterns of the world. Moreover, the dramatic low cost of bulk cargo carriers after World War II has changed the location decisions of manufacturing industries. These industries do not need to locate their factories near raw material sites. Seaside industrial zones together with large-scale seaports have also developed worldwide. On the other hand, many conventional dry-bulk ships with on-deck cargo handling gear are still operating in ports which, for loading and/or unloading, do not have cargo handling gear at the berths.

2.4.4. Container Cargo Transportation

The international container trade started at the end of the 1960s. Like tankers, container ships do not have cargo-handling gears and the container-handling cranes are located at shore terminals rather than aboard ship. Unlike the tanker, container ships require large hatches in the deck for stowing the cargo, which consists of standardized containers usually either 20 or 40 feet in length. Below deck, the ship is equipped with a cellular grid of compartments, which are designed to receive the containers and hold them in place until unloading is achieved at the port of destination. Container ships are more advantageous than dry bulk cargo ships since they can handle more cargo more efficiently. Container handling is very easy and quick as container ships only take a few hours to be filled and can be under way to their ports of destination. An additional economy is the low cost of the crew of the ship while it is in port awaiting loading or unloading. Furthermore, because each ship can make more trips than before, container fleets require fewer vessels. There is also less pilferage, hence lower insurance rates and, finally, the assurance to the shipper that the shipment will not require any further handling until it arrives at its destination.

The size of a container vessel became larger through the years. The first Panamax

Container Ship, the Liverpool Bay, was launched in 1972. It has a beam length of 32 meters and a capacity of 2,500 TEU (twenty feet equivalent units). Because of the limitation of the beam length of the Panama Canal, the maximum capacity of the container ship stayed at the level of about 4,200 TEU for a long time. The American President Line's (APL) five C-10 class ships started service in 1988. These were the first post-Panamax container ships. The maximum size of a container ship reached almost 7,000 TEU in the year 2000, while a ship with more than 10,000 TEU is expected to be launched in the near future.

2.4.5. Canals

Canals changed inter-regional transportation drastically as they reduced the lead-time for cargo ships. There are several existing canals in the world, but the well-known canals are the Suez Canal and the Panama Canal. The Suez Canal connects the Mediterranean and the Indian Ocean. It extends for 163 kilometers between Port Said and the Gulf of Suez. The French-owned Suez Canal Company headed by Ferdinand de Lesseps built the canal. It was completed in 1869 after 11 years of construction. Originally, the Suez Canal was 26 feet (8 m) deep and 72 feet (22 m) wide. After successive widening and dredging, the canal had a minimum width of 180 meters and a depth of 21.5 meters in 1996. Moreover, the canal is one of the heaviest traffic sea-lanes and accommodates almost 20 thousand vessels per year.

The Panama Canal connects the Atlantic Ocean and the Pacific Ocean. It extends for 82 kilometers between Colon and Balboa. The ships that sail between the east and west coasts of the United States can save about 15,000 km instead of sailing through Cape Horn. Ferdinand de Lesseps, who succeeded in the construction of the Suez Canal, formed the Compagnie Universelle du Canal Interocéanique and began work in 1881. However, it became bankrupt in 1889 because of poor planning. The Hay-Bunau-Varilla Treaty between Panama and the United States granted the US canal-building rights in 1903. Construction under U.S. supervision started in 1904 and the canal began operation in 1914. The ships are raised 26 meters by three locks to a man-made Gatun Lake. The maximum beam length and maximum draft of a vessel that can pass along the canal is 32.3 m (105.8 ft) and 13.5 m (44.3 ft), respectively. The limitation is due to the size of the locks.

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Biographical Sketch

Dr. Inamura began his education in civil engineering at Tokyo Institute of Technology in Japan and completed graduate study in the same field of the university, where he received his Dr. of Engineering in 1974. Immediately after graduation, he joined the port-planning laboratory at the Port and Harbor Research Institute (PHRI) of the Ministry of Transport in Japan. He was promoted as a senior research engineer in 1976 and the chief of Port Planning Laboratory in 1977. He specialized in financial analysis and economic evaluation of port planning/projects for ten years. During this decade, Dr. Inamura was also involved in many port development projects around the world, for example in Nigeria, Indonesia, Egypt, and China. Most of those projects were feasibility studies of transportation projects sponsored by Japan International Cooperation Agency (JICA).

Dr. Inamura joined the department of civil engineering at Tohoku University, Japan, in 1984 as associate professor. His major fields of interest have expanded into transportation systems as a whole. He was dispatched by the Japanese government to the Asian Institute of Technology in Thailand to work as associate professor in transportation from 1987 to 1989. He served as the transportation course coordinator, Japanese faculty representative, member of the academic senate, and member of the presidential working group. He delivered many classes and supervised more than ten graduate students in two years. After returning from Thailand, he was promoted as a full professor in the department of civil engineering at Tohoku University in 1992, and moved to the Graduate School of Information Sciences in 1994.

Dr. Inamura is very active in the incubation of research works in the Asian region. He and his colleagues established an academic society named the Eastern Asia Society of Transportation Studies in 1994, which comprises fifteen countries and regions, and has been holding the biannual international conference on transportation research in the region since 1995. He served as chairman of the international scientific committee for four years.

Dr. Inamura has published eleven books dealing with transportation systems, transportation history, transportation engineering, and feasibility studies.