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2012 Modularization of Korea's Development Experience:

Expressway Construction and Management

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Ministry of Land, Infrastructure and Transport

UNIVERSITY OF SEOUL

2012 Modularization of Korea's Development Experience:

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2012 Modularization of Korea's Development Experience

Expressway Construction and Management

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Preface

The study of Korea's economic and social transformation offers a unique opportunity to better understand the factors that drive development. Within one generation, Korea has transformed itself from a poor agrarian society to a modern industrial nation, a feat never seen before. What makes Korea's experience so unique is that its rapid economic development was relatively broad-based, meaning that the fruits of Korea's rapid growth were shared by many. The challenge of course is unlocking the secrets behind Korea's rapid and broad-based development, which can offer invaluable insights and lessons and knowledge that can be shared with the rest of the international community.

Recognizing this, the Korean Ministry of Strategy and Finance (MOSF) and the Korea Development Institute (KDI) launched the Knowledge Sharing Program (KSP) in 2004 to share Korea's development experience and to assist its developing country partners. The body of work presented in this volume is part of a greater initiative launched in 2010 to systematically research and document Korea's development experience and to deliver standardized content as case studies. The goal of this undertaking is to offer a deeper and wider understanding of Korea's development experience with the hope that Korea's past can offer lessons for developing countries in search of sustainable and broad-based development. This is a continuation of a multi-year undertaking to study and document Korea's development experience, and it builds on the 40 case studies completed in 2011. Here, we present 41 new studies that explore various development-oriented themes such as industrialization, energy, human resource development, government administration, Information and Communication Technology (ICT), agricultural development, land development, and environment.

In presenting these new studies, I would like to take this opportunity to express my gratitude to all those involved in this great undertaking. It was through their hard work and commitment that made this possible. Foremost, I would like to thank the Ministry of Strategy and Finance for their encouragement and full support of this project. I especially would like to thank the KSP Executive Committee, composed of related ministries/departments, and the various Korean research institutes, for their involvement and the invaluable role they played in bringing this project together. I would also like to thank all the former public officials and senior practitioners for lending their time, keen insights and expertise in preparation of the case studies.

Indeed, the successful completion of the case studies was made possible by the dedication of the researchers from the public sector and academia involved in conducting the studies, which I believe will go a long way in advancing knowledge on not only Korea's own development but also development in general. Lastly, I would like to express my gratitude to Professor Joon-Kyung Kim and Professor Dong-Young Kim for his stewardship of this enterprise, and to the Development Research Team for their hard work and dedication in successfully managing and completing this project.

As always, the views and opinions expressed by the authors in the body of work presented here do not necessary represent those of the KDI School of Public Policy and Management.

May 2013

Joohoon Kim

Acting President

KDI School of Public Policy and Management

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Summary

Gyeongin Expressway was constructed in 1968 as its first expressway, and since then, the expressway has developed so rapidly for the relatively short period of about 40 years. As a result, now in 2010, it is operating total length of 4,010km with 32 lines. Considering that the damage on road network throughout Korea caused by the Korean Civil War in the early 1950s was very serious, the result of expressway construction is really enormous.

In addition to the rapid network expansion, the operation and maintenance system have been so much sophisticated by introducing the pavement management system, structure information system, road facility management system. Especially, from 1993, Intelligent Transportation System was introduced on the basis of the traffic management system and electronic toll collection system.

The purpose of the study is to provide insight of potential conditions when developing countries consider expressway construction. Since Korea is a newly developed country, the logistics from the beginning to its current state is examined: the construction system and its results, the reasons why the rapid growth was possible and the complications during and after the construction phase.

This study suggests the implications by analyzing the planning, design criteria, financing, and operation and maintenance system from the first expressway in the late 1960s up to the recent expressway. The chronological and phase analysis of expressway development in Korea could provide various implications on other countries. However, there has been much difference in the early and present expressway construction and management system. So the implications are also divided for low-income countries and for middle- and high-income countries.

Put simply, implication on low-income countries are strong leadership and central government initiative, key factor in achieving economic growths, concentrated investment through selection, and low design criteria. And implication on middle- and high-income countries are promotion of balanced development, objective planning with usage of Database, various domestic financing sources, high design criteria, and advanced operation and maintenance system.

As mentioned above, there are many implications to be learned in the low-income countries. Some could be also adopted in the mid- and high-income countries as well. However, since the socio-economic and cultural situations are quite different between Korea and other countries, it really depends upon your reasons which implications are most appropriate.

Chapter 1

Introduction

Introduction

Gyeongin's construction of the expressway began in 1968, and since then, the expressway has developed rapidly in a relatively short period of 40 years. Now, in 2012, its total operating length is 4,010km with 32 lines. The Korean Civil War in the early 1950s caused substantial damage on the road network. The subsequent rapid reparation and development of the expressway has largely impacted the economic growth by increasing the transportation capacity of human resources and goods.

The main purpose of the study is to provide insight of potential conditions when developing countries consider expressway construction. Since Korea is a newly developed country, the logistics from the beginning to its current state is examined: the construction system and its results, the reasons why the rapid growth was possible and the complications during and after the construction phase.

In Chapter 2, the periodic situation in Korea after the War, the economic growth during the first and second Five-Year Economic Development Plan, the background of the first expressway construction and an analysis of why the construction was necessary are reviewed.

In Chapter 3, the evolution of government policies due to the expressway construction and then-current managerial practices will be reviewed in chronological order.

In Chapter 4, the different criteria of the expressway construction and managerial practices are reviewed: planning, design criteria, financing, construction and operation. Also, detailed policy changes for each criterion are reviewed.

In Chapter 5, a side-by-side analysis of the economic growth influenced by expressways on Korea and on foreign nations is made.

Chapter 6 suggests implications for expressway construction and management systems based on South Korea's experiences. Implications for low-, middle- and high-income countries are suggested separately.

Chapter 2

Background of First Expressway Construction

1. Periodic Background
2. The 1st and 2nd Five-Year Economic Development Plan

Background of First Expressway Construction

The Korean Civil War lasted for three years in the early 1950s and it caused considerable damage on almost all sections of Korea. Even though the early 1960s was about 10 years after the truce of war, the economic situation of Korea was severe. To tackle the economic problem and to pursue the middle- and long-term development policies, Korea set up the first Five-Year Economic Development Plan in 1962, and it actually created the basis for economic independence and industrialization. As the 1st and 2nd Economic Development Plan of the 1960s accomplished high economic growth as it had been expected. Economic growth rate from 1962 to 1966 – the 1st Five-Year Plan period – was very high at 8.5% per annum. Due to industrial development and an increase in national income, the demand of roads increased. Thus, the necessity of expressway construction became much greater.

The Gyeongin and Gyeongbu Expressway were the first expressways connecting Incheon and Busan to Seoul, respectively opened in 1968 and 1970. These two expressways have played a vital role in the economic development by smoothly handling the increased demand of cargo importation and exportation.

This chapter reviews the periodic background of the 1960s and the expressway policies in the 1st and 2nd Five-Year Economic Development Plan.

1. Periodic Background

1.1. Before Setting Up the Five-Year Economic Development Plan

The Korean Civil War caused considerable damage on almost all sections of Korea. In particular, since the road network was used as a military supply route, it became to be a primary target and its damage level was more serious. After the first year of the War, the lengths of paved roads were reduced from 1,066km to 580km.

After the truce in 1953, the length of paved roads was 687km, as shown in <Table 2-1>. The paved road length by type in 1953 was composed of a national road of 332km, city·district road of 316km and local road of 39km. At that time, non-paved roads of 25,345km existed. The non-paved roads were poorly built gravel roads with narrow width ill-suited for vehicle traffic.

Table 2-1 | Roads in 1953

(Unit: km, %)

Classification	National road	Local road	City·district road	Total	Rate
Paved road	332	39	316	687	2.6
Non-paved road	5,374	10,160	9,811	25,345	97.4
Total	5,706	10,199	10,127	26,032	100

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012

The damage on bridges were also serious. As shown in <Table 2-2>, it indicates that 33km of national and local bridges in 1,319 sites were seriously damaged. Only about 37% of all bridges were accessible.

Table 2-2 | Bridge Damage Caused by the War in 1952

(Unit: km)

Classification	Sites	Total length	Damaged length
National road	498	29	16
Local road	821	23	17
Total	1,319	52	33

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012

The Korean government asked allied countries for foreign aid in restoration of the damaged roads. The first aid was provided from the US International Cooperation Administration in 1954. The aid was $236.7 million in 1955 and continued to 1962. Korea received a separate grant of $150 million from 1954 to 1962 just for road and bridge restorations. Up to the early 1960s, construction policy had been mainly focused on the restoration of damaged bridges and roads.

1.2. The Beginnings of the 1st Five-Year Economic Development Plan in 1962

During the 1st Five-Year Economic Development Plan period (1962 – 1966), 76% of the total road budget was spent on bridge rehabilitation and road pavement. Damage restoration was urgent. The Korean government carried out travel surveys and made plans to build expressways. However, the foreign aid agents and consultants disapproved the plan to build expressways. They thought it was too premature in Korea and priorities were given to the rehabilitation of national and local roads.

The results of the 1st Five-Year Plan exceeded the expected economic growths. As shown in <Table 2-3>, the economic growth rate between 1963 and 1965 was around 8% and in 1966 was 13.4%. The success of the 1st Five-Year Plan increased the confidence of the civilians as well as the government. Naturally, economic growth followed and continued into the future.

The number of registered cars was not yet large. However, it began to increase sharply. The increase suggested several experts to analyze the construction of expressways. In particular, since the top national priority was to drive the export-oriented economic policies, transporting import and export cargos from the port cities of Incheon and Busan to Seoul increased dramatically.

Table 2-3 | Economic Growth Rates During the 1st Five-Year Plan Period

(Unit: %)

Year	1962	1963	1964	1965	1966
Annual growth rate	3.5	9.1	8.3	7.5	13.4

Source: Monthly Korea Statistics Report, Economy Planning Board, 1970

2. The 1st and 2nd Five-Year Economic Development Plan

The Five-Year Economic Development Plan is a comprehensive plan including land and socio-economic development and creating the foundation for industrialization and economic independence. The basic direction of the Five-Year Plan is to nourish freedom and creativity of the people and to pursue the free market economy system. However, the government is involved directly and indirectly in some important industries. It is possible to achieve the balanced growth as a whole.

The 1st Five-Year Economic Development Plan was based on the 'Five-Year Comprehensive Economic Plan' of July 22, 1961 made by the National Reconstruction Council. The plan was finalized on January 5, 1962. It was the first officially announced economic development plan with its five-year time period from 1962 to 1966. Until the mid-1990s, seven Five-Year Plans were announced.

To narrow the scope of analysis, the focus here is to review the background of the first and second expressway constructions.

Box 2-1 | Changes in the Five-Year Plans and Road Policies

The main purpose of the Five-Year Economic Development Plan was to focus most of the nation's resources to stimulate the economy. Since a comprehensive land development plan was not set up, the Five-Year Plan was the most important national development plan.

In the 1960s when the 1st and 2nd Five-Year Plans were created, a major goal for the national policy was to create a foundation for economic independence and industrialization. The government was actively involved in some industries. Very high economic growths were achieved in the early 1960s and this caused a great increase in export and import of freight cargos. The movement of freight cargos led to the demand of road capacity. However, the road policies until mid-1960 was focused on pavement and bridge restoration, therefore the road supply could not match the demand.

As soon as the 2nd Five-Year Plan began in 1967, the government put almost all the resources to increase the road supply. The shift in resources led to new expressways. The construction work of Gyeongin Expressway began in 1967 and opened in 1968. The Gyeongbu Expressway soon followed and opened in 1970. The opening of these two expressways drastically increased the road supply.

In the 1970s when the 3rd and 4th Five-Year Plans proceeded, the major national policy goal was to foster heavy and chemical industry development to achieve an advanced industrial structure. A new expressway network connecting these industrial complexes was opened. Apart from the new expressway network, the pavement work of national and local roads were also expanded.

In the 1980s when the 5th and 6th Five-Year Plans proceeded. High economic growths continued, which increased the demand for roads. The situation was accelerated by the rapid increase of private cars in the mid-1980s. However, unlike the previous decades, the road supply in the 1980s did not meet the demands thus leading to heavy road congestion.

In the 1990s, a large-scale road development began again. An ear-marked tax system was introduced in 1994 to secure a timely investment of planned transportation infrastructure.

Since the late 1990s, the economic growths slowed down and the balance of payment often showed deficits. Thus, the road demand also decreased. By the 2000s, most of the road construction was completed and large-scale road expansion slowed down.

2.1. The 1st Five-Year Economic Development Plan

2.1.1. Overview

The 1st Five-Year Economic Development Plan was established to stimulate the economy and to create the foundation of economic independence and industrialization. Considering the 1st Five-Year Plan was initiated for land development, it put a lot of importance on the expansion of basic industries and social infrastructure. The government pursued land development projects that would ultimately lead to economic growth.

The actual investment amount that the government spent in road projects during the 1st Five-Year Plan period was nothing more than 1.0% of the whole fixed capital. This amount was lower than that in the late 1950s, when a lot of the grant-type aid for road restoration was given. This was due to the heavy emphasis on basic industries in the 1st Five-Year Plan. The rationale was to foster the growth of an independent economy within the limited government budget and resources.

2.1.2. Planned and Actual Roads

The road projects in the 1st Five-Year Plan can be classified into bridge construction, road pavement, road repair and new industrial road construction. As shown in <Table 2-4>, 53% and 33% of total road project costs were actually spent on bridge construction and road pavement respectively.

2,020 million won was spent on 18km of bridge construction in 431 sites, which was more than planned. Similarly 1,248 million won was spent on 488km of road pavement, which was also more than planned.

This shows that it was necessary to make more restorations than planned. The damage on bridges and roads were so severe that plans for constructing an expressway could not be considered in the 1st Five-Year Plan.

Table 2-4 | Road Projects During the 1st Five-Year Plan

(Unit: km, million won, %)

Classification	Planned			Actual		
	Length	Cost	Rates	Length	Cost	Rates
Bridge	17	1,634	50.9	18	2,020	53.0
Pavement	321	890	27.7	488	1,248	32.7
Repair	85	275	8.6	120	289	7.6
Industrial road	121	411	12.8	73	255	6.7
Total	-	3,210	100	-	3,812	100

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012

2.1.3. Change in Road Demand

To properly analyze the change in road demand during the 1st Five-Year Plan period, it is necessary to look at the data from 1961 and 1966. However, statistical data of road demand has been collected officially since 1963. The data shows only the commercial vehicles. This means the data of private cars is not included. The data here shows the change in road demand of commercial vehicles between 1963 and 1966. As shown in <Table 2-5>, passenger demand increased 104%, while freight demand increased 36%. Passenger demand increased much more than freight demand.

Table 2-5 | Changes in Railway and Road Demand During the 1st Five-Year Plan Period

(Unit: 1,000 people, 1,000 ton)

Classification	Passenger			Freight		
	Railway	Road (Bus and taxi)	Total	Railway	Road (Commercial truck)	Total
1963	109,348	742,325	851,673	19,774	18,050	37,824
1966	138,298	1,511,558	1,649,856	24,064	24,528	48,592
Increase rate	26%	104%	94%	22%	36%	28%

Source: Annual Traffic Statistics Report, Ministry of Transportation, 1971

The increase demand for roads was 3 times larger than railways. We might infer that roads have become a more important infrastructure for passengers as well as freight tranportation.

The Annual Transport Statistics Report (shown above) includes the demand of commercial vehicles such as taxis, buses and commercial trucks. However, the number of registered cars was so small, which was less than 20,000 even in 1966. Private cars did not affect the road demand at that time.

2.1.4. Changes in Road Length and Pavement Rates

As shown in <Table 2-6>, the length of roads during the 1st Five-Year Plan period increased 23% from 27,169km in 1961 to 33,476km in 1966. This shows that the road demand was not met by the road supply. When reviewing by road type, the national road, including length and pavement, increased at greatly. On the other hand, the local road decreased. It was because some of paved local roads were upgraded and renamed to the national road.

The length of the city·district road increased from 10,884km in 1961 to 14,033km in 1966. because the increase was due to legally non-designated road such as the agricultural road being upgraded and renamed to the city·district road.

As far as road capacity in terms of dealing with vehicle traffic is concerned, it would be better to analyze the paved road length instead of road length or pavement rate. The paved road length, in all types of roads, increased 74% from 1,114km in 1961 to 1,942km in 1966. The biggest increase is shown in the national road. The metropolitan city road of 344km was newly introduced, however, the local road and the city·district road were decreased. There was no expressway yet.

Table 2-6 | Changes in Road Length and Pavement Rates During the 1st Five-Year Plan Period

(Unit: km, %)

Classification	Length		Pavement rates		Paved road length		
	1961	1966	1961	1966	1961	1966	Increase rate
Expressway	-	-	-	-	-	-	-
National road	5,706	8,186	12.6	16.5	719	1,351	88%
Local road	10,579	10,395	0.5	0.3	53	31	-42%
Metropolitan city road	-	1,862	-	18.5	-	344	-
City·district road	10,884	14,033	3.2	1.6	348	225	-35%
Total	27,169	33,476	4.1	5.8	1,114	1,942	74%

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012

2.2. The 2nd Five-Year Economic Development Plan

As more rapid economic growth than expected was shown during the 1st Five-Year Plan period, the 2nd Five-Year Plan was fully reviewed in depth before the 1st Five-Year Plan ended. Even though the 2nd Five-Year Plan began in 1967, the government began its review process from early 1965. The forecast for the economic growth was set at the government and ruling party joint meeting in November, 1965. The opinions of the domestic and foreign exports were aggregated in June, 1966 and the Plan was established on July 29.

2.2.1. Ending the 1st Five-Year Plan and Beginning the 2nd Five-Year Plan

Due to the success of the 1st Five-Year Plan, the economic growth rates increased considerably. Investments in road projects, largely in bridge restoration and pavement, were an indicator of the road supply. During that time, roads increased 74%. Further economic growth was expected for the 2nd Five-Year Plan, thus a higher demand for roads and the need to meet the demand would require faster building rates. More investments for roads were necessary in the 2nd Five-Year Plan. Particularly, since the supply of roads in the 1st Five-Year Plan focused on the post-war restoration, there was a limit in increasing the road supply at a large scale. It was necessary to greatly expand the road supply that could support high economic growth in the future, not only for short-term but also for long-term growth.

The planning procedure for the 2nd Five-Year Plan began in 1965. It was based on a mid-term evaluation of the 1st Five-Year Plan. As shown in <Table 2-7>, the passenger and freight road demand increased 57% and 77% respectively between 1960 and 1965. Furthermore, it was estimated that due to the continuous high economic growths during the 2nd Five-Year Plan, the passenger and freight road demand in 1971 would increase 96% and 78% respectively. The road supply would not meet the road demand.

The lack in road supply became a serious constraint in achieving the 2nd Five-Year Plan itself. Therefore, when the 2nd Five-Year Plan was prepared, constructing toll roads in heavy vehicle traffic corridors such as Seoul to Incheon and Seoul to Suwon was considered. Here, toll roads are different from expressways and it will be discussed later.

Table 2-7 | Change and Estimation of Road Demand Before and After the 1st Five-Year Plan

(Unit: million ton-km, million-km)

Classification	Actual demand in 1960 (A)	Actual demand in 1965 (B)	Increase rate (B/A)	Estimated demand in 1971 (C)	Increase rate (C/B)
Bus and taxi	7,590	11,932	57%	23,410	96%
Commercial truck	3,030	5,365	77%	9,553	78%

Source: The 2nd Five-Year Economic Development Plan, 1966

2.2.2. Planned and Actual Road

When the 2nd Five-Year Plan was set up, there was a toll road plan of 10 routes totaling 143km – the roads included Seoul to Incheon, Seoul to Suwon, Cheonan to Onyang, etc. Toll roads did not mean expressways for high speed traffic. Each toll road in the Plan was short distanced rather than long distanced. Each toll road was not connected. In a strict sense, there was no expressway plan, at first, in the 2nd Five-Year Plan.

In 1968, a year after the 2nd Five-Year Plan was implemented, road traffic congestion had become more serious and railway capacity as an alternative almost reached its limit. To solve the road congestion problem, the 'Ten-Year Expressway Plan' was separately prepared. To implement the Ten-Year Expressway Plan effectively, appropriate financing sources were needed. Apart from the foreign-aid, domestic financing sources were made. The 'Road Rehabilitation Promotion Act' and the 'Act on Ear-marked Account for Road Rehabilitation Project' were enacted in 1968. All the gasoline and diesel taxes and toll revenues were only used for road project investment.

As already mentioned, the top national priority was to develop an export-oriented economy and this was well documented in almost all Five-Year Plans. Exporting and importing cargos through Incheon and Busan ports increased a lot during that time. Traffic congestion began to occur in Seoul to Incheon and Seoul to Busan corridors.

The construction of Gyeongin expressway (connecting Seoul and Incheon) and Gyeongbu expressway (connecting Seoul and Busan) was planned to accommodate the increasing exporting and importing cargos. The above-mentioned Ten-Year Expressway Plan established a very ambitious long-term plan, which suggested building a new expressway of 874km in the 2nd Five-Year Plan and another 926km in the 3rd Five-Year Plan. The construction of expressways became the most important goal in the 2nd Five-Year Plan.

The investment on road projects in the 2nd Five-Year Plan enormously increased. As shown in <Table 2-8>, 90.4 billion won was spent, compared to 3.8 billion won in the 1st Five-Year Plan. Out of the total investment amount, 72% was spent on expressways. A major difference is the 1st Five-Year Plan spent 93% of its budget on bridge construction, road pavement and repair. In the 2nd Five-Year Plan, only 23% was spent. Much more was invested toward expressway construction in the 2nd Five-Year Plan.

Table 2-8 | Planned and Actual Roads in the 2nd Five-Year Plan

(Unit: km, million won , %)

Classification	Planned			Actual		
	Length	Cost	Rates	Length	Cost	Rates
Expressway	539.6	41,323	64.3	655	65,417	72.4
Quasi-expressway	82.0	3,680	5.7	106.7	3,625	4.0
Bridge	19.8	7,111	11.1	13.8	5,961	6.6
Pavement	649.0	6,130	9.5	705	7,311	8.1
Repair	1,232	4,907	7.6	763	7,187	8.0
Industrial road	194.0	1,162	1.8	79	900	1.0
Total	-	64.313	100	-	90,401	100

Source: The 2nd Five-Year Economic Development Plan, 1966

2.2.3. Change in Road Demand

During the 2nd Five-Year Plan, 655km of expressways was built. As a result, many passengers and freights began to use more roads and less railroads. Even if it is estimated that 20% of railway passengers diverted to roads, the actual diversion rate reached 42%.

As shown in <Table 2-9>, the number of bus and taxi passengers in 1971 increased about 1.8 times. The railwaypassengers decreased. In case of freights, roads became more important. Roads and railways carried similar freight tonnage in 1966. However, roads increased about three times in 1971, while railroads increased only 1.3 times.

The number of registered cars increased much higher by an annual rate of 36.5% during the 2nd Five-Year Plan period. It reached 60,677 in 1971 from 17,502 in 1966. However, considering the population, it might be said that the number of cars is not high at all.

Table 2-9 | Changes in Railway and Road Demand During the 2nd Five-Year Plan Period

(Unit: 1,000 people, 1,000 tons)

Classification	Passenger		Freight	
	Road (Bus and taxi)	Railroad	Road (Commercial truck)	Railroad
1966	1,511,558	138,298	24,528	24,064
1971	2,743,769	131,251	73,934	31,955
Increase rate	82%	-5%	201%	33%

Source: Annual Traffic Statistics Report, Ministry of Transportation, 1971

2.2.4. Changes in Road Length and Pavement Rates

As mentioned in the 1st Five-Year Plan, the road supply includeds the total paved road lengths and pavement rates. As shown in <Table 2-10>, the paved road length increased about 197% from 1,942km in 1966 to 5,770km in 1971. The increase rate of 197% in the 2nd Five-Year Plan is about 2.7 times of 75% in the 1st Five-Year Plan.

A new expressway of 655km was built. The pavement rates of all types of roads increased a lot. The paved national road increased 954km from 1,351km to 2,305km. This is the same for local, metropolitan city and city·district roads.

During the 2nd Five-Year Plan, several expressways were constructed and many types of roads were drastically expanded.

Table 2-10 | Changes in Road Length and Pavement Rates During the 2nd Five-Year Plan Period

(Unit: km, %)

Classification	Length		Pavement rates		Paved road length		
	1966	1971	1966	1971	1966	1971	Increase rate
Expressway	-	655	-	100.0	-	655	-
National road	8,186	8,146	16.5	28.3	1,351	2,305	71%
Local road	10,395	10,760	0.3	2.2	31	237	665%
Metropolitan city road	1,862	5,661	18.5	34.2	344	1,936	463%
City·district road	13,033	15,413	1.6	4.3	209	663	217%
Total	33,476	40,635	5.8	14.2	1,942	5,770	197%

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012

Chapter 3

Achievement of Expressway Construction

1. First Two Expressways
2. Expressways in the 1970s and 1980s
3. Expressway in the 1990s and 2000s

Achievement of Expressway Construction

The Gyeongin and Gyeongbu expressways were the 1st two expressways. The basic expressway network in Korea was established between the 70s and 80s which included 12 lines equaling 671.6km. From the 90s to the present, considerable amount of expressways were constructed to form a '7×9' axes expressway network. in 2012, Korea had an expressway network of 4,010km.

The current expressway network in Korea is at the same level as advanced countries in terms of the supply side, considering the population and land size. Also, through the introduction of private capital and an advanced expressway management system, the same level as advanced countries in terms of management and maintenance side exists.

In this chapter, the achievement of expressway construction from the late 1960s up to present will be analyzed. Construction and management policies are described in chronological order. The expressways will be reviewed in chronological order.

1. First Two Expressways

1.1. Necessity of Expressway Construction

The Five-Year Economic Development Plans were established for reconstruction after the Korean War and to achieve economic development. With the success of the 1st Five-Year Plan, the economy developed rapidly and road demand by passenger and freight also continuously increased. In particular, as the exported-oriented industry began to form, transportation costs to move freight cargo became an important factor for further development. So the necessity to construct expressways was raised.

1.1.1. Industrial Complex Development

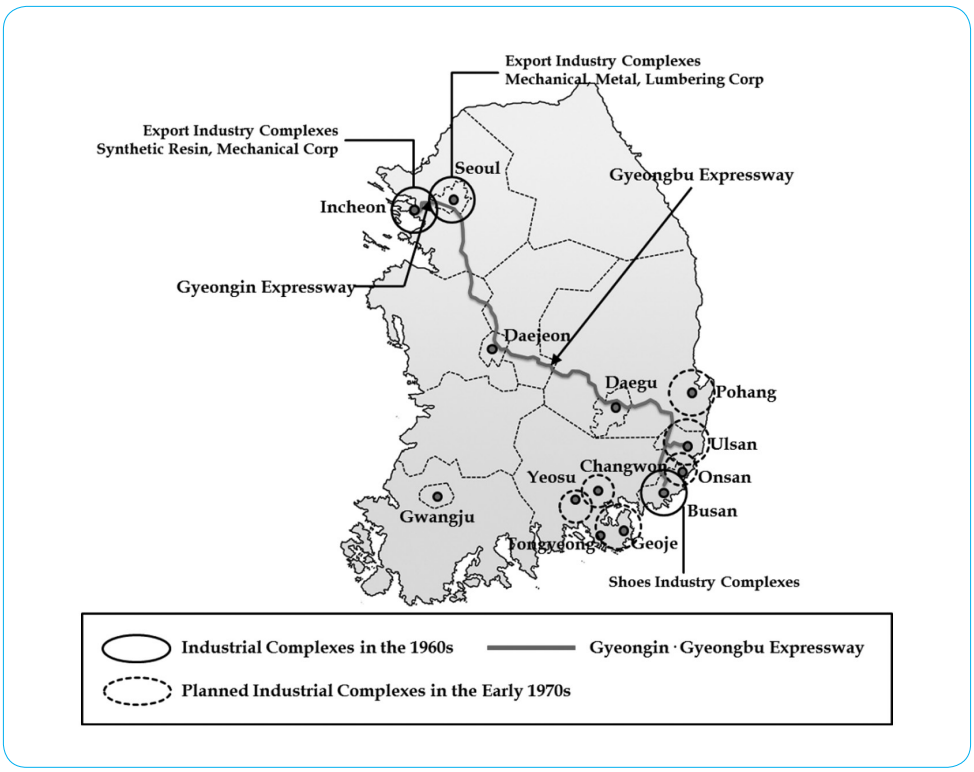
On January 20, 1962, one week after the 1st Five-Year Plan was announced, the government made a fundamental framework for an industrial complex development. Thus the Land Expropriation Special Act and City Planning Act was enacted. With the enactment of relative laws, on January 27, 1962, Ulsan Industrial Complex was designated as the first of its kind. Many industrial complexes followed suit.

Ulsan Industrial Complex was a heavy and chemical industrial complex. In contrast, most industrial complexes developed in the 1960s were mainly light industrial complexes. At the time, Korea's abundant resource was cheap labor. Industrial complexes were formed in and around Seoul, Incheon and Busan where labor was available.. In February 1966, the 1st complex of Korea Export Industry Corp. was constructed in Guro-dong, Seoul. Due to the success of the 1st complex, a 2nd and 3rd complex were developed. A 4th, 5th and 6th complex were developed in Incheon and Juan. Some areas in Seoul and Incheon were actively developed into export industrial complexes in the late 1960s.

This success of government-led Export Industry Corp. promoted the development of industrial complexes in and around Seoul and Incheon by private companies as well. Yeongdeungpo Mechanical Corp. and Korea Synthetic Resin Industrial Corp. in Seoul, and Incheon Mechanical Corp., Incheon Nonferrous Metal Corp., Korea Lumbering Corp in Incheon were some of the companies. The abundant labor supply due to refugees during the Korean Civil War and manufacturing bases built during the Japanese occupation period lead to the development of shoes manufacturing in Busan.

The development of industrial complexes greatly increased the demand of transportation. In order to reduce transportation costs, it was necessary to construct expressways connecting industrial complexes and large cities. Expressways should connect into ports. Most of the manufactured goods were exported or raw materials were imported through ports.

Figure 3-1 | First Two Expressways and Industrial Complexes in the 1960s and 1970s



1.1.2. Increase in Port Demand

Due to the export-oriented economy system, the ratio against the GDP continuously increased. As shown in <Table 3-1>, The export amount over GDP was 1.73% in 1961. It reached 9.38% in 1970.

Table 3-1 | Changes in the Ratio of Export Amount Against the GDP

(Unit: $10 thousand)

Classification	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Export amount (A)	4,088	5,481	8,680	11,906	17,508	25,033	32,023	45,540	62,252	83,519
GDP(B)	235,706	274,594	386,373	335,813	301,761	380,604	470,275	595,534	747,569	889,973
A/B	1.73%	2.00%	2.25%	3.55%	5.80%	6.58%	6.81%	7.65%	8.33%	9.38%

Source: World Bank (www.worldbank.org), Korean Trade Association (http://stat.kita.net/)

With this rapid increase of exports, the freight cargo volume through ports also increased. The port entry cargo volume, had great influences on the road traffic volume. Considering the port entry cargo volume in the early 1960s, the Busan port handled over half of the total exports and the Incheon port being a bit lower. With the success of the 1st Five-Year Economic Development Plan, the products in industrial areas such as Incheon increased greatly to occupy 44% of the national industrial output. As industrial products in Incheon were expected to increase much more in the future, the necessity of expressway construction to handle the traffic volume between Seoul and Incheon was raised.

The Busan Port was directly connected to US and Europe and it was the largest port in Korea. Large-scale shoes manufacturing complexes had already been developed in Busan area from the 1950s. Ulsan, not distant from Busan, became a heavy and chemical industrial complex. Due to Ulsan's development, cargo volume through Busan port was expected to increase largely.

The increase of port cargo volume in Incheon and Busan caused a rapid increase of traffic volume between Seoul and Incheon, and Seoul and Busan. Therefore, the necessity of expressway construction connecting these areas was raised.

Table 3-2 | Change of Port Entry Record in Incheon and Busan Port

(Unit: 1,000 tons)

Year	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Incheon port	644	1,208	1,597	1,102	1,190	1,732	2,750	3,895	5,244	7,684
Busan port	1,925	2,443	2,761	2,682	3,248	4,060	4,994	5,423	6,287	7,421
Total	3,608	5,189	5,923	5,761	7,448	9,178	13,923	19,199	25,172	29,172

Source: Annual Traffic Statistics Report, Ministry of Transportation, 1971

1.1.3. Rapid Increase in Road Demand

The 1st Five-Year Plan built around an export-oriented plan required an increased in freight traffic. Most industrial complexes were concentrated in and around Seoul, Incheon and Busan during the 1st Five-Year Plan. The movement of freight cargos increased greatly between these areas. Most of the cargos would be transported by road.

As shown in <Table 3-3>, the total freight cargo volume increased 11.5 million tons from 39.8 million in 1963 to 51.3 million in 1966. The modal share of roads increased from 18.1 million to 24.5 million tons. The freight cargo volume was expected to increase much more rapidly in the 2nd Five-Year Plan and onwards. Therefore, it was necessary to increase the transport infrastructure capacity. Since the railway capacity was almost reached in Seoul to

Incheon and Seoul to Busan, there was no spare capacity to cope with future freight volume increases. The only way was to increase the road capacity.

As expected, the freight cargo volume after the 2nd Five-Year Plan increased greatly. The total freight cargo volume increased from 51.3 million in 1966 to 103.8 million in 1966. The modal share of road increased much higher, from 24.5 million to 61.8 million tons. If the expressways had not been constructed, there would have been difficulty in carrying these freight cargo volumes. Economic growths in the 2nd Five-Year Plan and onwards would have been affected as well.

Table 3-3 | Freight Cargo Volume during the 1st Five-Year Economic Development Plan Period

(Unit: 1,000 tons)

Year	1963	1964	1965	1966	1967	1968	1969	1970
Road	18,050	18,716	24,014	24,528	28,615	46,093	56,575	61,775
Railway	19,774	20,311	22,377	24,064	27,440	28,857	30,643	31,551
Shipping	1,980	2,170	2,676	2,686	4,172	5,602	8,114	10,510
Total	39,804	41,197	49,067	51,278	60,227	80,552	95,332	103,836

Source: Annual Traffic Statistics Report, Ministry of Transportation, 1971

1.1.4. Expressway or Common Road

In the mid-1960s, when the first two expressways were planned, there were so many unpaved roads in Korea. There was a disagreement on priorities that the investment should go into common roads – pavement and expansion of national and local roads – versus new expressways. Specially, oppositions caused by local experts and the public aimed toward the notion that expressway construction was just to showcase President Park's achievements and that problems in financing sources and technical skills would arise.

The increase in exports was urgent for the economic growth, thus the reduction of transport costs was very important. As industrial complexes were developed in and around Seoul, Incheon and Busan and ports were developed in Incheon and Busan, the investment to increase the transport infrastructures capacity in Seoul to Incheon and Seoul to Busan corridors was the most important. This was particularly the case when the limited spare capacity in railway was considered.

A decision had to be made to choose a more suitable road type between expressways or common roads. Of course, it was possible to transport goods through common roads with the pavement and expansion of existing national and local roads. However, there were

problems in common roads. First, they had to be operated freely. Toll revenues could not be collected so the best financing sources would be given up. Second, it was more than 400km between Seoul and Busan so it would take too long to travel, maybe more than 10 hours. Furthermore, the Seoul to Busan corridor would be the most utilized road so a high-speed vehicle traffic must be guaranteed. Of course, as already mentioned, problems in expressways were also suggested. They were mostly financing sources and technical skills.

1.1.5. Necessity of Gyeongin Expressway

From the early 1960s, the dispute on the necessity of tolls on Seoul to Incheon and Seoul to Suwon corridors continued. A conclusion was made to include the construction of ten toll roads in the 2nd Five-Year Economic Development Plan. Studies from foreign and local transports showed that a toll expressway with higher design criteria rather than a toll road was more appropriate for a country with a large economic development.

The Ministry of Construction conducted preliminary surveys for road construction seven times from 1962 to 1967. Through a public announcement by the President in January 1965, Seoul to Incheon area was announced as a special zone[1] for development. The first feasibility analysis on Gyeongin (Seoul to Incheon) expressway was conducted by the Korea Engineering Corporation that made a contract with the Ministry of Construction in April 1968.

The study showed that since Seoul and Incheon areas were densely populated, the 1986 road traffic volume in Seoul to Incheon corridor was expected to increase 15 times than that of 1967. said the study showed that the most important transport infrastructure, Gyeongin (Seoul~Incheon) railway line, had reached its capacity. The national road No. 6 and No. 46 also reached its capacity. It was suggested that the construction of the expressway would solve serious road traffic congestion. In particular, as Seoul~Incheon corridor is a short distance of less than 30km, the expressway construction cost was relatively not large. However, the effects would be great. In the end, it was decided to construct an expressway.

1.1.6. Necessity of Gyeongbu Expressway

Like Seoul~Incheon section where the Gyeongin expressway was constructed, Seoul~Suwon section was planned as a toll road in the 2nd Five-Year Plan. It was recommended by transport studies done by foreign and local consultants that a short-

1. A special zone means some designated area in order to develop the industrial or economic complexes. If it is announced as a special zone, the transfer, inheritance, and gift taxes are highly charged in case of the real estate transaction. It might be said that it was used as a method to get the easy land acquisition in case of the expressway construction in the future by making real estate transaction very difficult.

distanced section of about 30km should be constructed into a high standard expressway rather than a toll road. Furthermore, the 1st Five-Year Plan pursued an export-oriented economy by developing large-scale heavy and chemical industrial complexes in south-east coastal areas near Busan and the large expansion of the Busan port. Thus, the necessity of a new expressway connecting Seoul and Busan, i.e. Gyeongbu expressway, was strongly suggested.

With the great success of the 1st Five-Year Plan, the freight volume had increased rapidly, this had been particularly so from the 1965. Due to the rapid increase in freight volume during the 1st Five-Year Plan, the transport issues would be addressed by President Park through the 2nd Five-Year Plan and also through the revolution of the land surface transport system. As one of his many pledges, he suggested the construction of the Gyeongbu expressway.

Important intermediate materials such as asphalt and cement needed to be easily procured so that the construction costs of the Gyeongbu expressway could be reduced. During the 1st Five-Year period, in May 1964, the oil refinery complex development work was completed in Ulsan so that the asphalt could be cheaply procured. The cement factory of Hyundai Engineering & Construction was opened in June 1964.

The Korean government had been encouraged by the success of the light industrial complexes in the 1st Five-Year Plan. It led to the national goal to develop heavy and chemical industrial complexes in coastal areas near Busan in the 1970s. In order to transport the products manufactured in southeast coastal areas near Busan to Seoul and Incheon, the Gyeongbu expressway was necessary. In particular, since the Busan Port was directly connected to the US and Europe by ships, the Busan Port needed expand to handle the exporting cargos.

1.2. Planning

In the mid-1960s, Korea had no experience on expressway construction. So the capability to plan the first expressway did not exist. All that could be done was to conduct a transport demand survey and ask foreign consultants to carry out transport studies.

1.2.1. Transport Study by the IBRD

It was necessary for the Korean government to establish specific road plans in the 2nd Five-Year Plan, and to receive foreign loans for financing road expansion projects. A request to the International Bank for Reconstruction and Development (IBRD) to conduct transport studies was made in September 1965. A consortium, consisting of four consultants – SOFRERAIL, BCEOM, NEI and NEDECO – made a contract with the IRBD and conducted the study. It lasted for six months and the conclusion follows:

- In spite of the effort for 12 years after the Korean Civil War, road network in Korea was still very poor.
- Since most efforts had been focused on restoring the damage caused by the War, there were only a few modern roads up to 1966.
- It indicated that the modal share imbalance between road and railway was serious.
- It suggested that, as the annual demand increase in freight and passenger would be 10.2% and 11.5% respectively. It was necessary to transform from a railway-based transport system to a road-based one.

It suggested that and additional 3,300km should be paved apart from the 1,660km paved roads. The department of roads would be expanded and restructured to the bureau of road and the government's transport administration system would be reformed. Out of the ten toll roads planed in the 2nd Five-Year Plan, the traffic volume in Seoul~Suwon and Seoul~Incheon section should increase a lot. So the expressway would be preferable to the toll road for the two sections.

However, when considering Korea's economic scale and development, domestic financing sources and the ability of toll payment by users was not sufficient, the toll road could only be continued by fully considering the repayment period and interest payment. In the end, it suggested that the toll road would not be introduced without getting foreign loans.

Box 3-1 | In Pursuit of the Gyeongbu Expressway

The former President Park Junghee (hereinafter, President Park) visited West Germany in 1964. The visit was to directly confirm the miracle of Rhine River that succeeded with the economic revival from difficulties caused by the 2nd World War. It was also to request a foreign loan. President Park was deeply impressed by Autobahn. And he thought that Gyeongbu expressway as the main trunk road of Korea connecting Seoul and Busan was urgent for the continuous economic growth so he started to see the Gyeongbu expressway as a future. The prime minister of Western Germany, Erhard told President Park that he felt pride and honor whenever he passed through the Autobahn. President Park was impressed at Erhard's attitude to the Autobahn and remembered the moment vividly even 10 years later. President Park showed so much interest in Autobahn that he got out of his car and carefully researched it several times. As soon as he came back, he spent much time planning the construction of the expressway with reports from experts. When President Park ran for presidential election again in 1967, he put the Gyeongbu expressway construction into his election pledges. However, there were oppositions from the media and academics. It was said that the chairman of Hyundai Group, Chung Juyoung (hereinafter Chairman Chung) was the only person who gave a shout of joy to his pledge. First of all, they wondered if the Korean government could afford such a huge financial burden. And they worried about the inflation after the odds of a breakthrough. What was worse, the IBRD released a report that the traffic volume was not that big, thus it would be of no value pouring resources into the construction. The opposition got bigger.

In this situation, President Park ordered Chairman Chung to estimate a reasonable cost for the Gyeongbu expressway since Hyundai Engineering & Construction had an experience in expressway construction in Thailand. Chairman Chung estimated the cost at 38 billion won. It was much lower than 65 billion won by the Ministry of Construction and 49 billion won by the army engineering team. Chairman Chung took charge of the construction.

President Park regularly invited Chairman Chung to his presidential office late at night and discussed ways to complete the work with the limited resources. He drew the design of expressway interchanges by himself. He visited the construction sites to see if things were not going well. Thanks to his drive, it was possible to complete the work of 428km expressway within only 2 years and 5 months from February 1968 to July 1970.

1.2.2. Transport Study by the Korea Industry Management Association

In May 1966 when the transport study by the consultant team of IBRD reached the final stage, the Korean Administrative Reform Committee requested the Korea Industry Management Association (KIMA) to conduct a comprehensive study on the road and transport administration system. The KIMA conducted the study for 5 months with

organizations such as bureau of land transport, bureau of land preservation and the US Operations Mission (USOM) and completed the report in October 1966.

The study focused on the financing sources for investment and the government's policies for transport service providers. The expressway construction was suggested as a remedial action to cope with the traffic overflow, so measures for expressway construction and management system were recommended as follows:

- As traffic volume congested the trunk road connecting Seoul and its satellite cities, the expressway construction was inevitable.
- In order to manage the new expressway construction, an official highway corporation as a public entity was necessary.
- The financing sources for expressway investment should be mobilized by the government loan, government aid, foreign loan, and private capital for the highway corporation.
- It was necessary to charge tolls for the debt by construction to be paid.

1.2.3. Planning

The Korean government founded 'Land Construction Bureau' and setup land development plans in 1960s. The 'Basic Land Development Plan' was established in July 1963 and the rehabilitation of trunk roads was proposed in July 1963. The 'Act on Comprehensive National Land Development Plan' followedin October 1963 so that it could provide a systematic legal framework for the national land development plan. The 'Basic Land Development Plan' was revised and supplemented to the 'Draft Grand National Development Plan' in August 1967. The expressway plans for Seoul~Incheon with six lanes and for Seoul~Suwon with four lanes were suggested here to proceed the 2nd Five-Year Economic Development Plan'. It was the first official expressway plan.

The planning of expressways could not continue because data for feasibility analysiswas not ready. Thus, the optimal route selection could not be followed as well. However, it was certainthat traffic volume would increase massively through the continuous rapid economic development so the expressway construction should be doneas soon as possible. In the end, the alternative expressway routes identified in 1/50,000 map and was checked on site.

For Gyeongbu expressway, the conceptual principles of the construction were set up. These included the travel time within 5 hours for Seoul~Busan, the development of many regions by passing through small and medium sized cities, the minimization of construction and maintenance cost, the completion of construction within 4 years with four lanes. Alternative routes which satisfied these principles were marked in a map and checked directly through the field trip, and then the final scheme was completed.

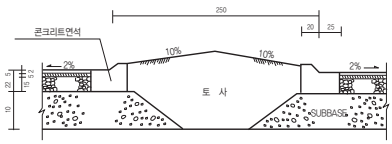
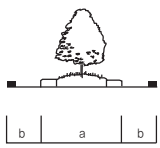
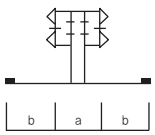
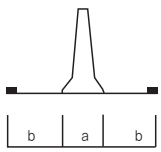
Transport database system was not installed and software for transport demand forecasting was not available as well. So it had been complicated to conduct the feasibility analysis. The planning was mostly done by the President Park and a few central government officials with local experts. This made it possible to reduce the time for the completion of the expressway. On the other hand, this also caused some problems like the occurrence of many traffic accidents and high maintenance costs.

1.3. Design Criteria

As the first two expressways minimized the number of tunnels and bridges to reduce cost, the road hadcurved much. The roads were designed to have four lanes that could afford the traffic volume. As shown in [Figure 3-2], the median strip was located at the green island without tree, with low height and narrow width. But it had possibility of causing dazzle of the light from the opposite direction that it put drivers at risk. Considering the current median strip types of concrete protective wall, guard rail and green island with tree, you could see the inadequacy of first type median strip.

Particularly, when the first two expressways were constructed, the road design criteria was not yet prepared. Gyeongbu expressway, which had many rivers and mountains in the line so the road alignment was not good, needed to be reviewed for the setup of the criteria. Gyeongin expressway passed through flat areas and the road alignment was quite good.

Figure 3-2 | Median Strip Structure

Type	Shape	Median strip (m)	
		Strip(a)	Lateral clearance including side strip(b)
First type, green island without tree		2.0	0.50
Current type, green island with tree		More than 2.0	0.50
Current type, guard rail		0.6	1.0
Current type, concrete protective wall		0.6	1.0

1.3.1. Design Criteria of Gyeongbu Expressway

The design criteria of the Gyeongbu expressway followed some principles. Since the reduction of construction cost was the most significant factor, the principles were set to find the shortest and economic paths to connect major cities such as Daejeon, Daegu, Ulsan, and Masan. Then the optimal routes were chosen by evaluating the connectivity with the regional and city development plan, traffic volume, topography, river, and land use plan.

The routes were classified into three classes - flat area as class 1, hilly area as class 2, and mountainous or city area as class 3. The design criteria was set for each class. The speed was limited to 120km/h, 100km/h and 80km/h respectively by class, and the grade set to2%, 3% and 5% for each. The minimum curve radius was set to 600m, 400m and 300m, and

the minimum phase 260m, 160m and 110m. The maximum load was set to 18 tons and the number of lanes was four throughout the route. All the interchanges were seperately graded.

The standard cross section had 24m in width, and it composed of curve type median strip of 2.0m in length with lateral clearance of 0.5m in each direction, and four lanes of 7.2m, hard shoulder lane of 2.55m, effective shoulder width of 0.75m in each direction. However, the land permitted six lanes for future use as well as four lanes in standard

The current design criteria of the expressways set the minimum curve radius to 460m with the minimum design speed of 100km/h. You could find that the design criteria of Gyeongbu expressway were much lower than those of current expressway. The reason is that the median strip was designed as the green island without tree, so fatal accidents might have been caused by the headlight from the opposite direction.

1.4. Construction

1.4.1. Construction by Local Companies

In the mid-1960s, there was a concern that which organization would undertake the construction of two expressways and a few local companies which had experience of Partininariwatat expressway construction in Thailand had been candidates. And specialists went to Delewe Cather International in US for 23 months in order to learn skills for expressway construction. Local companies also worked with the Korean army engineering officers, who had considerable capability through the technical cooperation with the US army.

The construction of Gyeongin expressway had completed in a very short time. The financial support from government and private capital with ABD loan also helped. The route was divided into four sections and each section was contracted to different companies. All the preparatory works such as planning and financing before the construction could be finished within a year. The design had been done simultaneously with the construction. The construction hardly ceased to complete the work in time. The construction continued even in winter when the grouhd was frozen. The Korean government spurred the construction to cope with the increasing road traffic volume.

One spectacular thing was that the ratio of land acquisition cost out of the total construction cost was very low. It was particularly low in Gyeongbu expressway - only 3.2%. Land owners showed their patriotism selling their estate to government in an extremely low price so the construction costcould be saved a lot.

1.4.2. Prevention of Poor Quality Construction Work

Not to repeat the same mistakes in the construction of first two expressways, several construction work supervisors were designated in each work field and they were in charge of review of construction work plan, actual construction work supervision and safety management. The construction work supervisors were appointed and trained by the executing director of each work field according to clause 17 of Land Development Project Management Regulations. At first, the training was done for 22 officers from army engineers due to a lack of local technicians. Later the training was extended to university graduates who majored in civil engineering.

1.4.3. Gyeongin Expressway

Gyeongin expressway is the first expressway in Korea which connects Seoul and Incheon. As shown in <Table 3-4>, since thelength is quite short - only 23.5km - it was easy for the government to finance and construct it. The whole route was divided into three sections and the work was separately done for each section. It was opened in December 1968, one year earlier than the time speculated, that is, it took only one year and nine months.

When Gyeongin expressway construction began in 1967, the Korea Expressway Corporation (KEC) was not established yet. KEC was established in 1969 and has taken the responsibility of construction and management of all expressways. So Gyeongin expressway was supposed to be constructed and operated by the private sector as the public-private partnership. Gyeongin Expressway Co., Ltd. was newly set up as a joint company of Hyundai Engineering & Construction, Daerim Industry, and Sambu Construction Company. It was in charge of construction, operation and maintenance. After KEC was established, the operation right of Gyeongin expressway was sold and transferred to KEC. Thus only construction part had left for Gyeongin Expressway Co., Ltd.

Table 3-4 | Overview of Gyeongin Expressway

Beginning /Completion	March 24, 1967/December 21, 1968
Total length	23.5km (four lanes)
Route	Sinwol-dong, Seoul ~Yonghyeon-dong, Incheon
Total cost	Construction cost: 2,799 million won Land acquisition cost: 581 million won Total cost: 3,380 million won

Source: Korea Expressway Corporation 30 Year History, Korea Expressway Corporation, 1999

1.4.4. Gyeongbu Expressway

The construction of Gyeongbu expressway began in February, 1968, one year after Gyeongin expressway. It was about 14 times longer than Gyeongin expressway - 428km in length. It was the largest project which the Korean government had ever had so far. The whole route was divided into four sections - Seoul~Osan, Osan~Daejeon, Daejeon~Daegu, Daegu~Busan. The survey, design and construction were done separately by each section.

However, there was a difficulty in building tunnels and bridges with our own techniques. Thus, we had to learn them from USA. In particular, Daejeon~Daegu section was the most difficult lastly ended in July, 1970. The whole construction took two years and five months, which was earlier than its original plan by one year and seven months. The army forces also worked in Suwon, Daejeon, and Eonyang work fields to reduce the construction cost as well as the time. This shows how much President Park put his effort on the Gyeongbu expressway construction.

Table 3-5 | Overview of Gyeongbu Expressway

Beginning /Completion	February 1, 1968/July 7, 1970
Total length	428km (four lanes)
Route	Sinsa-dong, Seoul ~ Guseo-dong, Busan
Total cost	Construction cost: 41,597 million won Land acquisition cost: 1,376 million won Total cost: 42,973 million won

Source: Korea Expressway Corporation 30 Year History, Korea Expressway Corporation, 1999

Box 3-2 | Problems by Too Hurriedly Constructed Gyeongbu Expressway

From the beginning, one of major goals of Gyeongbu Expressway was to finish the construction as soon as possible. The whole route of 428km in length was divided into four sections and the construction work continued day and night. Even in winter when the ground was frozen, fire was set after spreading straws and gasoline, or trucks were driven repetitively with a firing burner at the bottom. As such, every kinds of methods were used to shorten the construction time. In spite of these efforts, the completion of the Gyeongbu expressway construction should be delayed with the newly revised plan after lane marking work had been done.

At present, the land acquisition cost is about 40% or more of the road construction cost. However, land owners provided the land for the new expressway at a competitively low price as they thought it was a way to grow the economy by reducing the cost.

To reduce the poor quality construction, expressway construction work supervisors were designated in each work field. They took the responsibility for the review of construction work plan, actual construction work supervision and safety management. Okcheon tunnel in the Daejeon~Daegu section, one of the most difficult construction site, was collapsed 13 times during the construction. Except this, 77 people were dead during the construction since the work should be done day and night and safety concern was ignored.

In the end, Gyeongbu expressway became one of the fastest projects in the world. On the other hand, therein lies a lot of troubles by the too hurriedly constructed project which required many repair works afterward.

1.5. Financing

In the late 1960s, the damage of Korean Civil War mostly recovers and the success of the 1st Five-Year Plan brought the economic growth. Yet the expressway construction was still a large project. A lot of financing sources, not only the domestic capital but also the foreign loan, were necessary to pursue the project.

For Gyeongin expressway construction, it got a loan from Asian Development Bank (ADB). However, Gyeongby expressway faced the oppositions by foreign agents and consultants that prevented from getting a foreign loan. Thus, there was no option but taking the construction only with the domestic capital.

Considering the budget in 1967 was around 180 billion won, 43 billion won for Gyeongbu expressway project was a huge amount, almost one-fourth of the national budget. That is, it was not possible to find domestic financing sources in an easy way. The government decided to increase taxes related to cars. In particular, the gasoline tax was doubled from 100% of its

manufactured price to 200%. The government budget spending had been concentrated on the expressway, while the spending on other sectors should have been cut.

1.5.1. Gyeongin Expressway

Gyeongin expressway has a relatively short distance of 23.5km and its construction cost was not high. However, when Gyeongbu expressway construction was considered, if was in need of financing from foreign loan. It was not difficult to borrow a loan from ADB. ADB requested to establish the Korea Expressway Corporation to construct and manage expressways.

When Gyeongin expressway was planned, the estimated cost was 2.0 billion won, however, the actual cost increased to 3.38 billion won. As shown in <Table 3-6>, the government investment through car related tax and bond issuance was 1.47 billion won, the private capital was 1.28 billion won, and the ADB loan was 0.63 billion won. The private capital also joined to the investment to cover the lack of government finance. Gyeongin Expressway Co., Ltd. was newly set up, which composed of three construction companies, i.e. Hyundai Engineering & Construction, Daerim Industry, and Sambu Construction Company. The companies made an agreement with the government to get the operating right of Gyeongin Expressway after the opening.

However, since Korea Expressway Corporation (KEC) was newly established in February 1969, KEC took the responsibility for all the expressway construction and management. Therefore, KEC compensated Gyeongin Expressway Co., Ltd. for its investment cost in March 1970 and managed Gyeongin expressway thereafter.

Table 3-6 | Financing Sources of Gyeongin Expressway

(Unit: 100 million won)

Financing sources	Amount
Car related tax and bond issuance	14.7
Private capital	12.8
ADB loan	6.3
Total	33.8

Source: Korea Expressway Corporation 30 Year History, Korea Expressway Corporation, 1999

1.5.2. Gyeongbu Expressway

Korean government decided to construct Gyeongbu expressway as soon as possible. Since the planning should have been done in less than a year, the appropriate feasibility analysis could not be made. But it had difficulties in estimating the cost so the government asked the estimation of the cost into five organizations including Seoul city government, Hyundai engineering & construction, the ministry of finance, the ministry of construction, and the military engineering bureau. However, there was a huge discrepancy among the estimated numbers varied from 18 billion won to 65 billion won. For reference, the cost of Japanese expresswaywas roughly estimated at 350 billion won which was about twice the central government budget in 1967.

The top priority was to secure the financing sources. As already mentioned, the government tried to get a loan by asking IBRD to conduct the transport study. However, the IBRD study opposed the construction of Gyeongbu expressway. Instead, it proposed the expressway construction of other sections such as Seoul~Gangreung, Pohang~Busan~Soo ncheon~Yeosu~Gwangju, and Daejeon~Mokpo. IBRD suggested a $1.5 million loan only in case of those proposed sections. In the end, the foreign loan for Gyeongbu expressway turned out to be nothing.

Then the only remaining financing source was the domestic capital. All the availabledomestic financing sources should have been brought in. As shown in <Table 3-7>, car related taxes such as car excise tax, gasoline and diesel tax were increased so much. The tax was planned to cover 19.9 billion won. The bond was issued for 8.4 billion won and the government budget carried 6.7 billion won. Emphasized that the Gyeongbu expressway construction was a national project, a small proportion of the Japan reparation claims fund was invested.

As the higher economic growths than expected continued in the 1970s, the demand for Gyeongbu expressway had increased more than its estimation. As a result, the Gyeongbu expressway construction had played a great role. It was inevitable to achieve the continuous economic growth. On the other hand, it was argued that it was very risky to invest most of domestic financing sources into one mega project. If the high economic growth had not been achieved, the huge investment might have caused a serious financial difficulty.

Table 3-7 | Financing Sources of Gyeongbu Expressway

(Unit: 100 million won)

Financing sources	Amount
Car related taxes	199
Bond issuance	84
Government budget	67
Toll revenue	15
Japan reparation claims fund	27
Total	331

Sources: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012
Annotation: It shows the planned financing sources and is different with the actual ones

1.6. Operation and Maintenance

1.6.1. Establishment of Korea Expressway Corporation

For the systematic operation and maintenance of roads, laws had been organized since the early 1960s. As shown in <Table 3-8>, road related laws under the Japanese colonization were abolished and the Road Act first appeared in December 1961. Then the Toll Road Act was enacted in 1963 to open, construct, operate and maintain toll roads.

Table 3-8 | Road Related Act for Expressway Construction

(Unit: 100 million won)

Classification	Date	Purpose
Road Act	1961. 12. 27	To abolish road related laws under the Japanese colonization
Toll Road Act	1963. 11. 5	Toll charge for the financing source
Expressway Act	1970. 8. 10	Act for regulating only for expressway

Source: Homepage of The Office of Legislation (http://www.moleg.go.kr)

In the early days of expressway construction, the legislation for expressway management was not organized, so the Ministry of Construction managed it according to the existing laws such as Road Act and Toll Road Act. However, as the construction of Gyeongin expressway hascompleted in December 1968, a new organization was needed to manage the operation. Korea Expressway Corporation (KEC) was established on February 15, 1969 for the purpose. The KEC was supposed to managethe first two Gyeongin and Gyeongbu

expressways. The Expressway Act was enacted in August, 1970 for regulating expressway route designation, interchange type selection, traffic limitation, etc.

For the return on investment, the private company took control of the operation of Gyeongin expressway and it underwent sufferings from the takeover process. However, the government made an agreement with the company to cover the deficit caused by the transfer of the operating right to KEC. The process ended in March 1970, a year after the establishment of KEC. From then, the KEC has taken the whole responsibility for expressways in Korea.

1.6.2. Role of Korea Expressway Corporation

Even before the expressway construction began, the government planned the establishment of public entity to control the construction process and manage the roadHowever, the appearance of the entity was delayed because of the oppositions against the construction.

At first, the government formed the national expressway pursuit committee and construction plan task force team before KEC to conduct its role instead. However, ADB, which lent a loan for the Gyeongin expressway, put pressure on the establishment of the public entity to take in charge of the expressway construction and management. So the Ministry of Construction began to establish KEC inJuly 1968.

In the end, the KEC was established according to the KEC Act No. 2083, Presidential decree No. 3745, and KEC Act ordinance in February 1969. It was in charge of all the works related to expressways such as the toll road facility management, toll collection, construction and rehabilitation of expressways, bond issuance, etc.

1.6.3. Maintenance

When KEC went out, the systematic maintenance system was not established yet. There were 776 employees in total, nonetheless, there was almost no maintenance equipment such as snow clearing trucks. The measurement of damage in road was dependant on bare eyes.

2. Expressways in the 1970s and 1980s

2.1. Necessity of the Expressway Construction

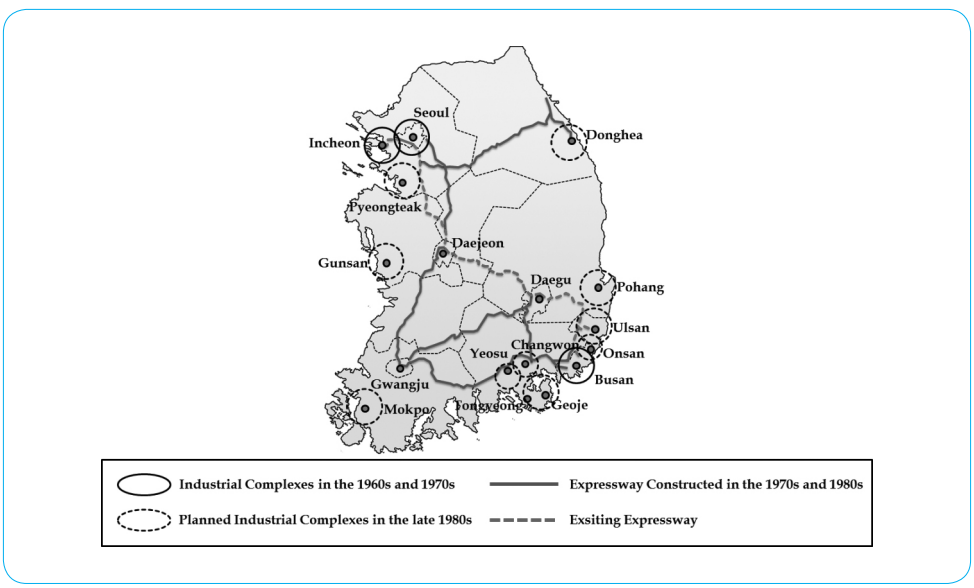
2.1.1. Development of Industrial Complexes

In 1960s, the focus of development of industrial complexes wasmainly on the light industry. And it turned to the heavy and chemical industry in 1970s for the national industrialization. In accordance with the move, Heavy and Chemical Industry Promotion

Committee was established in 1973, and the Industrial Complex Development Promotion Act was enacted and proclaimed in the same year. And the government subsidized the local companies to alleviate financial burden. Heavy and chemical industry complexes required huge developments of infrastructures such as road, port, water, and others, and were built around the coastal region considering import of raw materials. These industrial facilities were established in larger scale than the existing ones. The growth of heavy and chemical industries like steel manufacturing, oil refining and petro chemistry brought larger benefit and enriched the country. As shown in [Figure 3-3], large scale of coastal industrial complexes were constructed in the southeast region includingPohang, Onsan, Changwon, Yeosu, Tongyeong, and Geoje.

In the late-1980s, the balance of development among the cities became an issue so the development of industrial complex spreaded over the nation - the northern part of the east coast, Asan gulf of west-coast, Gunjang, and Mokpo. And they led the active development of west coast in the 1990s.

Figure 3-3 | Expressways and Industrial Complexes in 1970s and1980s



2.1.2. Change in Road Policy

After construction of Gyeongin and Gyeongbu expressway, construction of expresswaycontinued until the mid-1970s. Thus, 6 more expressways including Honam expressway, which connects Seoul and Gwangju, Yeongdong expressway between Seoul and Gangneung, Donghae expressway along the east coast, and Seohaean expressway

through the west coast, were constructed in this term. However, most of them had lower demand over less traffic compared to the huge traffic of Gyeongbu expressway,, and Yeongdong and Donghae expressway were poorly constructed with two-lane because the traffic volume deviated from the estimation. And median was not installed, and tunnel and bridge were not solid that they were exposed to the risk of accidents.

Moreover, expressway construction had stopped for a while after the mid-1970s because national road construction was supposed to precede the expressway construction. After the national road construction, pavement ratio of national road, local road, metropolitan city road, and city-district road increased from 2.2%~34.2% to 55.7%~89.1% as shown in <Table 3-9>.

Also, the critics raised their voice against the imbalanced development of nation which was caused by large industrial complex development concentrated on Seoul~Busan line. And the demand for the expansion of common roads began to increase when Gyeongin and Gyeongby expresways were completed. Accordingly road improvement projects were prioritized in 1970s and 1980s. As a result, construction ratio of the expressway was relatively low.

As the domestic economy grew because of three low booms[2] in the mid-1980s, road traffic was rapidly increased followed by huge increase of the number of vehicles. And the roads were not capable of taking the number so the need for expressway accelerated the construction again after the late 1980s.

Table 3-9 | Change of Length and Pavement Rate by Road Type in the 1970s and 1980s

(Unit: km, %)

Classification	1970	1975	1980	1985	1990
Expressway	551 (100)	1,142 (100)	1,225 (100)	1,415 (100)	1,551 (100)
National road	8,122 (28.3)	8,232 (45.5)	8,232 (55.3)	12,241 (77.1)	12,161 (89.1)
Local road	10,880 (2.2)	10,777 (7.3)	11,021 (11.0)	10,166 (37.2)	10,672 (63.6)
Metropolitan city road	5,476 (34.2)	6,767 (53.2)	7,939 (62.3)	10,018 (72.4)	12,298 (83.0)

2. Three low boom: Korean economy enjoyed unparalleled boom because of low dollar value ·low oil price·low interest rate between 1986~1988.

Classification	1970	1975	1980	1985	1990
City·district road	15,216 (4.3)	17,967 (7.5)	18,535 (12.3)	18,422 (34.9)	20,033 (55.7)
Total	40,244 (14.2)	44,885 (24.0)	46,951 (34.1)	52,264 (54.2)	56,715 (71.5)

Source: National Statistical Office(http://kosis.kr/)
Annotation: the number in brackets is a pavement rate

2.1.3. Increase in Road Demand

The 1st and the 2nd Five-Year Economic Development Plan were successfully promoted with industrial complexes and it brought higher demand for traffic capacity which increased from 2.7 billion trips in 1970 to 12.7 billion trips in 1990s.

And the number of automobile also increased. It increased from 60,000 in 1970 to 2,070,000 in 1990. The growth was dramatic since mid-1980s when GDP reached 200,000 Won (approx. $1900), and it was predicted that the number would be greater in 1990s.

Table 3-10 | The Change of the Road Demand and the Number of Automobile in the 1970s and 1980s

(Unit: 10 thousand trips, 10 thousand tons, 1 thousand vehicles, 1 thousand won /person)

Classification		1970	1975	1980	1985	1990
Road demand	Passenger	274,377	454,274	803,901	1,060,105	1,272,188
	Freight	6,178	8,453	10,453	14,870	21,513
Number of automobile		61	84	249	557	2,075
GDP per person		90	302	1,046	2,119	4,409

Source: National Traffic DB Center(http://www.ktdb.go.kr/), National Statistical Office(http://kosis.kr/)
Annotation: 1) Road demand of passenger is the demand of express bus, intercity bus, intercity bus, chartered bus, taxi demand
2) Road demand of freight is the demand of commercial truck

2.2. Planning

2.2.1. Mid- and Long-Term Traffic Plan Establishment

Mid-and long-term plans of expressway construction were led by the central government in the 1970s and 1980s. MLTM, the competent ministry of expressway construction, planned the First National Land Development Plan, which is the nation's top priority, in

1972. The early National Land Development Plan was designed on 10 years basis, and the 1st and 2nd Five-year Economic and Social Development Plans were promoted around these 10 years. The expressway construction plan was established as the National Land Development Plan. The first five-year Economic and Social Development Plan included 1,944km of expressway construction. In the second five-year Economic and Social Development Plan, a new 346.1km long expressway and the expansion of already existing 466.5km of expressway were included.

2.2.2. Feasibility Analysis by the Competent Ministry

During this time period, expressway construction plans were not so different from those related to earlier expressways, and planning based on initial feasibility analyses was not yet the norm. Initial planning was conducted based on rough consideration of topography and status of land usage, with final plans being executed after conducting feasibility analyses. Deferred feasibility analyses was largely due to the absence of proper scientific method usage, leading to inaccuracy of the feasibility tests. However, expressway construction plans did not face many issues, as economic development was being achieved at a rapid pace and expressway construction was not yet being implemented in large scale. The limited expressways that had been planned were successfully able to be constructed.

Expressway plans were established through two phases of planning: logistics demand planning and systematized national truck road network planning, respectively. However, because these plans were made prior to the establishment of a database for traffic analysis, The IBRD appointed a road director as the Head of the Road Analysis Team in 1972 to efficiently manage the fund upon its introduction in 1970s, and to also take charge of feasibility analyses and drawings for road construction and improvement. Although the scientific feasibility analysis method had not yet been developed, professional opinions were beginning to be reflected in planning process, as opposed to those of government leaders.

2.3. Development of Expressway Design Criteria

The Namhae and Yeongdong Expressways were constructed as two-lane expressways, and were built smaller in size than the Gyeongin and Gyeongbu expressways. This occurred to most expressways constructed between 1970 and 1980 because funding came from IBRD loans and low design standards were applied after conducting economic, technical, and financial feasibility analyses based on IBRD loan project guidelines. The Yeongdong and Namhae expressways were constructed with the lowest standards, worse than criteria used to construct both the Gyeongin and Gyeongbu expressways. The first road design guidelines

were published in 1976 and systematized after amending 'The Act of Road Structure' in November 1979, that added design guidelines for vehicle-based roads.

Comparing the 'Road Design Guidelines' developed in 1976 to the design standards of the Gyeongbu expressway as shown in <Table 3-11>, the class of expressways improved from three levels to four levels. The design standards of the Gyeongbu expressway were classified into flat, hilly, and mountainous areas from one to three levels, but 'The Road Design Guideline' stopped at just the flat and mountainous classifications, with traffic loads limited to levels one through four. Design specifications for speed of the Gyeongbu expressway were 80km/h, while 'Road Design Guideline' specifications were 60km/h. The effective width of the minimum shoulder was also lowered from 2.5m to 1.75m, the minimum median strip width was lowered from 2.0m to 0.75m, and the minimum flat curve radius was lowered from 300m to 200m.

Due to these lower design standards, poor driving environments of the Yeongdong and 88 Expressways caused frequent accidents. In particular, the Yeongdong expressway experienced frequent accidents due to poor driving conditions, including sharp curves and steep slopes. The Yeongdong Expressway and 88 Expressway recorded high deaths per 100 traffic accidents of 25.9 persons and 23.6 persons, respectively. In order to reduce accidents, curve straightening projects were executed between 1995 and 2000.

In addition, most expressways built in the 1970s including the Gyeongin and Gyeongbu Expressways were paved with asphalt. Although asphalt pavement has lower tolerance for heavy vehicles and thus requires more frequent maintenance than concrete pavement, asphalt is more widely used as it is cheaper and easier to construct than concrete. However, as the domestic concrete industry developed toward the late-1970s, paving with concrete became cheaper, allowing wider use of concrete pavement, staring with Namhae Expressway.

Table 3-11 | Design Criteria in Road Design Ordinance of 1976

Classification	Gyeongbu Expressway		Road Design Ordinance of 1976		
Classification Level	Level 1	Flatland	Level 1	over 30,000 vehicles (flatland)	
			Level 2	10,000 ~ 30,000 vehicles (flatland)	
	Level 2	Hill land		over 30,000 vehicles (mountain area)	
			Level 3	under 10,000 vehicles (flatland)	
	Level 3	Mountain area		10,000 ~ 30,000 (mountain area)	
			Level 4	under 10,000 (mountain area)	
Design Speed	Level 1	120km/h	Level 1	120km/h	
			Level 2	100km/h	
	Level 2	100km/h			
			Level 3	80km/h	
	Level 3	80km/h			
			Level 4	60km/h	
Design Load	15t		15t		
Effective Shoulder Width	2.5m		Level 1	3.0m	
			Level 2	3.0m	
			Level 3	2.5m	
			Level 4	1.75m	
Minimum Curve Radius	Level 1	600m	Level 1	1,000m	
			Level 2	700m	
	Level 2	400m			
			Level 3	400m	
	Level 3	300m			
			Level 4	200m	
Median Strip	2.0m			Standard	Reduction
			Level 1	3.0m	1.5m
			Level 2	3.0m	1.5m
			Level 3	2.0m	1.25m
			Level 4	2.0m	0.75m

Source: Seoul~Busan Construction Report, Korea Expressway Corporation, 1974
Road Design Ordinance, Korea Expressway Corporation, 1976

2.4. Construction

Most expressways constructed during the 1970s and 1980s were originally planned to connect newly developed industrial complexes and major cities, rather than Seoul and Busan. Large industrial complexes were developed during the rapid economic growth in the 1970s and 1980s, with expressway construction plans executed in parallel, as traffic volumes among large cities and industrial complexes increased. As such, the Namhae Expressway was constructed in 1973 to connect coastal industrial complexes in the south, and Donghae expressway was constructed two years later in 1975 to connect coastal industrial complexes in the east.

As there was little demand for new expressway construction to connect major cities other than Seoul and Busan, the Yeongdong Expressway was constructed with two lanes to connect the Yeongdong region in 1971. Similarly, the Honam Expressway was constructed to connect the Seoul-Honam region in 1973. The 88 Expressway was constructed in 1984 to connect the southeastern region of Gyeongsang and the southwestern region of Honam. With completion of those expressways, the expressway network enabled commuters to connect nationwide.

Revisiting the bigger picture, large industrial complexes were constructed in line with the active economic growth of the 1970s and 1980s, and expressways were constructed to connect those industrial complexes to facilitate a national expressway network and balanced economic development of the nation. The Namhae, Honam, 88 Expressways and nine other expressways with 1,029km total roadway were constructed, and the connection of all capital areas through this basic expressway network became possible. The Joongbu Expressway was the first expressway to be built after a brief halt of expressway construction following the mid-1970's, with its purpose being to mitigate traffic congestion in the Seoul metropolitan area. The 88 Expressway was also extended to connect Yeongnam with Honam.

Domestic construction companies conducted approximately 691 overseas road construction projects, starting with the Pattani-Narathiwat expressway in Thailand in 1965 and various road expansion projects during the Middle East boom of the late 1970s and early 1980s. These overseas road construction projects improved the technologies of domestic construction companies, which were then used to build out subsequent expressways in Korea.

Heavy rains in September 1979 destroyed and buried twenty-four parts of the domestic expressway system, significantly cutting off traffic flow. Although the Namhae Expressway was originally designed to hold up to 8.2t for five years, there were frequent re-pavements. According to media reports in 1985, within a year of opening the 88 Expressway,

approximately 100~200m of the expressway disappeared entirely and urgent repairs were needed on more than forty sections. This raised questions of whether construction companies actually constructed based on best-practice standards and also made it necessary to create a system to supervise highway construction projects.

Table 3-12 | Expressway Construction in the 1970s and 1980s

(Unit: km, year)

Line	Length	Opening Year
Yeongdong Expressway	234	1971
Namhae Expressway	189	1973
Honam Expressway	248	1973
Donghae Expressway	60	1975
88 Olympic Expressway	181	1984
Joongbu Expressway	117	1987
Total	1,029	-

Source: Korea Expressway Corporation Homepage (http://www.ex.co.kr)

2.5. Funding Sources

2.5.1. Large Scale Foreign Loan

Foreign loans were difficult to receive up until the mid-1960s. However, the successful construction of the Gyeongin and Gyeongbu Expressways helped with the introduction of foreign loans. The deployment of the Korean Army to the Vietnam War also made funding of foreign loans from advanced countries possible. US loans granted to Korea due to the deployment of the Korean Army sharply increased funding for road projects and expressway constructions. Funding from foreign loans amounted to approximately $59 million for the construction of the Jeonju-Suncheon sections of the Honam Expressway, the Busan-Suncheon sections of Namhae Expressway, Saemal-Gangneung sections of the Yeondong Expressway, and the Gangneung-Mookpo sections of the Donghae Expressway. This funding accounted for approximately 35% of the total construction costs of these expressways. Most expressways constructed in the 1970s and 1980s were funded with foreign loans from the ADB and IBRD.

Table 3-13 | Foreign Loan for Expressways Constructed in the early 1970s

(Unit: domestic capital: 1 million won, foreign capital: $1,000)

Line	Opening Year	Total cost	Domestic Capital	Foreign Capital
Yeongdong Expressway	1971	22976 (100)	18384 (80.0)	11480 (20.0)
Namhae Expressway	1973	22,273 (100)	12,490 (56.3)	25,073 (43.7)
Honam Expressway	1973	22,892 (100)	16,022 (70.0)	17,927 (30.0)
Donghae Expressway	1975	7,436 (100)	2,086 (28.0)	5,350 (72.0)
Total		75,577 (100)	48,982 (64.8)	59,830 (35.2)

Source: 2011 White Paper on Road, Ministry of Land, Transport and Maritime Affairs, 2012
Annotation: Percentage compared to total cost

2.5.2. Domestic Financing Sources since 1980s

The rate of expressway construction was high during the 1970s and sharply slowed down during the late-1970s. This phenomenon continued until the 1980s, after which the construction of expressways continued at a moderate pace. Dependency on foreign loans decreased substantially during this period as well as Korea's GDP per capita passed $2,000 during the 1980s. Required capital was funded by the Korean Government and the Korea Expressway Corporation, with toll revenues on existing expressways being used to pay for expressway construction as well.

After the 1970s, domestic road investment budgets were actually decreased due to government policies to invest into industrial development sections for economic development. Furthermore, these road investment budgets were used to expand and pave national and local roads rather than expressways. Road investments as a percentage of GDP consistently decreased from 1.09% in 1970 to 0.53% in 1980, and has only recovered marginally since 1985.

Table 3-14 | Analysis of Road Investment Cost Against GDP

(Unit: 100 million won)

Classification	1970	1975	1980	1985	1990
Road Investment (A)	302	554	1,247	4,572	12,967
GDP (B)	27,751	104,778	391,096	856,991	1,913,828
Proportion (A/B)	1.09%	0.53%	0.32%	0.53%	0.68%

Source: Road Work Handbook, Ministry of Land, Transport and Maritime Affairs, 2011

2.6. Operation and Maintenance

Operation and Maintenance systems were established to preserve road functions, to promote convenience and safety of passenger cars on expressways constructed during the 1970s and 1980s. and to repair damaged roads. The number of employees employed by the Korea Expressway Corporation greatly increased from 2,255 in 1980 (three times more than when the company was founded) to 3,553 in 1990.

While there were various improvements in administration including the introduction of new snow removal techniques, limiting overloaded vehicles, communication networks for operations and maintenance, and traffic accident statistic databases, high technology operation and maintenance systems had not yet been established.

3. Expressway in the 1990s and 2000s

3.1. Necessity of Expressway Construction

3.1.1. Development of Industrial Complexes and the Balanced Development of the Nation

Expressway construction was heavily influenced by the build-out of industrial complexes during the economic development before 1990. After the 1990s, road policy was changed so that it would fit a more balanced development of the nation, as industrial complex construction began to slow.

Until the 1980s, expressways were mainly constructed for national economic developments by connecting industrial complexes. From the 1980s to the 1990s, road policies planned increases in total length of roads in major cities to mitigate traffic congestion, as traffic congestion increased due to the rapidly increasing number of cars.

The national expressway network had been constructed in and around the capital area of Korea, while excessive concentration of traffic volume grew via the development of the Gyeongbu axis through the late 1990s. The necessity of expressway construction based on a balanced development of the nation continued to increase as well. Under these circumstances, the expressway master plan based on the 7×9 axis expressway network, which consisted of seven South-North axes and nine East-West axes, was developed. In the expressway master plan, there was a concept to form the entire nation into a half-day zone. The 7×9 axis expressway network was a plan to build the country into a single zone that can access the expressway within thirty minutes, from anywhere in country. Under this plan,

1,853km of road across 19 expressway lines was constructed, with most of this construction taking place during the 1990s and 2000s.

Traffic congestion had been severe since the 1980s due to insufficient investments into the transport industry. This led to increased financing for Korea's transportation infrastructure and expressway construction during the 1990s and 2000s.

3.1.2. Increase in Traffic Volumes

Traffic volumes and the supply of cars greatly increased along with high economic growth from the 1980s to the 1990s. However, the number of passenger using roads decreased from 1990 to 2010 as shown in <Table 3-15>, due to only public transportation demand being shown (individual transportation demand has been excluded from this chart). In fact, the number of cars on the road and traffic volumes rapidly increased. As the result of this increase, traffic congestion became a very serious issue, and the necessity of road construction became critical during the 1990s.

The rate of vehicle volume growth decreased in the 2000s when compared to the 1990s due to a significantly larger base of vehicles being established during the 1990s. The nominal number of growth in vehicle volume increased significantly.

Table 3-15 | Change of Traffic Volume and the Number of Automobiles in the 1990s and 2000s

(Unit: 10 thousand trips, 10 thousand tons, 1 thousand vehicles)

Classification		1990	1995	2000	2005	2010
Traffic Volume	Passenger	1,272,188	1,128,951	1,041,058	880,184	964,640
	Freight	21,513	40,837	49,617	52,600	61,953
Number of automobile		2,075	6,006	8,084	11,122	13,632

Source: National Traffic DB Center(http://www.ktdb.go.kr/), National Statistical Office(http://kosis.kr/)

Annotation: 1) Traffic Volume of passenger is the volume of express bus, intercity bus, intracity bus, chartered bus, and taxi

2) Traffic Volume of freight is the volume of commercial truck

3.1.3. Change in Road Policy

Financing sources for expressway construction were greatly increased during the mid-1990s through the introduction of the traffic tax and account for transport infrastructure. Through increasing financing sources, expressway construction was actively promoted through continual consideration of balanced national development.

As shown in <Table 3-16>, the total length of actual expressways increased greatly from 1,551km in 1990 to 3,859km in 2010. During the 2000s, after the traffic tax and account for transport infrastructure had been introduced, the total length of expressways increased by almost two times from 2,121km to 3,859km in 10 years. Expressway facilities also became larger through many extension works. In <Table 3-17>, the total length increased almost four times from 4,928km to 17,926km. Not only expressways, but also the construction of national and local roads were actively promoted, leading to the increase in total length of two-lane expressways from 1.5 times and 3.1 times during the 1990-2010 period.

Table 3-16 | Change in Length and Pavement Rate by Road Type in the 1990s and 2000s

(Unit: km, %)

Classification	1990	1995	2000	2005	2010
Expressway	1,551 (100)	1,825 (100)	2,131 (100)	2,968 (100)	3,859 (100)
National road	12,161 (89.1)	12,053 (99.5)	12,413 (98.2)	14,224 (97.3)	13,812 (98.0)
Local road	10,672 (63.6)	13,854 (72.2)	17,151 (78.3)	17,710 (79.0)	18,180 (82.0)
Metropolitan city road	12,298 (83.0)	14,082 (90.6)	17,839 (88.7)	17,506 (99.4)	18,878 (99.0)
City-district road	20,033 (55.7)	32,424 (61.6)	39,240 (60.4)	49,885 (60.9)	50,835 (65.0)
Total	56,715 (71.5)	74,237 (76.0)	88,775 (75.8)	102,293 (76.8)	105,565 (80.0)

Source: National Statistical Office (http://kosis.kr/)

Annotation: the number in brackets is a pavement rate

Table 3-17 | Change in Paved Road Length Based on Two-Lane in the 1990s and 2000s

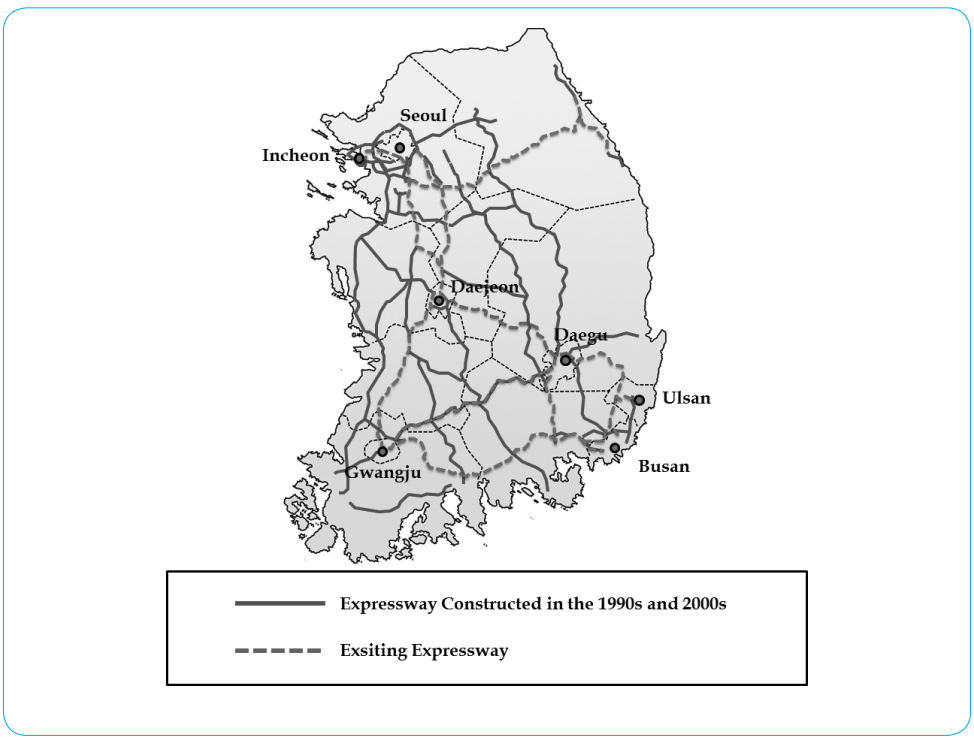
(Unit: km)

Classification	1990	1995	2000	2005	2010
Expressway	4,928	6,147	9,120	13,299	17,926
National Highway	27,675	29,223	33,622	39,988	42,690
Local Road	21,559	19,921	29,154	36,662	67,366
Metropolitan City Road	30,684	34,492	45,876	49,057	53,192

Classification	1990	1995	2000	2005	2010
City-District Road	42,184	50,677	55,530	70,998	82,688
Total	127,029	140,460	173,302	202,894	263,862

Source: Yearbook of Road Statistics, Ministry of Land, Transport and Maritime Affairs, 1990~2011

Figure 3-4 | Expressway Constructed in 1990s and 2000s



3.2. Planning

3.2.1. Mid- and Long-Term Plans of the Competent Ministry and Problems of Feasibility Analysis

During the 1980s, heavy traffic congestion was largely due to a rapid increase in registered cars. The Ministry of Land, Transport and Maritime Affairs (MLTM) announced the 7×9 axis expressway network plan in the 3rd Comprehensive National Land Development Plan in 1992. Most expressways constructed during the 1990s and 2000s were mainly established under the 7×9 axis expressway network plan.

The plan for a national arterial network suggested that 5,000km of expressway was needed. This meant that more than 3,520km expressway needed to be constructed. The driving force behind this excessive expressway construction plan was the competent ministry, MLTM. Feasibility analyses of expressways were also advantageously promoted.

3.2.2. Establishment of the National Transportation DB

Despite feasibility analyses conducted by the MLTM, financing sources could not cover all construction plans at that time. As criticisms of the excessive plan increased, more objective feasibility analysis methods were demanded. The national transportation database was built to satisfy this need.

The reliability of feasibility analyses conducted before development of the transportation database was very low due to existing databases having been built by non-public organizations. The new database was developed by the Korean Government, securing objectivity and reliability of the analyses.

3.2.3. Preliminary Feasibility Analysis by Budget Ministry

As expressway construction continued to require many financing sources, national finances were insufficient to continuously promote a high number of expressway construction plans. As insufficient funding limited the ability to execute the many expressway construction plans created by MLTM, a new method of expressway feasibility analyses was necessary in order to determine which expressways should be prioritized for construction.

The decision to create a budget ministry-led feasibility analysis system in 1999 was driven by the belief that the budget ministry would be more effective than the MLTM in managing such a system. The preliminary feasibility analysis system was utilized for projects with total project cost of over 50 billion won and financial support from the federal government of over 30 billion won. It was a system used to evaluate feasibility in advance of promotion of a major project. This system played a great role in establishing effective planning.

Ever since the establishment of a national database in the late-1990s, more scientific and objective analyses has been made possible, rather than previous individual feasibility analyses. The database consisted of a nation-wide database and a database for six metropolitan areas, making it possible to select and use a proper database for large scale projects.

3.2.4. Individual Project Management by the Budget Ministry

Expressway construction plans as a part of the Comprehensive National Land Development Plan was judged by a preliminary feasibility analyses conducted by the budget

ministry. All expressways in the plan could not be constructed considering limited national finance. Given not all sections of the 7×9 axis expressway network plan would experience sufficient travel demand in the immediate term, some sections of the expressway plan have not yet been considered for construction. The complete opening of 7×9 axis expressway network remains difficult.

3.3. Design Criteria

In order to properly review expressway design criteria during the 1990s and 2000s, criteria in the 'Guideline of Expressway Construction Management and Maintenance' revised in 1992 was used as a primary reference document. Expressway design criteria created during the 1990s were more standardized than criteria used in the past, marking a great improvement in design standards compared to considerably lower design standards implemented during expressway construction during the 1970s. Standards regarding road alignment and geometric structure, including aspects such as design speed, minimum radius, minimum number of lane, and structure installation were greatly improved.

Expressway design standards first implemented in 1976 were revised in 1992. A study comparing the Road Design Ordinance created in 1976 and the Guideline of Expressway Construction Management and Maintenance created in 1992 found a number of significant differences in design criteria. The biggest difference between the two guidelines was that the criteria of expressway grade disappeared, and design speed criteria were now categorized by level, mountain area, and city area. Design speeds in mountainous and city areas were included in the lowest grade as 100km/h, with minimum radius being upgraded to 460m in the 100km/h section. This meant that expressways were changed to be more linear in direction.

The MLTM changed the criteria of minimum expressway lane count to four lanes because of significant cost increases from constructing two-lane expressways using the 1992 criteria on geometric structures. As the regulation of constructing an additional climbing lane[3] was added, expressway capacity improved considerably. Within the geometric structure criteria, criteria regarding medians were also changed. In the past, there was either no median or the median was constructed as a trappable curb. This presented the danger of vehicles crossing the median and causing fatal crossover collisions. However, the revised guidelines regulated median construction such that they could only be built as green belt, guardrail, and concrete barriers to increase safety. In addition, as truck became more oversized via the development of the auto industry, design loads for expressways were also upgraded from 15t to 40t.

3. Additional climbing lanes are constructed largely in hilly sections of expressways in order to mitigate traffic flow interruptions, as large vehicles cannot travel as fast in mountainous areas.

Expressways constructed after the 1990s were more sophisticated and standardized compared to those constructed during the 1970s and 1980s. These improvements were largely attributed to major changes in design criteria presented in the Guideline of Expressway Construction Management and Maintenance created in 1992.

Table 3-18 | Expressway Design Criteria in Road Design Ordinance in 1992

<table>
<tr><th>Classification</th><th colspan="2">1976 Road design ordinance</th><th colspan="2">1992 Road design ordinance</th></tr>
<tr><td rowspan="4">Design Speed</td><td>level 1</td><td>120km/h</td><td>Level</td><td>120km/h</td></tr>
<tr><td>level 2</td><td>100km/h</td><td>Mountain area</td><td>100km/h</td></tr>
<tr><td>level 3</td><td>80km/h</td><td rowspan="2">City area</td><td rowspan="2">100km/h</td></tr>
<tr><td>level 4</td><td>60km/h</td></tr>
<tr><td>Design Load</td><td colspan="2">15t</td><td colspan="2">less than 40 tons
(Design standard vehicle weight)</td></tr>
<tr><td rowspan="4">Effective Shoulder Width</td><td>level 1</td><td>3.0m</td><td colspan="2" rowspan="4">Minimum 3.0m</td></tr>
<tr><td>level 2</td><td>3.0m</td></tr>
<tr><td>level 3</td><td>2.5m</td></tr>
<tr><td>level 4</td><td>1.75m</td></tr>
<tr><td rowspan="4">Radius of Level Curve</td><td>level 1</td><td>Minimum 1,000m</td><td>120km/h</td><td>Minimum 710m</td></tr>
<tr><td>level 2</td><td>Minimum 700m</td><td rowspan="3">100km/h</td><td rowspan="3">Minimum 460m</td></tr>
<tr><td>level 3</td><td>Minimum 400m</td></tr>
<tr><td>level 4</td><td>Minimum 200m</td></tr>
<tr><td rowspan="5">Median Strip</td><td>Standard</td><td>Reduction</td><td>Regional part</td><td>Minimum 3.0m</td></tr>
<tr><td>3.0m</td><td>1.5m</td><td rowspan="4">City part</td><td rowspan="4">Minimum 2.0m</td></tr>
<tr><td>3.0m</td><td>1.5m</td></tr>
<tr><td>2.0m</td><td>1.25m</td></tr>
<tr><td>2.0m</td><td>0.75m</td></tr>
</table>

Source: Road Design Ordinance, Korea Expressway Corporation, 1976~1992

3.4. Construction

A total of twenty-one lines amounting to 2,225km of expressway were planned for construction during the 1990s in order to solve the ever increasing issue of traffic congestion. This level of expressway construction led to construction costs exceeding budgets for expressway construction. As a result, investable funding for each expressway

decreased. Total construction periods were extended, and inefficiencies were created by delayed expressway completion.

In one case, delays lasted up to one year and nine months, relative to initial expected completion dates <Table 3-19>.

Many of these issues stemmed from the MLTM, which as the principal planning agency, wanted to build more expressways, without considering budget constraints In 1999, it became possible to review expressway feasibility more objectively by introducing preliminary feasibility analyses, which led to the improvement of this ineffective promotion system.

3.4.1. Introduction of Supervision System

In 1990, the government introduced the 'Construction Supervision System', mandating private supervision companies to perform construction supervision in order to prevent poor construction. However, an accident involving the collapse of the New Haengju Bridge and Cheongju Wooam Apartment occurred in early 1990. Due to these accidents, the government introduced the 'Responsible Supervision System', raising oversight responsibilities for the 'Supervision Bureau' in January 1994.

The Supervision system included the responsibility to check that construction was executed as designed, without violating the related laws.

The 'Responsible Supervision System' is a system that enforces comprehensive supervision for projects that are considered necessary for supervision review by the Korea Expressway Corporation and the MLTM. These projects typically total construction costs of over 20 billion won. Areas of supervision are classified into direct supervision, responsible supervision, partial responsible supervision, construction supervision, and confirmatory supervision. Major components of each type of supervision are as follows:

- Direct Supervision: Employees belonging to the agency mandating construction performs the supervision
- Responsible Supervision: Supervision authorities belonging to the agency mandating construction supervise all aspects of the project including quality, construction, processing, safety and environmental management
- Construction Supervision: The main task is to teach skills and train regarding safety, construction management, and confirmatory supervision
- Confirmatory Supervision: The main task is to confirm quality management and overall construction quality

Table 3-19 | Expressway Construction in the 1990s and 2000s

(Unit: km, year)

Line	Length	Opening year
2 lines excluding Jungang expressway	424	1990~1995
2 lines excluding Daejeon-Tongyoung expressway	339	1996~2000
5 lines excluding Seohaean expressway	658	2001~2005
8 lines excluding Jungbu Inland expressway	844	2006~2010
Total	2,265	-

Source: Korea Expressway Corporation Homepage (http://www.ex.co.kr)

Table 3-20 | Example of Expressway Construction Delay in the 1990s and 2000s

(Unit: year)

Name of Line	Initial section beginning	Completion goal	Completion	Delayed period
Outering Expressway of Seoul	1988.4	1990.12.31	1991.11.29	11 months
Jungang Expressway	1989.11.06	1993.12.31	1994.12.12	1 year
Daejeon Nambu ring Expressway	1994.02.06	1997.12.31	1999.09.06	1 years 9 months

Source: Korea Expressway Corporation Homepage (http://www.ex.co.kr)

3.5. Financing Procurement

In the 1990s and 2000s, as expressway constructions continued to pick up speed in order to resolve serious traffic congestion issues stemming from the 1980s, significant financing also became necessary. In order to finance an ever increasing amount of projects, transport taxes on gasoline and diesel were introduced in 1993 as the primary financing source for transport infrastructure. Any insufficient funding was covered by a private investment system implemented in 1994.

Road investments as a percentage of GDP greatly increased with the expansion of financing for transport infrastructure beginning in 1990, increasing by 1.25% in 2000, approximately two times more than the 0.68% in 1990. However, as investments into SOC have been reduced, road investments have also recently decreased.

Table 3-21 | Road Investment against GDP

(Unit: 100 million won)

Classification	1990	1995	2000	2005	2010
Road investment	12,967	33,715	75,331	76,614	77,817
GDP	1,913,828	4,096,536	6,032,360	8,652,409	11,732,749
Road investment cost compared to GDP	0.68%	0.82%	1.25%	0.89%	0.66%

Source: Road Work Handbook, Ministry of Land, Transport and Maritime Affairs, 2011

3.5.1. Ear-Marked Tax and Account for Transport Infrastructure

As the number of registered cars rapidly increased by an annual average of over 20%, heavy traffic congestion became a serious issue during the 1980s. With this traffic congestion came an increasing need for additional road construction. In order to secure financing sources to consistently increase transport infrastructure, transport taxes ear-marked for transport infrastructure investments were imposed on gasoline and diesel in 1993. These taxes were initially introduced as a ten year temporary tax, due to natural inefficiencies imbedded in ear-marked tax structures. However, due to continuous financing issues, the traffic taxes were extended and continue to be in place today. Funding amounts have increases substantially since 1990, as traffic taxes account for approximately 70% of total financing sources for transport infrastructure. This increase in funding led to an active period of expressway construction during the 1990s and 2000s.

Uses for ear-marked taxes in the transport infrastructure space began to expand in 1993. Ear-marked taxes funded by gasoline taxes began to fund not only road constructions, but urban railway, high-speed railways, airport and seaport projects as well.

As the introduction of the traffic tax and account for transport infrastructure were able to act as secure stable financing sources for transport infrastructure as shown in <Table 3-22>, it was now possible to cover the rapidly increasing traffic demand via responsive construction of transport infrastructure. Before introducing the ear-marked tax concept, financing sources for transport infrastructure was 0.14 billion won in 1990. After introducing the ear-marked tax concept, this financing amount significantly increased to 0.62 billion won in 1995. However, there remains some concern about the ineffective utilization of this transport tax, as ear-marked taxes are only investable into transport infrastructure.

Ear-marked taxes and accounts have been critical for securing sufficient financing for construction of a rapidly increased transport infrastructure. However, the ear-marked tax structure may be an inefficient investment method due agency problems and should be

managed carefully by regulatory bodies. In addition, as it is difficult to abolish earmarked tax plans and special accounts already introduced, it is also necessary to consider defining proper standards regarding temporary management and extensions of these accounts.

Table 3-22 | Analysis of Tax Revenue included in Financing Sources of Transport Infrastructure

(Unit: 100 million won)

Classification	1980	1985	1990	1995	2000	2005	2010
Transport tax	-	-	-	33,718	84,036	102,878	139,701
Automobile individual consumption tax	206	887	4,188	10,190	6,075	6,810	11,563
Liquor tax	2,977	5,012	10,217	18,404	22,542	23,522	23,759
Total(A)	3,183	5,899	14,405	62,312	112,653	133,210	175,023
GDP(B)	391,096	856,991	1,913,828	4,096,536	6,032,360	8,652,409	11,732,749
A/B	0.81%	0.69%	0.75%	1.52%	1.87%	1.54%	1.49%

Source: National Tax Statistics Annual Report, National Tax Service

3.5.2. Private Capital Investment System

Private capital investment system is a system for introducing private capital into a social goods project such as roads, railways, schools, sewerage arrangements, etc., that a private company builds and operates rather than a government entity. In Korea, the private capital investment system was implemented in 1994 by the enactment of the 'Act on Private Capital Inducement in Social Overhead Capital Facilities'. This bill was promoted for the introduction of private capital into public goods services because the limited government funding for such projects could not cover urgent demand.

As Korea introduced earmarked taxation, transportation infrastructure funding increased greatly. Even with this increase, however, the government could not completely finance all of its roadway construction initiatives because of the numerous plans that were in the pipeline, especially in regards to the 7×9 axis expressway network in the 1990s and 2000s. To solve this problem, the government introduced a private capital investment system for complementary financing of transport infrastructure. The private capital investment system allowed the government to raise the required capital from the private sector in order to build and operate these planned public facilities. In addition, this system also benefited these public goods projects by introducing the operational efficiencies of the private sector while also being completed earlier than it would have taken the government if no private funding was used.

'Private Capital Inducement Act' was enacted in 1994, and later revised into the 'Private Capital Investment Act for Social Overhead Capital Facilities' in 1997. Following this, the Minimum Revenue Guarantee (MRG) instruction was introduced in 1999. MRG is the system that guaranteed private investors a minimum operational revenue in exchange for their participation in a public project. If actual operational revenues did not meet an agreed upon minimum, the government covered the difference. After the introduction of the MRG instruction, private capital investment projects increased significantly. The percentage of private capital investments against total government financial investments of Social Overhead Capital was 1.2% until 1997, which increased by 16.8% in 2007.

Table 3-23 | An Increase of Private Capital Investment

(Unit: 100 billion won, %)

Classification	1995~97	1999	2001	2003	2005	2007	2009
SOC investment(A)	25.6	12.2	15.2	17.6	18.3	18.4	25.5
Financial investment	25.3	11.7	14.2	16.0	15.8	15.8	22.0
Private investment(B)	0.3	0.5	1.0	1.6	2.5	2.7	3.5
Proportion(B/A)	1.2	4.1	6.6	9.1	13.7	14.7	13.7

Source: Korea Expressway Corporation Homepage (http://www.ex.co.kr)

For minimum revenue guarantee projects, it was expected that there would not be a significant difference between expected revenue and actual revenue. This, however, was not the case in practice, as there was a huge discrepancy between expected revenue and actual revenue, which became a huge financial burden for the government. As a result, the act related to private capital investment was revised into the 'Private Capital Investment Act for Social Infrastructure,' and MRG on private proposal projects was abolished in 2005. Since 2009, MRG on government-notified projects was also abolished, and MRG disappeared altogether from private capital projects.

Table 3-24 | History of Private Capital Investment

Year	Content
1994	• Enactment of 'Private Capital Inducement Act'
1997	• Revised into 'Private Capital Investment Act for Social Overhead Capital Infrastructure'
1999	• Introduction of MRG (Private proposal project, National notification project)

Year	Content
2005	• Revised into 'Private Capital Investment Act for Social Infrastructure' • Abolition of MRG (Private proposal project)
2009	• Abolition of MRG (National notification project)

As MRG was introduced in the expressway project, private capital investment was actively promoted. Beginning with the Incheon International Airport Expressway construction, private capital expressways of 8 lines over 390km were constructed in the 2000s.

Private capital investment systems are helpful in gathering the capital needed to supply social overhead capital facilities on a timely manner. However, unconditional guarantees of revenues like MRG systems act to decrease the efforts of private companies in the efficient and successful operations of those facilities, and can therefore be a waste of national funding.

Table 3-25 | Private Capital Expressway

(Unit: vehicle)

Line	Length	Opening year	Line
Incheon International Airport expressway	36.6	2000	6~8 lines
Cheonan-Nonsan expressway	82.0	2002	4 lines
Daegu-Busan expressway	82.1	2006	4 lines
Seoul beltway around	36.3	2006	8 lines
Busan-Ulsan expressway	47.2	2008	4~6 lines
Yongin-Seoul expressway	22.9	2009	4~6 lines
Incheon bridge	21.4	2009	2~6 lines
Seoul-Chooncheon expressway	61.4	2009	4~8 lines
Total	389.9	-	-

Source: National Statistical Homepage (http://www.kostat.go.kr)

Box 3-3 | Introduction of Private Capital Investment System

Private capital investment system is a system for introducing private capital into a social goods project such as roads, railways, schools, sewerage arrangements, etc., that a private company builds and operates rather than a government entity. In Korea, the private capital investment system was implemented through the enacting of the 'Act on Private Capital Inducement in Social Overhead Capital Facilities' in 1994. This bill was promoted in order to introduce private capital, because constrained government budgets could not cover urgent spending demands.

The combination of early private capital investment systems and Minimum Revenue Guarantee (MRG) systems together introduced some problems, however. MRG is the system that guarantees a minimum revenue amount for the private investor from a particular public goods project, the difference of which is payable by the government. It can be seen that this may be desirable for the vitalization of private capital projects, but the resulting moral laxity of private investors through excessive demand estimation significantly increases the financial burden of a national budget. Because government budgetary spending increased too much as a result of MRG enactment in 1999, Korea abolished this system completely in 2009.

Private capital investment systems are helpful in gathering capital for the supply of social overhead capital facilities in a timely manner. However, when structured in such a way that private companies need not assume operational responsibility like with the MRG system, such a system can create significant capital waste of national budgets.

3.6. Operation and Maintenance System

3.6.1. A Principal of Private Operation

The Korea Expressway Corporation has been responsible for all expressway operations since the Korea Expressway Corporation was established in 1969. However, with the introduction of the private capital investment system in 1994, the operations of roads developed through private capital investments were conducted by private companies. Starting with the Incheon International Airport Expressway constructed in 1995 and later opened in 2000, 8 lines of private capital expressways were constructed in the 1990s and 2000s. With this, the first privately funded and operated expressways in Korea appeared.

With the opening of privatized expressways, appropriate tolls needed to be calculated and agreed upon by the Korea Expressway Corporation and private companies. As the operating organizations and toll rates were different, the final toll charged to the public was calculated using the distance and toll rate.

3.6.2. Advanced Operation System

Intelligent Transport Systems were integrated into Korea's expressways starting in 1993, focusing primarily around Traffic Management Systems and Electronic Toll Collection Systems. Some supplementary systems were installed throughout the whole road network for ITS implementation, such as super-high optical communications network, 2,843 Vehicle Detection Systems, 1,546 CCTVs and 913 Variable Message Signs. In addition, Toll Collection Systems were installed and operated at about 300 points within the expressway network, with Hi-Pass, a rolling speed Toll Collection System, introduced throughout the expressway network by the mid-2000s. Through these efforts, Korea has constructed expressway operation systems at a level that is on par with advanced countries.

Examination of each advanced operation system is as follows:

Toll Collection System is the system that was installed at expressway tollgates for toll collection, receipt issuance by vehicle classification (detector), automatic toll ticket issuance, and recognition of vehicles. After an operational test period of one year and two months starting from June 1993, the system was implemented in 291 areas on 1,757 lanes of the closed type, and 14 areas on 153 lanes of the opened type during the period starting from August 1994 to September 2012. In a closed type system, a toll road ticket is issued at the entrance tollgate and checked at the exit tollgate, where the calculated toll is collected.

Variable Message Sign (VMS) is the equipment that is installed throughout the road network that supplies drivers with information on traffic conditions, information on land control systems, parking guidance, or other helpful information. Typically, it displays traffic information using radio wire communication. By October 2012, Korea Expressway Corporation installed and operated 913 VMSs in expressway lines and 181 VMSs at the entrance of tunnels.

Figure 3-5 | Example of TCS Installation

Figure 3-6 | Example of VMS Installation

Hi-Pass is the high-tech rolling speed electronic toll collection system that initiates toll payments while driving through the high-pass lane at a speed under 30km/hr by using radio communications (infrared light or frequency) to communicate with a High-Pass card located within an On Board Unit (OBU). The program was started in 2007 and installed in 313 areas on 784 lanes of closed type and in 15 areas on 87 lanes of opened type tollgates. Utilization rate of this system throughout the whole expressway network was 57% in November 2012.

Exclusive bus lane on an expressway is the system that gives priority to buses. This system was enforced in order to reduce traffic congestions on expressways by decreasing the number of car on the roads and encouraging people to use public transportation networks. The enforced section of the exclusive bus lane on the Gyengbu expressway covers 37.9km from Osan IC to Yangje IC on weekdays, and 134.1km from SintanjinIC to Yangje IC on weekends and public holidays.

Figure 3-7 | Example of High-Pass Installation

Figure 3-8 | Example of Expressway Bus Lane

Besides this, special traffic measures have been made and enforced during special periods when traffic demand is at a seasonal high, such as national holidays like New Year's Day and Chuseok or summer vacation. Also, real-time traffic control systems such as hard shoulder lanes, ramp control, and other systems were expanded and managed.

Advanced expressway traffic management systems were introduced to provide convenience to the public by increasing public transportation capacity during periods of rapidly increased demand, providing enough information for dispersion of traffic volume, and establishing appropriate safety measures in the case of a traffic accident.

3.6.3. Advanced Maintenance System

The Korea Expressway Corporation has been promoting scientific expressway maintenance systems as a major strategy after the late-1990s, and has been maintaining expressways systematically with the introduction of Pavement Management Systems, Structure Information Systems, and Road Management Systems.

Pavement Management System (PMS) incorporates all the maintenance processes from system design to maintenance as one aggregated concept. In Korea, the MLTM first implemented the system on national roads after importing the system from France in 1987, and has been applied to expressways as well starting from 1997. PMS has been used for calculating the budget invested in annual pavement maintenance and selecting the section to be repaired. In addition, Korea promoted the improvement of system accuracy and road pavement techniques by improving the system and examination equipment every year.

Construction Information System (CIS) is the system that helps passengers utilize expressways safely and conveniently by checking the structural integrity of bridges, tunnels, and other facilities, including repairs and maintenance of the structures continuously. The Highway Corporation introduced this system in 1999, and is subdivided into Bridge Management System (HBMS), Tunnel Management System (TMS), and Culvert Management System (CMS).

Road Management System (RMS) is the system that manages the supplementation of the slope face of expressways and the installation and management of soundproof walls and emergency parking zones. Supplementation of grade slope is defined as the analysis of slide slope conditions of expressways constructed in the earlier periods, and includes daily checks, regular checks and special checks. It also incorporates supplementation engineering by color and structure. The first soundproof walls were installed on expressways in 1983 to reduce the noise created by vehicles. Since then, the aural environment of expressways has improved continuously with additional installations of soundproof walls of 903km by 2012. The emergency parking zones were made as shelters for disabled cars to promptly get out of road sections where the shoulder width is under 3.0m.

2012 Modularization of Korea's Development Experience
Expressway Construction and Management

Chapter 4

Analysis of Expressway Construction and Management System

1. Planning System
2. Design Criteria
3. Financing System
4. Construction System
5. Operation and Maintenance System

Analysis of Expressway Construction and Management System

1. Planning System

1.1. First Two Expressways

In the 1960s, economic development was Korea's top priority. Therefore, there were many industrial complexes that were developed in and around Seoul, Incheon and Busan. The first Gyeongin and Gyeongbu expressways were planned to connect these industrial complexes and ports.

It was not possible to plan these first two expressways with systematic methodology, however, as there was not enough detailed data nor a viable tool for analysis. There was no clear way to do a feasibility analysis as well. Therefore, alternative routes on land for the Gyeongbu expressway were checked by eye with a 1:50,000 scale map and field surveys.

Also at the time, there were no experts on expressways in Korea, resulting in much of the planning for the first two expressways to be done by President Park and a few government officials. There were a few issues that arose later from the planning process, but this methodology served to reduce the planning time period significantly.

1.2. Mid- and Long-term Planning and Feasibility Analysis by Competent Ministry

Almost all expressway plans are led by the Ministry of Land, Transportation and Maritime Affairs (MLTM), with the extremely rare few led by a private entity. As it became necessary to build more expressways, the MLTM set up the 'Comprehensive National Land Development Plan' and proposed the mid- and long-term expressways plan. Three Comprehensive National Land Development Plans were released every decade up until 2001. At present, the 4th Plan with an outlook of 20 years was made and is in progress until 2020.

Until the late 1990s, detailed databases for transport demand analyses were not established and there was no clear way of conducting feasibility analyses. As a result, the MLTM resorted to planning as many expressways as possible without proper consideration of budget constraints. With the many expressways planned and in the pipeline, the MLTM needed to then try and find more financing sources. As a result, many of the planned expressway completion dates were delayed.

The over-planning of expressways and resultant delays in the completion dates caused public criticism and raised the question regarding the efficiency of expressway construction. It was suggested that a prioritization schema was necessary between alternative expressway plans that was dependent on budget constraint variables. For instance, as the ratio of roadway investments to GDP had been decreasing steadily since the 1980s, it became more important to prioritize alternative expressway development. In other words, more accurate feasibility analyses needed to be carried out prior to such planning using a detailed database of information to accurately assess expressway construction plans within budgetary constraints.

1.3. Establishment of National Transportation Database

Traditionally, when feasibility analysis on an expressway project was carried out by the MLTM, they often used data from a previous transportation project, resulting in a lack of consistency depending on which project's transportation data was used. The result of the feasibility analyses was therefore quite often doubted. It was necessary to establish a national transportation DB that would allow for data consistency across all projects.

The government therefore established the national transportation DB in 1998. It consists of one nation-wide DB and six metropolitan city-wide DBs. Since 1999, the national transportation DB was used in the feasibility analysis of all road projects planned afterwards, and it has been argued that as a result, the credibility of feasibility analyses was much improved.

1.4. Pre-feasibility Analysis and Project Management by Budget Ministry

The sharp increase in private cars since the mid-1980s have caused serious traffic congestions throughout the expressway network, which resulted in an increase in planned expressways from the 3rd Comprehensive National Land Development Plan, particularly within the nationwide 7×9 axis expressway network. The plan required more expressways within a limited budget, thus requiring a more accurate and objective feasibility analysis on expressways. This meant that the feasibility analysis would be carried out by the Ministry of Strategy and Finance as they controlled the budget allocations, rather than the MLTM. This is the same for privately funded road projects.

As the role of feasibility analyses on government and privately funded road projects became more pertinent, a more analytic method was necessary in order to improve the reliability of the analyses in 1998. Guidelines for conducting a feasibility analysis were prepared in-detail.

The added requirements of a feasibility analysis may have extended the timeline from expressway planning to its completion, but also had the effect of reducing waste in budgetary spending and introducing more caution and analysis to expressway planning.

2. Design Criteria

2.1. First Two Expressways

When the first two expressways were constructed, there were no overarching design criteria for expressways, and so the design criteria of the International Bank for Reconstruction and Development were adopted and modified. In particular, as far as the Gyeongbu expressway was concerned, the design criteria were very poorly suited to the project as there were many rivers and mountains along the line.

Four lanes were planned, with median strips and interchanges that were grade separated. Depending on the terrain, other design criteria differed along the length of the highway: the speed was set at 120km/h, 100km/h and 80km/h; the gradient was 2%, 3% and 5%; the minimum curve radius was 600m, 400m, and 300m; and the minimum load was 15 tonnage.

2.2. Establishment of Expressway Design Standard

The first design criteria for expressways were established in 1976. When the number of cars and traffic volume increased with economic development, the criteria were revised to a higher standard in 1992.

2.2.1. Number of Lanes

Many expressways were constructed from 1967 to the mid-1970s. Because of limited financing sources and un-experienced local techniques, design criteria were set at a low standard. For example, the Youngdong and Donghae expressway were opened in the early 1970s. Since they had to pass rough mountainous areas and the government did not have enough financing sources, they were constructed with two lanes in either direction. Furthermore, the curve radius was not wide enough and the gradient was very steep.

As a result, there were many fatal traffic accidents that occurred during the operation of these expressways. They were eventually expanded into four lanes during much of the 1990s. When the design criteria were revised in 1992, the minimum number of lanes for an expressway was set at four in either direction.

2.2.2. Asphalt/Cement Pavement

Until the late 1970s, all expressways were paved using asphalt concrete. However, the overlay pavement during maintenance made the level of the asphalt surface higher. This caused another problem in maintenance. As a result, cement concrete pavement was suggested to solve the problem with the asphalt surface. The cement concrete pavement needs a higher level of technology than asphalt concrete, so it was not introduced during the construction of the early expressways.

With the improvement of cement concrete pavement technology, this technique was introduced in 1978. At first, asphalt concrete of 5cm was overlaid onto cement concrete pavements of 25cm; eventually, full cement concrete pavements became the standard in the early 1980s.

2.2.3. Median Strip and Curve Radius

For the early expressways, the median strip curve was made of earth and sand. On occasion, a vehicle would break through the median strip and cause fatal traffic accidents with contra-flow vehicles. To prevent this problem, the median strip was changed into a cement concrete protective wall.

Geometric design criteria were also improved to increase the stability of high-speed vehicle traffic. These include minimum values of grade curve radius and length, longitudinal curve radius and length, road width, and visibility distance. The minimum load was also upgraded from 15 to 40 tonnages and the effective shoulder width from 1.75m to 3.0m.

2.2.4. Grade Separated Interchange

All four-lane expressways in the 1960s and 1970s were constructed with grade-separated interchanges, while many two-lane expressways were constructed with grade crossing interchanges in the early 1970s. Because of the traffic congestion caused by grade crossing interchanges, these were changed into grade-separated interchanges with their expansion into four lanes in the 1990s.

3. Financing System

3.1. First Two Expressways

When the construction of first two expressways was reviewed in the late 1960s, the Korean economy was very poor due to the damage of the Korean War. It was very difficult to finance the construction using only domestic capital. The Korean government tried to borrow foreign capital to finance the expressways, but foreign agents and consultancies thought the expressway construction was premature, particularly the Gyeongbu expressway. As a result, foreign capital could not be brought in for the construction of the Gyeongbu expressway.

In order to raise domestic capital to build the Gyeongbu expressway, car related taxes such as gasoline and diesel taxes, car license and registration fees, etc., were significantly increased. Tolled expressways were introduced instead of toll-free ones. Some part of the Japan Reparation Claims was also used in the financing of the expressway. In particular, land acquisition costs could be saved by inducing active participation of land owners, while construction costs could be reduced by using military personnel for labors.

3.2. Ear-marked Fuel Tax and Account for Transport Infrastructure

Unlike the 1970s, investments in roadwork, including expressway construction, had been significantly reduced during the 1980s. On the other hand, the number of private cars has rapidly increased since the mid-1980s. As a result, road traffic congestion had become an ever increasing problem since the late 1980s. As a result, there was a significant need for road investments during the early 1990s, but the issue was in financing these projects.

To find stable sources of financing, ear-marked tax initiatives were introduced in 1994 despite the opposition from the Ministry of Finance, who worried about the potential inefficiencies of pre-allocated capital resources. Gasoline and diesel taxes were ear-marked for transportation infrastructure investments. Originally, these ear-marked taxes were limited to a period of just ten years, but was extended three times and is still in

place currently. Income from these ear-marked taxes comprise 70% of the transportation infrastructure account.

At first, the transportation infrastructure budget was used only for road investments. However, its scope has grown to now include all transportation infrastructure such as road, railway, airport, and seaport. Although the introduction of ear-marked fuel taxes made it possible to expand the transportation infrastructure budget by a significant amount, there has been criticism directed towards inefficiencies in the allocation of available capital resources.

3.3. Introduction of Privately Financed Investment System

The expressway plans introduced in the 1990s to build roadways by the nationwide 7×9 axis expressway network had too many planned construction sites for the budget that was available. Although earmarked taxes were introduced, it was difficult to finance all of the expressway construction plans using only the government's capital. As a result, the privately financed investment system was introduced in 1994 with the enactment of the 'Act on Private Capital Inducement in Transport Infrastructure'. The act allowed Build-Operate-Transfer type public and private partnerships, which made it possible to build 420km with 9 lines of additional expressways, representing around 11% of the whole expressway network.

Since then, the act was revised to the 'Private Investment Act in Social Infrastructure' in 1997, with the subsequent introduction of the Minimum Revenue Guarantee (MRG) system in 1999, which guaranteed the revenue of expressway operations while sharing the risk with a private company. MRG guarantees a minimum level of revenue, with the government obligated to finance the difference in actual revenue with the MRG level of revenue. This significantly increased private investments in expressway constructions.

The MRG system was extremely favorable towards private companies, as it was difficult to verify accurate demand forecasts during planning and agreement, often resulting in high minimum revenue levels that were rarely met once the expressways were being operated. As a result, it became a serous fiscal burden for the government, forcing the abolishment of the MRG system for unsolicited projects in 2005, and then for all projects including solicited projects in 2009.

4. Construction System

4.1. First Two Expressways

By the late 1960s, a few Korean construction companies already had some experience in expressway construction in Thailand. As a result, all the planned expressway construction contracts were handed out to private Korean companies. In order to adopt some of the more sophisticated construction techniques, some engineers were sent to Delewe Cather International in the USA for a 23-month training period, in addition to the technical support received from US military officers. In order to complete the construction work in the shortest time frame possible, the expressway lines were divided into four or five sections, with each section having a separate construction contract.

With the experience and technical skills acquired during the first two expressway construction projects, Korean construction companies now had the expertise to be able to complete larger projects both abroad and domestically.

4.2. Introduction of Construction Supervision System

Although the technical skills of the construction companies improved, as the number of construction projects increased, the number of accidents caused by low quality construction increased as well. As a result, the 'Construction Supervision System' was introduced in 1990, which required independent supervising companies to oversee and give approval for the quality of a construction project's execution. It was the job of the construction supervisor to make sure all construction was performed according to the design specifications and without violating its relative laws and guidelines.

In 1994, the supervision system evolved into the 'Responsible Supervision System,' which reinforced the requirements for projects worth more than 20 billion won. With the introduction of this supervision system, poor quality construction was significantly reduced.

5. Operation and Maintenance System

5.1. Korea Expressway Corporation and Early Operation and Maintenance System

After the construction of the Gyeongin expressway and the first section of Gyeongbu expressway, expressway management began under the Ministry of Construction. However, the ADB, which provided a substantial loan for the Gyeongin expressway, requested for

the establishment of the Korea Expressway Corporation (KEC). Since then, the KEC has been in charge of expressway management exclusively. Their oversight includes the operation and maintenance of expressways, toll collection, construction and rehabilitation of expressways, and issuance of bonds.

As far as the maintenance of the early expressways is concerned, surface damage was assessed by the naked eye and then repaired accordingly. At the time there were no sophisticated maintenance systems.

5.2. Private Operators

Originally, all expressways were operated and maintained by the KEC. With the construction of privately financed expressways beginning in 1994, private operators could operate and maintain its expressways for a certain period, usually for 30 years after its opening. As of 2010, 420km of expressways are managed and operated by private companies.

5.3. Advanced Operation and Management System

Expressway management systems were established to effectively manage Gyeongin Expressway and Gyeongbu Expressway, as road damage and accidents started to occur more frequently. Up until 1972, motorcycles over 250cc were allowed on the expressways and there was no restriction on overloaded vehicles. This has since changed, and motorcycles are no longer allowed and check-points for overloaded vehicles are now operated.

In the 1980s, the rapid increase in traffic volume was met with the proportional increase in traffic accidents. This resulted in the establishment of the improvement plan for accident black spot by analyzing traffic accident data rigorously and the proper investigation of the scene of the accident. Accident date, place, vehicle type, accident type, etc. were recorded as data points and utilized for the establishment of traffic accident prevention measures.

In the 1990s and 2000s, with the introduction of pavement management systems, structure information systems, and road facility management systems, it was possible to operate and maintain the expressways systematically. In 1993, the Intelligent Transportation System was introduced to oversee the traffic management system and electronic toll collection system. With these efforts, Korea became home to one of the most advanced expressway operation and maintenance systems in the world.

Chapter 5

Comparison with Others and Evaluation of Expressway

1. Comparison with Foreign Countries
2. Contribution to Economic Development

Comparison with Others and Evaluation of Expressway

1. Comparison with Foreign Countries

1.1. Comparison of Expressway Construction and Management

1.1.1. Planning System

Similar to the planning system in Korea, feasibility studies on alternative expressway routes are carried out in almost all advanced countries. The studies are conducted under the guidance of the central or local government, and the fully described guidance manuals for these studies are usually prepared and updated. In every case, there is a certain law or act requiring a feasibility analysis in the planning operations for expressway construction.

In the case of Japan, once a feasibility study is conducted, the Road Act designates the routes of the expressway. Then they are further designated through the approval of the 'National Land Development Committee for Truck Road Construction'. The expressways are then constructed by the Japan Highway Corporation as a government agent. Recently, however, Japan Highway Corporation was separated into several corporations and privatized in 2005.

In the case of China, prior to its open-door policy in 1978, there were almost no expressways because car ownership rates were very low. Even after the open-door policy was introduced in 1978, there were not enough roads. With the Cultural Revolution, pending social and foreign issues were resolved and much more attention was given to economic development. Thereafter, Deng Xiaoping argued that 'road construction must be conducted foremost in order to become wealthy,' and as a result the Chinese government established road construction as a key pillar in its plan for economic development. The Ministry of

Transport in China announced the '7×9 axis Nationwide Trunk Road Network Construction Plan', which was similar to the Korean expressway construction plan. Construction work began in 1998, with the basic expressway network already well established in China by 2010.

Most foreign expressway planning systems are very similar to the systems in place in Korea. Planning is under the control of the central or local government, as expressway construction requires significant levels of financial investment, and in most cases, a feasibility study on alternative expressway routes is carried out and decisions are made based on its results.

1.1.2. Financing System

In Korea, the financing of expressways is almost the sole responsibility of the central government through tax revenues and toll revenues. About half of the construction cost is subsidized by the central government while the operator finances the other half during operation. In most other developed countries, regionalization—or localization—is much more developed than in Korea. This means that a proportion of expressway financing is the responsibility of the local branch of government.

In the case of Germany, the Autobahn plan was established by the federal transport plan along with the federal financial plan. The Autobahn plan had some federal government budget allocated for its construction purposes, but since there are no tolls, the rest of the financing became the responsibility of the local branches of government.

Most road projects in France are executed through a contract between the central government and regional/local government. Road projects are planned by the regional or local governments, and then finalized through negotiations with the central government. Some grants and subsidies are given to the regional government branches by the central government, with further financing possible by the participation of private companies in its construction and operation.

The Australian government established a National Expressway System Plan in 1974 to provide the financing required for the construction and maintenance of highways. In July of 2004, the Australian federal government replaced all support programs pertaining to expressway construction and maintenance originally conducted by the National Expressway System with the newer Auslink Network System. The Auslink Network System is a new road policy that further provides extensive long-range roads and railway transportation networks.

The financing system of expressways in Japan is very similar to the system in place in Korea. Earmarked taxes and earmarked accounts for road investments were introduced in Japan for the financing of road projects. In 1952, the Road Rehabilitation Special Act was enacted in order to collect toll on certain roads. Since then, toll revenues became the single most important source of financing, as toll prices are relatively high in Japan.

In the case of the USA, President Eisenhower announced a ten-year project plan to upgrade all types of roads in 1954. To implement this plan, a law was enacted to enforce 50:50 financing between the federal and local governments. The Highway Trust Fund (HTF) was introduced in 1956 in the form of a user charging system in order to expand financing sources to construct the inter-state expressways, which became the heart of its national trunk network. The HTF supports expressway construction primarily through gasoline and some heavy truck taxation. The gasoline tax has been increasing continuously, and accounts for 90% of HTF by 2005. At present, the US federal government is in charge of 80% of all expressway construction and maintenance.

The central government in most countries takes a leading role in financing expressways. If the expressways are tolled, the operator's toll revenues are also an important financing source. Since regionalization or localization is more common in countries outside of Korea, the local governments also take some responsibility for the financing of expressways. In many cases, an earmarked tax system is introduced, although the level of tax is quite different between countries.

1.1.3. Operating System

In most countries, when expressways were first built, they were managed by the government or a public entity. At some point, all the operators suffer from operating deficits and management inefficiencies, requiring some form of restructuring. Some of these public entities become privatized, while some of these entities partner up with private companies to form public private partnerships (PPP) in order to promote competition.

In the case of Japan, expressways were operated and managed at first by a public entity in lieu of the central government, which was called the Japan Highway Corporation. In 1999, some expressways managed by the Japan Highway Corporation were spun-off and came under the control of local governments. The public entities formed to manage them, the Metropolitan Highway Corporation, Hanshin Highway Corporation, etc., eventually became privatized in 2005.

In France, expressways can be divided into tolled expressways and un-tolled expressways. Since 1973, the number of tolled expressways has been increasing. At present tolled expressways make up the majority of the expressway system with a ratio of 75:25. The

number of un-tolled expressways did not increase due to the government's limited budget for roads. It is important to note that while un-tolled expressways are managed by the central government, tolled expressways are managed by private companies, who themselves make decisions on toll level and collection, collection period, finance procurement, construction and maintenance. Therefore, the distinguishing characteristic of French expressway systems is that it is not governed by the central government, but by private entities in charge of construction, operation, and management.

Most expressways around the world were first operated by the central government or its agent. However, because of operating deficits and inefficiencies, some of the expressways were separated from the central government and became the charge of local governments. When these entities were still unable to properly manage the expressways, they were either privatized or made into PPP entities.

1.2. Achievement of Expressway Construction

Korea has constructed more than 4,000km of expressways within the last 45 years. When global expressway lengths are compared, Canada and Luxembourg have the longest expressway length per population, while China and Canada have the longest length per car. Since land sizes are also a notable limiting variable, the Netherlands, Belgium, and Luxembourg have the longest length per land size.

Korea's expressway length per head is 0.06m per person, which is comparable to the UK, China, and Japan, while lower than Germany, France, Belgium, and the Netherlands. Korea's expressway length per head may be lower than other countries due to its population density. Korea's expressway length per car is 0.20m per car, which is higher than the UK and Japan, while lower than the USA, Germany, and France.

Expressway length per land size in Korea is lower than in Belgium, Luxembourg, and the Netherlands, whose land mass is much smaller than Korea. Attention should be given when compared with the UK and Japan, however, where land size is similar to Korea. Here, Korea exceeds the two countries' expressway length per land size by a factor of two, which implies that Korea's expressway supply rate is on par with that of more advanced countries.

Table 5-1 | Expressway Length of Major Countries

Expressway Length				
Nation	Expressway (km)	Per head of population (m/head)	Per No. of Car (m/Number)	Per Land Size (m/km)
Korea	2,968	0.06	0.20	31.14
USA	75,435	0.25	0.32	7.83
UK	3,519	0.06	0.12	14.46
Germany	12,037	0.15	0.25	33.71
France	10,805	0.17	0.29	19.02
Japan	6,915	0.05	0.09	18.30
Canada	16,900	0.52	0.92	1.69
PRC	41,005	0.03	1.30	4.27
Belgium	1,747	0.17	0.32	57.24
Luxembourg	147	0.32	0.44	56.54
The Netherlands	2,500	0.15	0.32	60.20

Source: International Road Federation Homepage (http://www.irfnet.org/)
Annotation: Data is based from 2002 to 2005

2. Contribution to Economic Development

The development of an expansive transportation system acts as a substantial catalyst for the economic growth of a nation. Countries with well-developed transportation networks have generally achieved great economic success in history. The production of an expressway can especially accelerate economic growth, as it reduces travel times and travel costs for passengers and goods, while simultaneously increasing respective shipment and transportation volumes. The resulting effect of building an expressway is the reduction of production costs. The reduction of production costs are conducive to the reduction of the price of goods, and these lowered prices will ultimately incite more purchasing demand. The increase of the demand will, in turn, raise the volume of production and result in national economic growth. Therefore, it is known that the construction of an expressway, which increases spatial accessibility, will considerably influence the growth of a national economy.

There have been many studies conducted over the years to investigate the effects of expressways on economic growth. Between 1950 and 1960, studies to investigate the effects of the US interstate highways on US national economic growth were implemented,

using macro analysis methodology. Aschauer analyzed the effects of the social overhead capital (SOC) on elasticity of output in 1989. He found that the elasticity of output of SOC resulted in a value between 0.39 and 0.56. This value suggests that the 10 percent increase of SOC produces an increase of output from 0.39 to 0.56 percent. Munnell also found that the elasticity of the construction of SOC like an expressway on production output was 0.33. Positive values of the elasticity of output contribute to constructive effects.

On the other hand, there are various studies that claim that an expressway does not substantially influence national economic growth. However, Hulten and Schwab failed to find any evidence that supported the claim that as SOC and the rate of SOC increased, faster production output would result locally. Forkenbrock and Foster found that an expressway would not necessarily provide any noticeable effects after some sort of transportation service was established. Fernal also found that effects of US interstate highway on local economic growth actually decreased as time passed. This is the case because interstate highways provided great influence on economic growth when transportation-intensive industries were the forefront industries of the nation. However, their relative influence on high-tech industries has recently weakened.

Through review of previous study results, there is a positive relationship between expressway constructions and economic growth. Generally, it is known that expressway constructions result in reducing the production costs of private companies and improving production output greatly, and consequently the construction's influence on and economic growth. However, it is hard to define a quantifiable relationship clearly or find any numerical proof of the relationship. As mentioned in previous sections, the main reason of Korea's great economic growth from restoring the war-torn nation was a valuable investment to the SOC. Typically, expressway constructions reduced travel time and costs, and this cost reduction resulted in increasing vehicle traffic as well as the travel demand of passengers and goods. As the length of constructed expressways increased, the number of registered passenger cars and trucks increased more rapidly as well. Because the number of trucks traveling about increased in transport records, the higher number of expressways brought in more demand of logistical distribution.

Also, there are many other effects of expressway network constructions in our daily lives. These constructions have improved the quality of life and have contributed to maintaining a balance between regional development and economic growth.

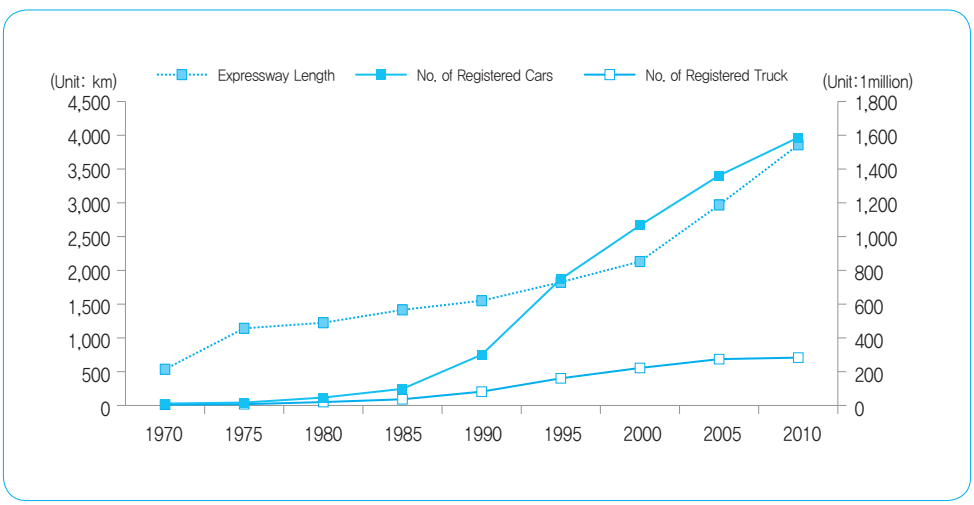
Table 5-2 | Expressway Length and Road Freight Record Changes

Year	Expressway Length (km)	No. of registered cars			Road Freight Record (1 million ton/year)
		No. of Registered Cars (A) (1 million)	No. of Registered Truck (B) (1 million)	Proportion (B/A) (%)	
1970	536.6	12.7	4.9	38.7	61.8
1975	1,142.4	19.4	8.3	42.7	84.5
1980	1,224.6	52.8	22.7	43.0	104.5
1985	1,415.4	111.3	41.3	37.1	148.7
1990	1,550.7	339.5	92.5	27.2	215.1
1995	1,824.5	846.9	181.7	21.5	408.4
2000	2,131.2	1,205.9	251.1	20.8	496.2
2005	2,968.1	1,539.7	310.2	20.1	526.0
2010	3859.3	1794.1	320.3	17.9	620.0

Source: 40 Years Expressway Construction, Korea Expressway Corporation, 2009

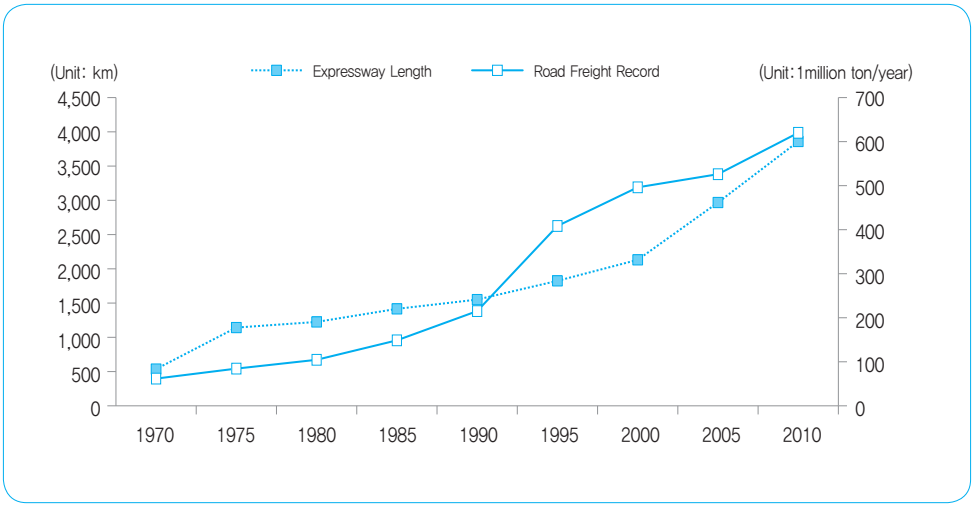
Annotation: Source after 1976 – Korea Statistical Information Service (KOSIS),
Source prior to 1975 – Traffic Census Chronology

Figure 5-1 | Relation Between Expressway Length and Number of Registered Cars



Source: 40 Years Expressway Construction, Korea Expressway Corporation, 2009

Figure 5-2 | Relation Between Expressway Length and Road Freight Record



Source: 40 Years Expressway Construction, Korea Expressway Corporation, 2009

2012 Modularization of Korea's Development Experience
Expressway Construction and Management

Chapter 6

Implications

1. Overview
2. Implications on Low-Income Countries
3. Implications on Middle-and High-Income Countries

Implications

1. Overview

The history of Korean expressways has only spanned 40 years since the establishment of the Gyeongin expressway, Korea's first expressway constructed in 1968. However, Korea currently operates an expressway system that rivals those of other economically advanced countries, with a 4,010km long network and sophisticated operational frameworks set in place.

This study explores these implications by analyzing the planning, design criteria, financing, and operation and maintenance system from the first expressway in the late 1960s up to the more recent status of the expressway. The chronological and phase analysis of expressway development in Korea could provide various implications and insight when compared to those of other countries.

However, there have been many changes in the socio-economic landscaping from the early to the present expressway construction and management system in Korea. Hence, the implications are also divided for low-income countries as well as for middle- and high-income countries.

2. Implications on Low-Income Countries

2.1. Strong Leadership and Central Government Initiative

When the construction of first two expressways in Korea was reviewed in the late 1960s, the Korean economy was still in its early developing stages. At the time, it was still difficult to construct two expressways that would ultimately cost approximately one-fourth of national budget at that time. It was insisted by President Park and central government officials that

two expressways were necessary to develop the export-oriented industries. Without them, it would be impossible to handle the ever-increasing freight volume between manufacturing areas, large cities and ports. Opposition was encountered as foreign aid agents, foreign and local experts disapproved the construction of two expressways during these times.

Although some traffic surveys and feasibility studies had been carried out, there were stark differences between the expressway's endorsers and opponents, making progress difficult. In spite of strong oppositions, President Park made a decision to construct two expressways almost simultaneously since both of them were necessary to accommodate the rapid growth of the economy. President Park, along with central government officials, did not only facilitate the initiation of the expressways' construction but also took various measures to ensure their prompt completion.

Through these proactive leadership of the President with central government officials, the construction period and costs were greatly reduced, resulting in the successful and early completion of these expressway systems.

2.2. Key Factor in Achieving Economic Growths

In the 1960s, the light industrial complexes were developed in and around Seoul, Incheon and Busan, where large labor forces were now easily available. A few heavy and chemical industrial complexes were also developed near coastal areas. Most goods manufactured in industrial complexes had to be exported through ports. This made it necessary to connect the industrial complexes and ports by expressways.

Moreover, the rate of economic growth was approximately 8% per annum during the 1st Five-Year Plan period, and even more than 13% in 1966. Growth rates surpassed most expected rates at the time. From the encouraging rates of the economic growth during the 1st Five-Year Plan, the Korean government was able to establish an economic confidence and maintain the continuous high economic growths in the 2nd Five-Year Plan onwards.

In order to transport the rapidly increasing manufactured goods in the industrial complexes through ports, it was vital to construct expansive expressways. Naturally, many expressways were constructed to connect these industrial complexes and ports. The transportation cost was reduced greatly and it resulted in contributing greatly to the development of export-oriented industries, which has been the forerunner in national priorities.

2.3. Concentrated Investment through Selection

Every government, including those in economically advanced countries, has unique budget constraints. The financing sources more often than not fail to meet long-term investment quotas. Right after the Korean War, the Korean government in the 1960s had to engage in a plethora of public restoration projects. Thus, it did not have ample remaining budgets to build a new transport infrastructure. Even if the government decided to build expressways, the problem was consistently and efficiently financing them. Of course, foreign aid was desperately needed. And with the help of outsourced funding for the Gyeongin expressway, it was possible to finance about one-fifth of construction costs through the ADB loan.

Still, the more serious problem, specifically, was the building of the Gyeongbu expressway. Its estimated construction cost was 10 times that of the Gyeongin expressway, which amounted to almost one-fourth of the national budget at that time. Even if the government tried persistently to obtain foreign loans, it failed because of many doubts regarding the future Korean economy by foreign aid agents and experts. Even many Korean experts strongly opposed the construction of the Gyongbu expressway.

As a result, the government decided to find all the available domestic financing sources. Fuel taxes were significantly raised, car-related taxes were introduced, large-scale corporate bonds were issued, and private capital was also induced. A large proportion of national financing sources were actually concentrated on one mega project. Although the Gyeongbu expressway succeeded in the end, it was still a very risky decision for the Korean government. If the Korean economy had not achieved high growths continuously since the 1970s, the mega project may have failed.

The government not only invested a dangerously high amount of national funds in financing the expressway construction, but it also put a bulk of its efforts from top officials to manage its construction procedures. President Park and some central government officials personally participated in the route selection work. The most cost-effective route was chosen, although its design criteria had to be less prepared. Subsequently, this caused many traffic accidents and required more maintenance costs later. To reduce the time of the construction period, the construction work actually began even before the detailed design work was completed. The construction work was supervised by top officials and military men. Some soldiers even worked for free in collaboration with the private companies. In the end, the construction work of the 428km Gyongbu expressway would be finished within an unbelievably short time period of two years and five months.

2.4. Low Design Criteria

Out of the first two expressways built in the late 1960s, the design criteria of the Gyeongin expressway were higher than anticipated because its route passed through flatter areas. In contrast, the design criteria of Gyeongbu expressway was very low. Since its route passed through many rivers and mountains, it would build many tunnels and bridges so that it would necessary to reduce construction costs. The curve radii was not wide enough because it was designed by minimizing tunnel and bridge sizes. The median strip curve was made of earth and sand. Considering the difficulty in its financing sources, it could not help adopting the low design criteria for the time being.

However, the design criteria in other expressways built in the 1970s and early 1980s were somewhat lower than those of the Gyoungbu expressway. It is with the help of the IBRD, which partly financed those expressways, that allowed for a low design criteria. Next, the first 'Road Design Criteria Ordinance' was enacted in 1967 and its design criteria were lower than those of the Gyeongbu expressway. The minimum design speed was 60km/h, its minimum effective shoulder width was 1.75m, and its minimum curve radius was 200m, etc. After these implementations, a few expressways were constructed into two lanes going both ways with a narrow curve radius and stiffness, and even excluded a median strip. These expressways initially caused a lot of problems, particularly increasing the number of fatal accidents. They could not efficiently handle the rapid increase in traffic volume. Most of the two-lane expressways were expanded into more than four lanes since the 1990s. Since then the country has prohibited the construction of two-lane expressways.

When expressways are planned in low-income countries, two-lane expressways are always considered a rational alternative because of budget constraints and low traffic volumes. However, the high design criteria would be recommended when lane expansions in the future would be inevitable. Also, the neighboring land of these two-lane expressways would also be acquired, when its acquisition cost of the neighboring land would most likely skyrocket in the future.

3. Implications on Middle-and High-Income Countries

3.1. Promotion of Balanced Development

The main purpose of expressway construction has changed in correlation to the more recent flourishing of the Korean economy. This may mostly be due to the economic development in the 1960s, 1970s and 1980s. A few important things to be considered during those days were reductions in travel times for transporting goods as well as connecting the

industrial complexes. Since economic growth has been consistently high, there has been less opposition regarding the maintaining the primary purpose and efficiency of expressway construction.

In the 1990s and 2000s, however, the main purpose of expressway construction may have changed into promoting the balanced development of the land as a whole. The travel time savings in carrying passengers as well as goods, and how well connecting the under-developed areas became important when expressways were to be developed. In particular, as the economic growths has stabilized in recent years, there has been criticism claiming that too many expressways had been constructed without considering the long-term costs of maintenance and reconstruction. There was a noticeable spike in particularly in the late 1990s when the Korean economy had experienced a serious financial crisis.

As a result, it was suggested that the planning system should be reviewed to prevent the inefficiency of more current expressway construction, and feasibility analysis system should be revised more frequently.

3.2. Objective Planning with the Usage of DB

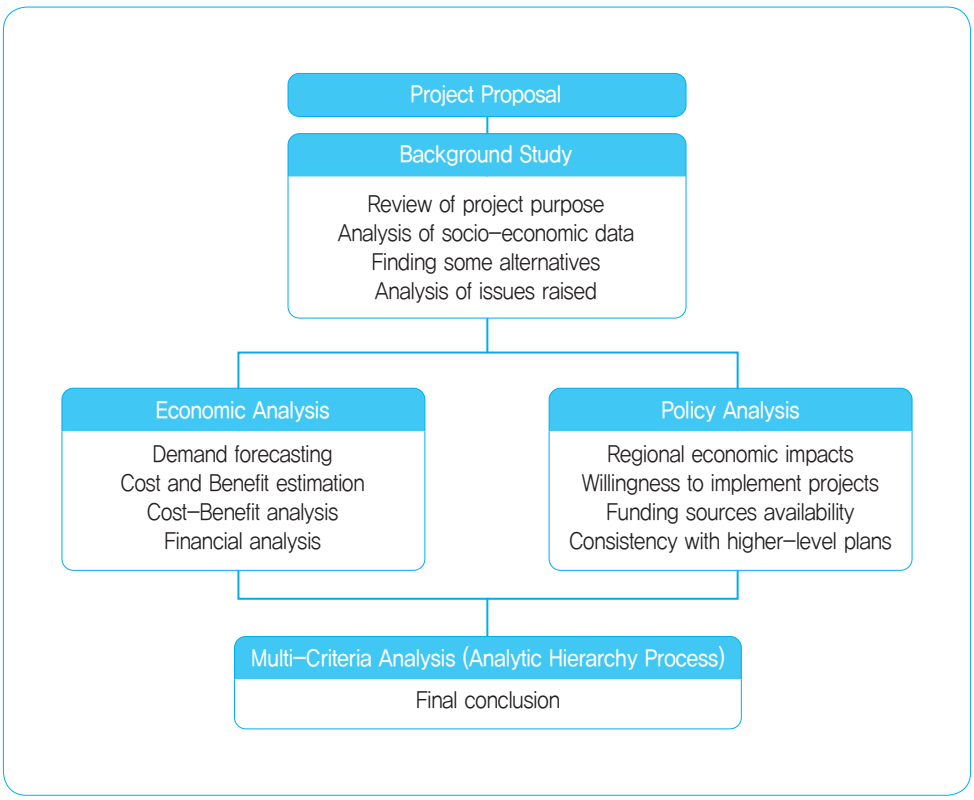
The expressways require very large investments, and so it becomes very difficult to cease construction once it has begun, due to the staggering sunk costs. Therefore, meticulous planning should always be implemented and overseen. This means the planning, along with the feasibility analysis should be very objective and accurate and strictly regulated. The feasibility analysis until the 1990s had some difficulties in terms of maintaining a high level of objectivity and accuracy.

Since the construction and operation and the planning has been conducted by the Ministy of Land, Transport, and Maritime Affairs (MLTM), the MLTM ultimately strives to build more expressways without always considering its restrictive budget constraints. This had become a more serious issue after the MLTM established enough financing sources from the introduction of the ear-marked tax system in 1994. The feasibility analysis results were often biased, in order to facilitate the building of newly reviewed expressways. To make matters worse, transport demand forecasting was sometimes manipulated. As a result there had been a recently deeply-rooted doubt regarding the accuracy of the feasibility analysis results.

To improve these issues, some revolutionary measures had been taken in 1999. Apart from the feasibility analysis conducted by the MLTM, the ‘preliminary feasibility analysis’ was introduced and carried out by the Ministry of Strategy and Finance, which was in charge of the allocation of the national budget. All infrastructure projects over 50 billion won would be reviewed by the newly implemented preliminary feasibility analysis. The

flow of the preliminary feasibility is shown in [Figure 6-1]. This would become the same process for the public private partnership unsolicited project. A similar analysis called the 'private capital investment adaptability analysis' would also eventually be applied.

Figure 6-1 | Preliminary Feasibility Study (PFS) in Korea



Source: Korea Development Institute (www.kdi.re.kr)

The feasibility analysis result is often dependent upon the framework of the database used for the analysis. Furthermore, the result is often different depending on the used parameters in the methodology. Therefore, many efforts had been exerted on developing a more standardized database and methodology. Now, it is required to use the national database and the predefined sophisticated methodology for the preliminary feasibility analysis. It is argued that the objectivity and accuracy of the preliminary feasibility analysis has been greatly improved.

The national transport database was first established in 1998 in order to prevent estimation biases in future demand forecasts caused by using project-based data. It consists of one national transport database and six metropolitan area databases for future 30 years

at five-year increments. The database has been updated regularly through the analysis of transportation patterns. The current and future origin and destination matrices are calculated through the household travel survey conducted every 5 years. These matrices are reviewed and validated by comparing them to actual traffic volume data.

Another effort to prevent estimation biases in future demand forecast is to predefine the preliminary feasibility analysis methodology in detail and in clarity. This was done by preparing the guideline manual. The manual describes the parameters in forecasting the future transport demand, the value of travel time, the construction cost by transport infrastructure and by structure type, etc. The first manual was published in 1999 and it has been updated almost every three to four years. The 5th version is now available.

3.3. Various Domestic Financing Sources

As mentioned earlier, with the great success of the Gyeongbu expressway construction and management, there was very little difficulty in getting foreign loans in the 1970s and 1980s. However, as the economy had reached the mid-income range, the country faced a sudden difficulty in obtaining foreign loans. On the other hand, the number of private cars had rapidly increasing since the mid-1980s. About one million cars were registered every year. The result was a peak in serious traffic congestion, which led to more road investments. But the problem now, was how to finance these rapid changes. The only feasible way was to expand the domestic financing sources for road investments.

For these reasons, the ear-marked tax for road investment was introduced in 1994. By clarifying the relationship between tax and its spending, the ear-marked tax reduced the resistance of tax-payers, in contrast to the general tax. In the case of the general tax, most tax-payers did not recognize the relationship between the tax they pay and the benefits they received. Tax-payers are usually very resistant of any general tax increases.

On the other hand, in case of the ear-marked tax, tax-payers would easily recognize the relationship between the tax and the corresponding benefits. If the road-related tax is increased, tax payers would expect that road spending would increase in the future, suggestive of improved roads. Thus, the resistance on the ear-marked tax increase would be manageable. But, there is the critical disadvantage in the ear-marked tax as well. As the ear-marked tax revenue is only used for very specific purposes, it is also restricted in many ways for this very reason. The efficient allocation of tax revenues is severely restricted so at times, the country must endure the inefficiencies. In order to mitigate the inefficiency, the ear-marked tax was applied for a limited time period, spanning 10 years in Korea. The time period has been extended continually in spite of strong oppositions.

Although the ear-marked tax has substantially contributed to expanding financing sources for road investment, it was not enough to cope with the rapid increase in road demands caused by the explosive increase in private cars. The private capital inducement system by the public-private partnership (PPP) was introduced in 1994. The most important factor in the PPP is the method of sharing the risk between public and private sectors. In the case of transport infrastructure, the greatest risk is the future demand forecasting, as this is directly related to the future revenue. When the PPP was first introduced, the private sector was not willing to take the future demand forecasting risks, and so the government guaranteed the minimum revenue when the actual revenue was less than estimated revenues. This is called the MRG (minimum revenue guarantee) and its rate was consistently at 90% in the early period. The expressway PPP projects have been contracted. However, the estimated demand was about 50% of estimations in many expressways so that many government subsidies have been given to the private sector. The MRG rate had been reduced to 50% and was completely abolished in 2009.

3.4. High Design Criteria

When the expressways were first constructed in Korea, there was nearly no design criteria. Some low design criteria of the IBRD was modified and adopted. With the rapid economic development, the criteria was not suitable in Korea. The design criteria ordinance was enacted and updated. The recently updated criteria in 1992 demonstrates high design criteria regarding many aspects.

The minimum lanes of expressways are four lanes going both ways. The lowest design speed is 100km/h. The minimum radius, effective shoulder width and minimum load axle are greatly improved. The additional lane for hilly sections and the expansion of the width of median strip are now reinforced. All the interchanges are separated by grade.

With the adoption of high design criteria, the capacity of expressway have been significantly expanded, the vehicle speed fastened, and the frequency of traffic accident have been greatly reduced. The convenience of driving has improved in many ways.

3.5. Advanced Operation and Maintenance System

The advanced operation and management systems of expressways not only manages expressways effectively, but they also have great influence on their safety and convenience. However, advanced technology and costs are incurred as a result. Korea introduced the advanced operation and management system in the 1990s.

Since 1993, a high-speed fiber optic network, vehicle detector, CCTV and variable message sign board have been installed in order to implement the Intelligent Transportation

System (ITS) in all the expressways. This has played a large role in improving the expressways' operation and management.

Since the introduction of the Electronic Toll Collection System (ETCS) in 1993, it has been possible to reduce delays caused by cash payments in toll booths for entering and exiting the expressways. The ECTS was further developed with the introduction of the Hi-Pass system, a non-stop toll payment system, since the mid-2000s.

In the late 1990s, an even more advanced maintenance system was introduced. The typical advanced systems are the pavement management system (PMS), the highway bridge management system (HBMS), the tunnel management system (TMS), CMS, and the road facility management system.

Chapter 7

Conclusion

Conclusion

Korea has a relatively short history of expressway construction and management, spanning just over 40 years. Nonetheless, in terms of both quantity and quality, Korea has now established one of the best expressway networks amongst advanced countries. During the last 40 years, Korea's economy has changed drastically, from being a low-income country in the 1960s to a high-income country in the present. Expressway construction and management system in Korea has also changed rapidly in accordance to its constant economic growth.

Perhaps it would be more effective to analyze the expressway system changes in chronological order. The past 40 years are divided into the first two expressways built in the late 1960s, the expressways built in the 1970s and 1980s, and lastly the expressways built in the 1990s and 2000s. Still, some preparatory stages should be carried out before expressway construction work is initiated. Now, expressway construction and management system is divided into six stages. This is necessary for the construction, planning, design criteria, construction, financing, and operation and maintenance of expressways.

After the Korean Civil War in the early 1950s, almost all infrastructures in Korea were seriously damaged. Up until the early 1960s, many efforts were put into the restoring the country. Furthermore, the government established the 1st Five-Year Economic Development Plan in 1962 to restructure the Korean economy. The top national priority was to develop the export-oriented economic system. Some industrial complexes were developed in and around Seoul, Incheon and Busan. The products manufactured in these cities were exported through Incheon and Busan ports. As the economic growth rates came to be higher than expected, freight cargo between Seoul and Incheon and Seoul and Busan have increased drastically. For this reason, the construction of the first two expressways, Gyeongin expressway connecting Seoul and Incheon and Gyeongbu expressway connecting Seoul

and Busan, were considered in the mid-1960s, just before the enacting of the 2nd Five-Year Plan in 1967.

As shown in <Table 7-1>, the first two expressways were constructed to connect industrial complexes and ports. Despite strong opposition of the Gyeongbu expressway by foreign aid agents and local experts, the President and a few central government officials have still come to constructing these expressways. There was no design criteria to follow and the construction work began along with detailed planning work. Since it was not possible to obtain foreign loans, the domestic financing sources were largely expanded and the government budget was almost completely spent. The Korea Expressway Corporation was soon established after the first expressway was opened.

In the 1970s and 1980s, due to continuous high economic growths, more industrial complexes were developed. The first ten-year expressway construction plan and the comprehensive national land development plan were also established. According to these plans, more expressways were constructed to connect industrial complexes. With the success of the first two expressways, it was possible to get foreign loans from the IBRD and ADB. Even though the design criteria were published in 1976, they were too low. Some two-lane expressways were also built. These low design expressways caused a lot of accidents later. The feasibility analysis had been conducted subjectively by the competent ministry, and from this a newly supplied expressways made to accommodate the rapidly increasing traffic volume.

Table 7-1 | Change by Each Phase of Domestic Expressway Construction and Management Process

Classification	Phase of first two expressways construction	Phase of construction in 1970s and 1980s	Phase of construction in 1990s and 2000s
Necessity	• Development of industrial complex • Increase of exporting·importing freight volume	• Expansion of industrial complex • Increase of road demand • National Land Development Plan	• Exponential increase of road demand • Construction of 7×9 axes expressway network
Plan	• Plan by president and a few government officials	• Mid- and long-term traffic related planning • Feasibility analysis by the competent ministry	• Pre-feasibility analysis by the budget ministry • Scientific planning by national transport DB

Classification	Phase of first two expressways construction	Phase of construction in 1970s and 1980s	Phase of construction in 1990s and 2000s
Design	• Design criteria doesn't exist	• Road Design Ordinance was published, however, it was a low design criteria	• High design criteria due to a revision a Road Design Ordinance
Construction	• Construction of domestic construction company • A fair number of poor cases were occurred in spite of the efforts for poor construction	• Development of construction skills through many number of foreign construction experience • Due to many poor constructions, the necessity of construction supervision system was raised	• Introduction of construction supervision system
Financial sources	• Due to a failure of foreign loan acquisition, most of construction was made by domestic capital • Concentrated investment through selection	• Due to a success of first two expressways, a large scale of foreign loan was acquired.	• By introducing transport tax and ear-marked account for transport infrastructure, the financing sources of road construction increased. • Private capital utilization by introduction of private investment system.
Management and maintenance	• Establishment of Korea Expressway Corporation • Still poor management and maintenance system	• Scale expansion and maintenance system of road construction was introduced, however, it is still poor.	• Introduction of advanced management and maintenance system

In the 1990s and 2000s, as the number of private cars greatly increased, road traffic congestion had become a serious issue. As a result, the large scale of the expressway master plan with 7×9 axes had been established. Many expressways were going to be constructed, despite the difficulty in financing them. Thus, the ear-marked transport tax system was

introduced along with a private capital inducement system by the public-private partnerships. There were some problems regarding the subjective biases of feasibility analysis result. In the late 1990s, the feasibility analysis has been conducted by the budget ministry. The objectivity and accuracy have been improved by developing the national transport database and by publishing the guideline manual on its methodology. More sophisticated expressway operation and management systems have been introduced in the late 1990s.

As mentioned above, there are many implications to be learned in low-income countries. Many of them could also be adopted in the mid- and high-income countries. However, since the socio-economic and cultural situations differ between Korea and other countries, the appropriate implications must be measured, analyzed, and implemented accordingly.

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