

99-53

21 가

(1)

**A Preliminary Study
on the Optimal Modal Split
of the National Transportation Systems**

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99-53

21 가

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**A Preliminary Study
on the Optimal Modal Split
of the National Transportation Systems**

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(EU)

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	13
1	17
1.	17
2.	18
3.	18
4.	19
5.	19
2	21
1.	21
2.	28
3.	33
3	37
1.	37
2.	53
3.	58

4	63
1.	63
2.	73
3.	80
4.	83
5	가	95
1.	.....	95
2.	.....	95
3.	.....	98
4.	가	98
6	.....	101
1.	.....	101
5.	.....	105
	.....	109
ABSTRACT	.....	112
1	.....	117
2	.....	127

< 2-1>	.....	21
< 2-2>	.....	29
< 2-3>	.....	31
< 2-4>	.....	31
< 2-5>	.....	32
< 2-6>	.....	35
< 2-7>	.....	35
< 3-1>	.....	38
< 3-2>	.....	39
< 3-3>	.....	40
< 3-4>	.....	41
< 3-5>	.....	41
< 3-6>	.....	42
< 3-7>	.....	42
< 3-8>	.....	42
< 3-9>	.....	43
< 3-10>	.....	43
< 3-11>	.....	44
< 3-12>	.....	47
< 3-13>	.....	48

< 3-14>		.....	49
< 3-15>		.....	50
< 3-16>		.....	50
< 3-17>		.....	50
< 3-18>		.....	51
< 3-19>		.....	52
< 3-20>	가	.....	53
< 3-21>		.....	54
< 3-22>		.....	55
< 3-23>		.....	55
< 3-24>		.....	59
< 3-25>	SOC	.....	60
< 4-1>	가	(1996)	64
< 4-2>	가	(1996)	65
< 4-3>		.....	65
< 4-4>		.....	66
< 4-5>	가	(1996)	67
< 4-6>	가	(1996)	68
< 4-7>		.....	68
< 4-8>		.....	69
< 4-9>	가	.....	71
< 4-10>	가	.....	71
< 4-11>	가	.....	72
< 4-12>	가	.....	73
< 4-13>		(1970 -1996)	76
< 4-14>		.....	82
< 4-15>		.....	84

< 4-16>	.....	91
< 4-17>	.....	93

< 1-1>	.....	20
< 2-1>	.....	28
< 2-2>	.....	33
< 2-3>	.....	34
< 3-1>	.....	47
< 3-2>	.....	52
< 3-3>	.....	56
< 3-4>	.....	56
< 4-1>	(1980-1994)	74
< 4-2>	.....	79
< 6-1>	가	107

가 21 ,
 가 .
 21 . ,
 ,
 '60
 가 ,
 '80 가
 가 .
 . , , 가 ,
 가 ,
 .
 가

1980

가

1980

1 GNP 가

가

가

가

(ITS)

가

가 가

(Intermodalism)

가

가

ITS

가

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2000

가

가

가

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21

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2020

(O/D)

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가

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가

가

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가

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SOC

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가

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21

가

가

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가

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가

2.

21

2000

가

가

3.

21

가

, , ,
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4.

가

가

21

4

가

SOC

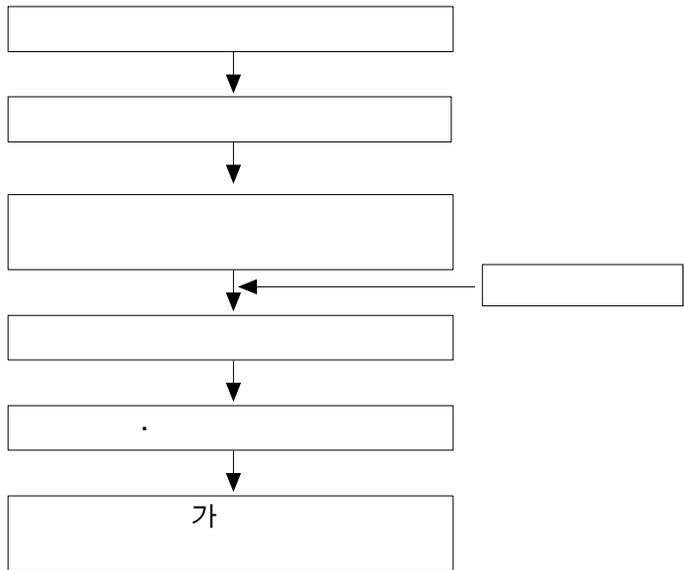
5.

21

6

가

< 1-1>



< 1-1 >

1.

, , . , ,
5
< 2-1> .

< 2- 1>

	1945 ()	1970 ()	1971 1980 ()	1981 1990 ()	1991 ()
		.			

< 2-1 >

	1945	1970 <1961 >	1971 1980	1981 1990	1991
	· 1, 2 ·	· · · · (68) · · 10	· · (1,200km)	· · , 88	· , 가 · 가 ·
	· ·	· · · ·	· ·	· () · 2,3,4 ·	· ·
	· ,	· · · 5 ·	·	· , ·	· () · (94)
	-	- · (69)	· ·	· · · 2 (88)	· ·

1) 1899 1945 :

가
가 4330

, 1,2 治道 ,

1911 1938 1,2 治道

24,500km (2.4%), 1945

25,550km , 1997 84,968km(

62,866km) 30% . 1898

, 1905 1945

6,362km(2,642km)

1997 85% .

1883 , , 3 1945

18,000 1997

(295,257) 6.1% .

2) 1970 :

(1954 1957)

, 가 1 3 , 가 1

8 , 2 2 . (1958 1962)

, ,

, (86.7% 82.1%), (9.7% 14.9%), (3.6%

3.0%) , (67.0% 60.5%), (30.8% 37.5%),

(2.2% 2.0%) . 1,2 5 (1961 1971)
 , , (-km, -km)
 ,
 (87.5% 57.6%), (8.6% 10.8%), (3.9% 31.6%) ,
 (52.2% 32.3%), (45.9% 66.0%), (1.3% 0.8%) .
 .
 , 6.25
 , (,) ,
 , ,
 .
 1961
 , 1962 1967
 , 1968 가 ,
 40,635km(14.2%)
 .
 1961 ,
 1997 97%
 3,020km .
 50% . 5 (1955
 1959) 1962
 48,000 (1972)
 , ()
 , 1948
 가 1969 () .

3) 1971 1980 :

3,4 5 (197
 1 1981) , , (-km, -km
) ,
 . (32.3% 23.7%), (66.0%
 75.2%), (0.8% 0.5%) , (57.6% 37.5%),
 (10.8% 35.0%), (31.6% 27.5%) .

, ,
 , ,
 () .
 , (70.7)

가 가
 , ,
 ,
 , 1980 5 km(34.6%)
 60% . 1972 1976

2
 , 1977 1981
 가 31.6%
 가 . 1970

,
 가 가 . 2 (1988)
 70 80
 , 29 47 ,

1979 166 117 , 1980
 (-km, -km) 1997
 5.8%, 3.4% .

4) 1981 1990 :

5,6 5
 (1981 1991) , , (-km,
 -km) , (가)
 가 가 , (23.7% 25.6%),
 (75.2% 71.5%), (0.5% 0.3%) , (37.5% 19.6%),
 (35.0% 46.9%), (27.5% 33.4%) .

, 88 ,
 () 2,3,4 ,
 , 2 () .

5,6 5 (198
 2 1991) 58,088km , 76.4%
 , 1980

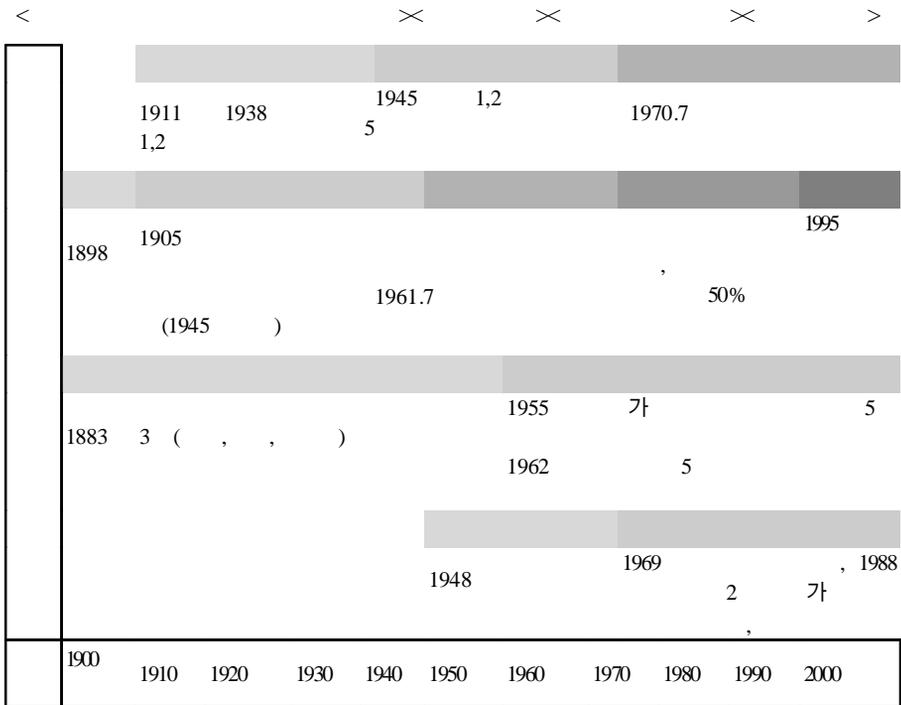
가 가 가
 가 . 가 20%
 가 . 가

2.

1)

가 가

< 2-1>



< 2- 1>

2)

(1)

1903 40 (稱慶式)
 1
 1911 1938 1,2 治道 24,500km
 , 1945 25,550km (4.2%)
 '97 84,968km (62,866km) 30%
 1961 , 1962
 1967 , 1968
 가 , ,
 ('70.7) 가 가

< 2-2 >

	1903	1945 1969	1970
	• 1903 • 1911 1938 1,2	• 10	• (1,200km) • , 88
	• : 25,550km (30%) • : 1,067km (: 4.2%)	• : 40,244km (30%) • : 3,864km (: 9.6%)	• : 84,968km • : 62,866km (:74%)
	•	• ()	•

1980

가 , 가 가 , 1997 84,968km
 가 가 ,
 (97 4,323km) .

(2)

1898 , 1905
 , 1945
 6,362km (2,642km)
 1997 85% .
 1961 ,
 1997 97%
 3,020km .
 50% .
 1972 1976 2 ,
 1977 1981 가 가
 31.6% 가
 , 20%
 가 . 가 가
 가 가 가 가 21

< 2-3>

	1898	1904	1905	1945	1945	1970	1971	1990	1991
	· 1898		· 1905		· 1961		·		·
	-		· 2,642km (85%)		· 3,020km (97%)		· : 3,121km		· : 3,118km
	-		·		·		· (20%)		-

(3)

1883 , , 3 1945
 18,000 1997 (295,257)
) 6.1% .
 5 (1955 1959) 1962
 1997
 295,257 ,
 () , 1970

< 2-4>

	1883	1945
	· 1883 , , 3	· 5 · ,
	· : 18,000 (6.1%)	· : 295,257
	·	·
	·	·

가 가

가

(4)

1948 가 () 1969
 , 2 (1988)

70 80
 , 29 47

, 1979 166 117

, 1980 (-km, -km) 1997

5.8%, 3.4% 가

가 1989

10

< 2-5>

	1948 1969	1970
· 1948		· · · 2 ((88))
·	((69))	· ·

3.

1)

40 1980 가

-km '60

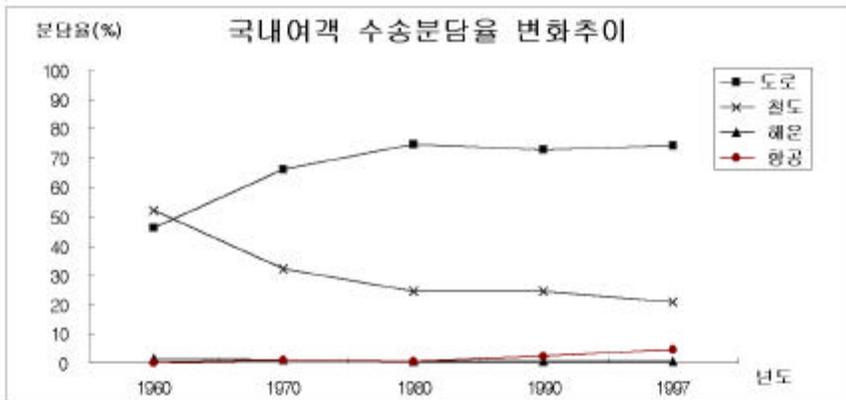
52.2%, 46.0%, 1.6%, 0.2% '97 20.9%,

74.3%, 0.3%, 4.5%

'60 가

6.25

1 5



< 2-2 >

2)

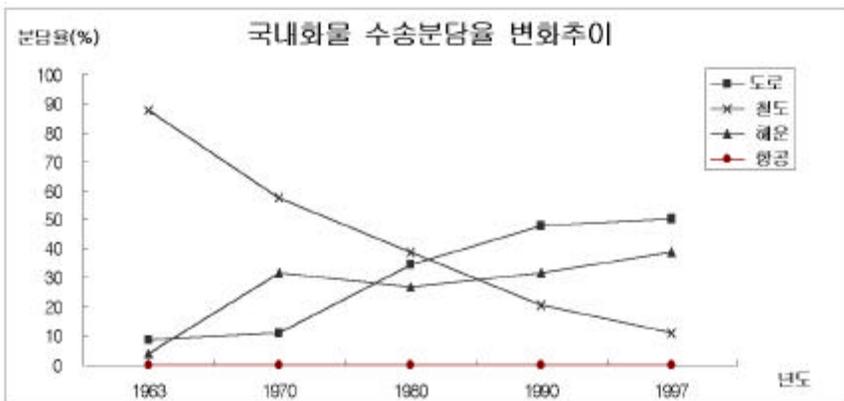
가 가
 , -km '63 87.5%,
 8.6%, 3.9%, 0.0% '97 10.8%,
 50.4%, 38.6%, 0.1% . '80
 가 가 ,

'70

가

가

가



< 2-6 >

	1960	1970	1980	1990	1997	가 (%)
(km)	25,550 (:16,241)	40,244	46,950	56,715	84,968	2.3
(km) (%)	1,067 (4.2)	3,864 (9.6)	15,599 (33.2)	40,544 (71.5)	62,866 (74.0)	8.1 (5.7)
(km) (km)	6,362(:2,642) -	3,020 5,500	3,199 6,007	3,121 6,435	3,118 6,580	0.3 0.6
()	18,000(:10,000)	18,781	82,261	224,323	359,929	6.0

: 1960 1945

: () ,

< 2-7 >

(: · km , · km)

		1960		1970		1980		1990		1997	
		4,344	46.0	20,045	66.0	72,391	75.2	126,338	71.5	148,247	74.3
		4,935	52.2	9,819	32.3	22,785	23.7	45,361	25.6	41,764	20.9
		147	1.6	241	0.8	479	0.5	524	0.3	571	0.3
		21	0.2	257	0.9	557	0.6	4,447	2.5	9,052	4.5
		429('63)	8.6	1,441	10.8	10,085	35.0	34,780	46.9	59,082	50.4
		4,358('63)	87.5	7,709	57.6	10,815	37.5	14,494	19.6	12,710	10.8
		194('63)	3.9	4,232	31.6	7,927	27.5	24,737	33.4	45,299	38.6
		0.2('63)	0.0	1.5	0.0	6	0.02	79	0.1	149	0.1

: 1980 ,

: () ,

2)

(1)

. < 3-2>
37가

< 3-2>

		□ ,
		□ ,
		□ , ,
		□ □ □
		□ km □
		□
		□ □
		□ □
		□

(2)

< 3-3> ,
 94km/h, 80km/h, 71km/h . ,
 , 가 13.67%,
 55.71%, 30.62% .

< 3-3>

	(km)						
	444.5	4:10	107	4:50	92	5:31	81
	418.5	4:34	92	5:08	82	5:43	73
	359.9	3:43	97	4:10	86	4:23	82
	449.4	5:30	82	6:00	75	6:51	67
	404.3	4:11	97	4:53	83	-	-
	444.0	4:47	93	5:37	79	-	-
	437.8	4:51	90	-	-	-	-
	255.7	3:55	95	4:18	60	4:47	54
			94		80		71
	313.9	5:17	59	5:40	55	6:08	51
	359.0	6:05	59	-	-	7:00	51

: , , '21 가 , 1998

< 3-4>

()	15,323,095	62,440,773	34,320,747	112,084,615
(%)	13.67	55.71	30.62	100

: , (), 1998

,

,

가 79km/h , 80km/h, 80km/h, 350km/h .

4 57

4 40 , 5 20 ,

1 5 .

55 11

가 .

< 3-5>

(km/h)	79	80	80	350	23.6	
(km/h)	150	180	100	-	-	
	4:57	4:40	5:20	1:05	-	
	5:14	4:10	5:00	1:00	-	
	6:05	3:20	3:50	0:55	-	
	-	-	-	0:55	11:30	

: , , '21 가 , 1998

, www.koreanair.co.kr

, (), 1998

<http://www.kicc.co.kr/info/bus/bus.htm>

1 5 700 , 1 9 700 ,
 4 4 300 .
 가

< 3-6>

(:)

	(km)						
	444.5	26,300	32,800	18,100	24,000	-	-
	418.5	24,800	31,300	17,100	23,000	-	-
	359.9	21,300	26,000	14,700	18,000	9,400	12,900
	313.9	18,600	23,300	12,800	16,100	-	-
	359.0	21,300	26,000	14,700	18,000	-	-

: , www.korail.go.kr, 1999

< 3-7>

	()		
	6,000	8,700	1:50
	11,100	16,400	3:50
	15,700	23,400	5:20
	11,900	17,700	3:55
	14,100	20,900	5:20
	9,200	13,500	3:50

: http://www.kicc.co.kr/info/bus/bus.html, 1999

< 3-8>

()	44,300	59,100	34,800	37,000	28,100	48,900	43,900	32,100	41,700
	1:05	1:10	0:55	1:00	0:55	1:00	1:00	0:50	1:00

: , www.koreanair.co.kr, 1999

< 3-9>

()	1	1,200	3,200	5,700	9,900	10,800	14,100
	2	1,200	3,300	6,000	10,300	11,300	14,800
	3	1,200	3,400	6,100	10,600	11,500	15,100
	4	2,000	5,700	10,300	18,000	19,600	25,500
	5	2,000	5,800	10,500	18,300	19,900	26,000

: , www.freeway.co.kr, 1999

< 3- 10>

(: km/)

	91	92	93	94	95	96
	13.60	13.87	13.89	13.43	12.86	12.97

: , www.kores.or.kr

< 3-11>

1

가

,

가

,

가

,

,

가

.

96

1

1200

2

1.73

,

30

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< 3- 11>

					Total
		0	1100	500	1600
		0:0	0:05	0:10	1:55
		0:10	1:10	0:20	
					Total
		500	1,300	500	2,300
		0:10	0:10	0:10	2:20
		0:30	1:00	0:20	
					Total
		(10km)	(31.2km)	(10km)	
		930	4100	930	5,960
		0:10	0:20	0:10	0:40

					Total
		0	6,800	500	7,300
		0:0	0:15	0:10	2:55
		0:10	2:00	0:20	
					Total
		500	6,000	500	7,000
		0:10	0:07	0:10	3:07
		0:30	1:50	0:20	
					Total
		(10km)	(152.3km)	(10km)	
		930	20,400	930	22,260
		0:10	1:30	0:10	1:50

: , , '21 가 , 1998

, www.koreanair.co.kr

, www.korail.go.kr

, www.freeway.co.kr

<http://www.kicc.co.kr/info/bus/bus.htm>

					Total
		0	13,200	500	13,700
		0:0	0:15	0:10	4:35
		0:10	3:50	0:10	
					Total
		500	11,100	500	12,100
		0:10	0:15	0:10	5:05
		0:30	3:50	0:10	
					Total
		(10km)	(288.5km)	(10km)	
		930	37,000	930	38,860
		0:10	3:00	0:10	3:20
					Total
		1,100	34,800	1,100	37,000
		0:10	0:30	0:10	3:25
		1:00	0:55	0:40	

					Total
		0	26,300	500	26,800
		0:0	0:15	0:05	5:10
		0:10	4:10	0:30	
					Total
		500	15,700	500	16,700
		0:10	0:08	0:10	6:38
		0:30	5:20	0:20	
					Total
		(10km)	(428km)	(10km)	
		930	54,400	930	56,260
		0:10	4:20	0:10	4:40
					Total
		1,100	44,300	1,100	46,500
		0:10	0:30	0:10	3:25
		1:00	1:05	0:30	

					Total
		0	24,800	0	24,800
		0:0	0:30	0:10	5:34
		0:10	4:34	0:10	
					Total
		500	14,100	0	14,600
		0:10	0:15	0:10	6:35
		0:30	5:20	0:10	
		(10km)	(453.4km)	(57km)	Total
		930	53,300	5,200	59,830
		0:10	4:30	0:45	5:25
					Total
		1,100	43,900	1,100	46,100
		0:10	0:30	0:10	3:50
		1:00	1:00	0:40	

					Total
		500	21,300	500	22,300
		0:05	1:00	0:10	7:12
		0:20	5:17	0:20	
					Total
		500	9,200	500	10,200
		0:10	0:08	0:10	4:58
		0:30	3:50	0:10	
		(10km)	(229.6km)	(3km)	Total
		930	31,200	300	32,430
		0:10	2:40	0:05	2:55
					Total
		1,100	37,000	1,100	39,200
		0:10	0:30	0:10	3:20
		1:00	1:00	0:30	

가 . 167 .
 165 .
 98.8% . 100
 59.9% , 16 9.6% , 28
 16.8% .
 가

< 3- 13> .

	(A)	(B)	B/A (%)	(C)	C/A (%)	(D)	DA (%)	(E)	E/A (%)
	7	7	100.0	7	100.0	5	71.4	3	42.9
	31	30	96.8	21	67.7	0	0.0	1	3.2
	18	18	100.0	8	44.4	3	16.7	5	27.8
	15	15	100.0	8	53.3	0	0.0	4	22.2
	11	11	100.0	9	81.8	1	9.1	0	0.0
	20	20	100.0	10	50.0	1	5.0	7	35.0
	23	22	95.7	16	69.6	2	8.7	1	4.3
	24	24	100.0	13	54.2	2	8.3	4	16.7
	14	14	100.0	8	57.1	1	7.1	1	7.1
	4	4	100.0	0	0.0	1	25	2	50.0
	167	165	98.8	100	59.9	16	9.6	28	16.8

1997 343,159 ,
 11,603 673 , 357 ,
 26 , 232 , 285
 가

144.7 , 772 가 .
 가 8.7 ,
 3 가 . , 1997 246,452 ,
 937 263
 0.381 0.047 8 .
 가 가 62.2 .

< 3- 14 >

	-km	148,247	41,764	9,052	571
		246,452	937	4	840
		343,159	673	26	285
		11,603	357	232	
	/ -km	2.315	0.016	0.003	0.500
		0.078	0.009	0.026	
	/	1.392	0.718	6.5	0.280
		0.047	0.381	58	
	()	2,314,916	4,540	175	50,234
		2,045,152	62,925	40,892	
	()	47,336	3,345	96,850	-
	()	4,407,404	70,810	137,917	50,234

: , 1997
 : , , 1998
 , , 1998
 , , 1992

(3)

, km

4 km 320 428
 4 1.34 .

< 3- 15>

(4)	320 / km
()	428 / km

: 98 가
 97 가

: , 1998 , 1998
 , , 1998

< 3-16> < 3-17> , 가
 2.2 .

< 3- 16>

(m)	13.2	23.4	30.6	37.8	45.0	52.2	59.4
(/1 /)	4,012	14,330	21,495	28,660	35,825	42,990	50,155
	2	4	6	8	10	12	14

: , , 1991

< 3- 17>

(m)	13.2	22.3	30.9	40.6	49.2	58.9	67.5
(/1 /)	21,000	42,000	63,000	84,000	105,000	126,000	147,000
			3	4	5	6	7

: , , 1991

(Train) 가 .(, 1998:37) < 3-18> 4 2.8 7.3 .

< 3- 18>

		()		(4)		
(m)		9.3m		24.4m		
	가	12 1,000	50 750	40	4	10
		3	4	15	3	10
		20	15	360	1,800	540
		20,000	11,250	14,400	7,200	5,400
lm		2,151	1,210	590	295	221

: 久保田 傳, , 1995. 25p.

가 , 가 . 1995 20.6% 24,442.7 가 77.6% 1000kcal 가 7.19 -km 0.4 -km 18 , 0.35 -km 20.8 . ,

1000kcal 가 10.24 -km 0.47
 -km 21.6 , 5.98 -km 1.7 .

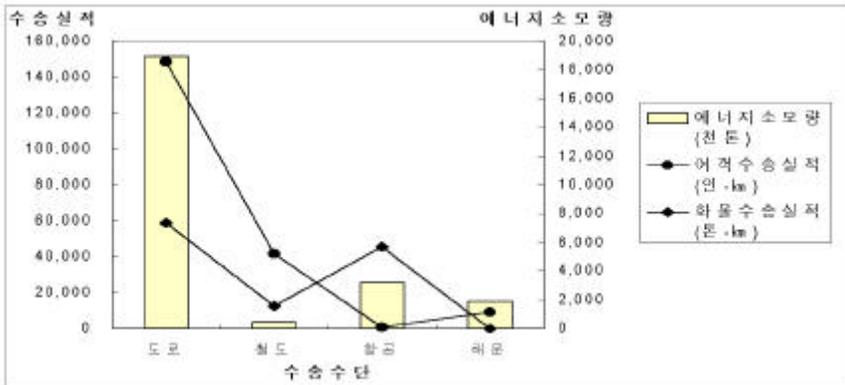
< 3- 19>

	()	18,962.2	453.8	3,163.8	1,862.9	24,442.7
	(%)	77.6	1.9	7.6	12.9	100.0
	(kcal/ -km)	2,522.41	139.10	-	2895.54	5557.05
	(kcal/ -km)	2,111.67	97.69	-	167.16	2376.52
	(-km/ 1000kcal)	0.40	7.19	-	0.35	0.18
	(-km/ 1000kcal)	0.47	10.24	-	5.98	0.42
		18.1	1.0	-	20.8	-
		21.6	1.0	-	1.7	-

:
 : , , , 1997

77.6% 18,962

. (3-2)



< 3-2>

(4) :

가 , 가

CO2 43%, 20%
3.4

< 3-20>

가

(: g/ -km, -km)

		CO2	CO	NOx	CxHy
		180	11	2.1	2.3
		78	0.13	0.46	0.30
		160	0.28	0.71	0.31
		207	2.4	3.6	1.1
		41	0.05	0.2	0.08
		1,160	1.4	5.3	0.8

: C.C.E. 1995. Vers une tarification equitable et efficace dans les transports: Options en matiere d'internalisation des couts externes des transports dans l'U.E. Livre Vert. COM(95)

2.

O/D

1998

가 가 가

(2)

. (3-3, 3-4)

< 3-22>

(: ,)

	50km	50~100km	100~200	200~300	300~400	400km	
	63,473	20,082	18,710	19,580	7,879	7,262	136,987
	3,367,088	1,065,788	853,674	158,960	44,187	42,026	5,531,724
	0	0.1	333	4,398	10,804	3,970	19,504
	3,430,561	1,085,871	872,717	182,937	62,871	53,259	5,688
	14,100	4,758	8,014	18,822	5,208	6,058	57,859
	359,385	199,781	238,425	109,163	41,882	14,345	962,981
	0	0	0.9	37	165	153	361
	374,385	204,539	246,440	128,027	47,255	20,561	1,021,202

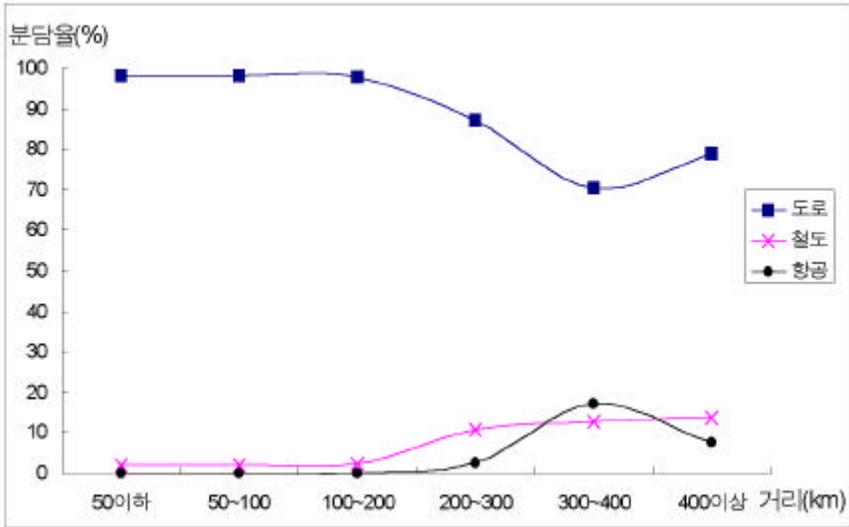
: 1994 O/D , 1998 O/D

: , , 1999

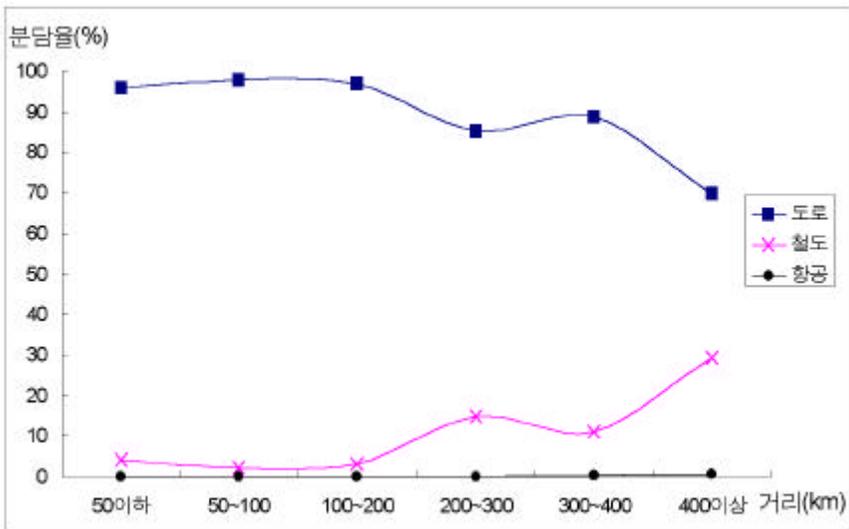
< 3-23>

(: %)

	50km	50 100km	100 200km	200 300km	300 400km	400km
	1.85	1.85	2.14	10.70	12.53	13.64
	98.15	98.15	97.82	86.89	70.28	78.91
	0.00	0.00	0.04	2.40	17.18	7.45
	100	100	100	100	100	100
	4.01	2.23	3.25	14.70	11.02	29.46
	95.99	97.67	96.75	85.27	88.63	69.77
	0.00	0.00	0.00	0.03	0.35	0.77
	100	100	100	100	100	100



< 3-3>



< 3-4>

2)

가 . 가, 가, 가, 가, 가

가

가

가

262km '97 4,323km 29.0% 가 '87

'91 5 '97 18

20.1% 가

'97 가 69 6

(GDP) 16.5% , '97 가 (GDP

10.7%) 1.6 , 18

가 46

가 , 1997

246,452 , 937 , 4 , 840

가 ,

가 가 62.2

가 , 1995

20.6% 24,442.7

가

77.6%

가

가

가

3.

1)

1970

1980

가

가

가

가

가

가

가

가

가

가

2)

40

5 1962 6 1991
 30
 , 1 5 60.6% 6
 10.1% 1 17.2% 6
 79.6%

< 3-24 >

(: %)

	1 1962- 1966	2 1967- 1971	3 1972- 1976	4 1977- 1981	5 1982- 1986	6 1987- 1991
	60.6	28.7	29.4	21.7	12.1	10.1
	17.2	52.0	51.6	47.1	46.7	79.6
/	22.2	15.5	16.3	15.0	10.6	9.2
	-	3.8	2.7	16.2	30.6	1.1

: , , 1992

5

55%

3 ,
 5 14 277
 4 4,168 3.2 가

가

가 , 가 , 가 , 가

< 3-25> SOC

(: , %)

		1992	1993	1994	1995	1996	가
		17,555	21,049	28,396	32,444	40,833	23.5
		61.1	56.4	57.0	54.4	55.6	
		4,720	7,303	7,973	10,598	13,574	30.3
		16.4	19.6	16.0	17.8	18.5	
		2,500	3,810	6,500	8,292	8,399	35.4
		8.7	10.2	13.1	13.9	11.4	
		1,089	2,079	3,200	3,628	4,452	42.2
		3.8	5.6	6.4	6.1	6.1	
		2,874	3,075	3,714	4,671	6,147	24.6
		10.0	8.2	7.5	7.8	8.4	
		28,738	37,316	49,783	59,633	73,405	26.4
		100.0	100.0	100.0	100.0	100.0	

: , 1996

가

가

,
가 .

3) .

, ,

가

, ,

.

4

가 ,
가 . . . ,
.

1.

1)

(1)

가

가

15.5km/ 가 가 5.52km/ 가
 가 10.6km/ 1
 6.9km/
 1.8km/
 0.31km/ km²() 4.61km/ km²()
 가 가 .

< 4- 1> 가 (1996)

(km)	143	62	69	138	345	317	372	127	893	633	3099	304.4
(km/)	14.1	11.7	6.9	15.5	8.78	5.52	6.33	8.20	15.29	7.73	-	10.6
(km/km ²)	4.61	1.44	0.75	0.31	0.68	1.05	1.52	3.10	1.63	1.77	-	1.40

: , OECD 가 , 1998
[http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

(,)
 가 , 가
 ,
 (< 4-2>).

< 4-2> 가 (1996)

(km)	3.4	2.4	3.1	10.3	12.6	16.1	16.9	2.8	32.3	41.4	141.3	14.4
(km/)	0.33	0.45	0.31	1.16	0.32	0.28	0.29	0.18	0.55	0.51	-	0.54
(km/ km ²)	19.7	55.7	33.7	22.9	25.0	53.4	69.0	68.3	58.8	116.0	-	56.2

: , OECD 가 , 1998
[http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

(2)

100% 10
 90% 93.7%,
 6.3% 15
 92.9% 94.7% 가

< 4-3>

(:%)

	93.5	94.2	96.1	92.7	92.5	92.9	94.7	91.4	91.9	91.8	93.7
	6.5	5.8	3.9	7.3	7.5	7.1	5.2	8.6	8.2	8.2	6.3

:
[http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

가
 가 .
 91.9% 가
 67.2%, 66.2% 가 58.2% 가 .
 가
 37.6% 21.0%
 5.0% 6.2% .
 5.2
 가 .
 33.2% 가가

< 4-4>

(: %)

	75.0	82.9	90.3	62.4	91.9	85.3	85.0	58.2	67.2	66.2	77.9
	12.7	6.2	9.7	37.6	5.0	9.2	7.5	2.9	21.0	15.9	15.1
	9.6	0.0	0.0	0.0	0.0	0.1	0.1	33.2	2.4	14.4	2.7
	2.6	10.9	0.0	0.0	3.0	5.4	7.3	5.6	9.3	3.4	4.2

: [http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

2)

(1)

3,099 km 2.3 7,269 km , 10
 52.5 km/ 10.6 km/ 5 .
 가
 가 , 가 .
 0.39 km/ km² 28%

< 4-5> 가 (1996)

(km)	6420.3	849.1	7269.4	3635.1
(km/)	24.2	28.3	-	52.5
(km/km ²)	0.68	0.09	-	0.39

: , OECD 가 , 1998

[http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

190 km 10
 141 km 가 0.56km/
 10 0.54 km/
 9.9km/ km² 10 (56.2km/ km²)

< 4-6> 가 (1996)

(km)	176	14	190	94
(km/)	0.66	0.45		0.56
(km/ km ²)	18.4	1.4		9.9

: [http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

(2)

88.7% 1% 가 10% . , .

< 4-7>

(: %)

	88.9	88.4	88.7
	0.6	0.3	0.5
	10.5	11.3	10.8

: [http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)

가

가

. ,

< 4-9> 가 (1996)

(: %)

	78.0	93.7	99.4	69.4
	22.0	6.3	0.6	30.6

: 1997

가

가

83.8% 16.2% 82.4% 17.6%

가

2

< 4-10> 가 (1996)

(: %)

	82.4	83.8	42.0	92.0
	17.6	16.2	58.0	8.0

1: 1997

2:

1)

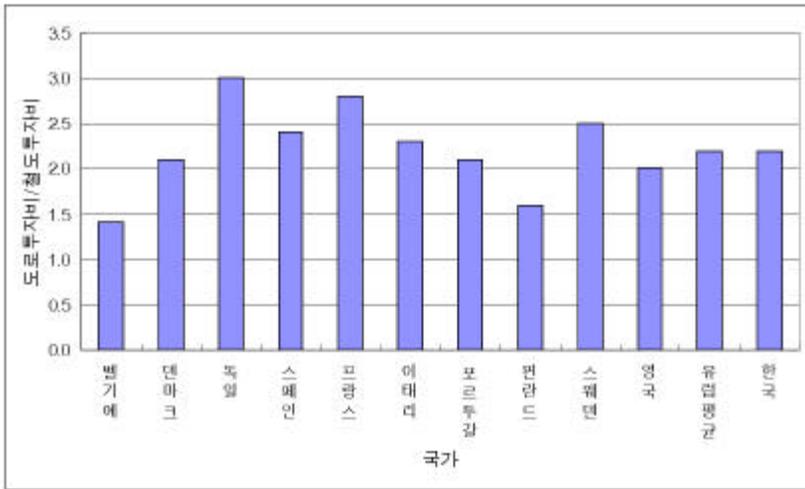
(1)

< 4-1> 1980 1994 10
 . 10 2.2 1.0 , ,
 3.0, 2.8, 2.5 .
 10 14 2.2
 . 15 가

(ECMT, 1983/ 1998).¹⁾

1990

가 가 .



< 4-1>

(1980-1994)

1) , 가

1970 1996 10
 237400km 306500km 29.1% 가
 17100km 15700km 8.2% 가 10
 가 , 11299km 11km 가
 가 .
 1970 1996
 , 1970 10 가
 13.9 12.6 .
 가 가 26.5 22.0
 2.9 8.4 . 1996
 10 1970 가 가
 10 19.6 .
 26.5 1970 10
 .
 1970 1996
 10 0.41
 가 (1.75) (1.87)
 (0.06) (0.08) 가 .
 1.10 , 2
 , 1970 가
 .

< 4- 13>

(1970 - 1996)

가	1970			1996			가 (B-A)/A
	(km)	(km)	/ (A)	(km)	(km)	1996 / (B)	
	12100	4232	2.9	14300	3380	4.2	0.48
	62300	2352	26.5	71600	2349	30.5	0.15
	432100	29527	14.6	633000	40826	15.5	0.06
	139400	13668	10.2	345000	12284	28.1	1.75
	792900	36117	22.0	893000	31852	28.0	0.28
	284200	16069	17.7	317000	16014	19.8	0.12
	30300	3591	8.4	69000	2850	24.2	1.87
	72100	5870	12.3	77800	5881	13.2	0.08
	191900	12203	15.7	272900	10300	26.5	0.68
	357300	19691	18.1	372000	17128	21.7	0.20
	237400	17100	13.9	306500	15700	19.6	0.41
	1023600	27104	37.8	1160000	20300	57.1	0.51
	40200	3194	12.6	82000	3100	26.5	1.10

:
 : , OECD 가 , 1998
 , , 1997
[http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm)
 , 世界の 統計, 1999

(2)

1970 10
 , 1970 88% 1996
 93% 가 , 1970 12% 1996 7%

가 , , ,
 1970 91.2%, 91.1%, 89.2%, 88.7%
 1996 94.6%, 91.8%, 91.3%, 92.6% 가 .
 1970 가
 가 .
 , 10
 1970 1996 2.2 가 3.1%
 가 . 가
 , , , 1970 1996 1.8 ,
 1.6 , 2.0 , 2.6 가 .
 6.6 가 , 가 가
 . 15
 가 1970 1996 가
 82.4% 가 가 , 2.5%,
 8.2%, () 0.9%, 6.0% 가

([http// europa.eu.int/ en/ comm/](http://europa.eu.int/en/comm/) , 1999).

가 1970
 , 1970 61% 1996
 84% 가 39% 16% .
 1970 1996
 가 .
 가 1.8 가 2.2%
 가 . 2.7 ,
 1.05 , 1.3 가 0.77

([http// europa.eu.int/ en/ comm/](http://europa.eu.int/en/comm/) , 1999).

20

가

1996

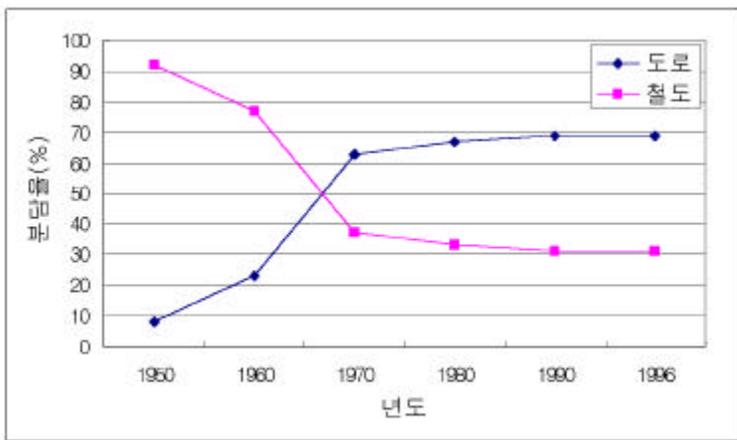
가

가

1970 587,200 km

1996 1,408,600 km

2.4 가



< 4-2 >

()

1970 가 73%, 27%

가

가

가

1996

92%

8%

3.

1)

< 4-14> 10 1970 1996
 26 가
 1) 가 , 2) 1 GNP 가 , 3)
 가 . 3
 (stepwise)

가 = -0.143
 + 0.932 × 가
 + 0.268 × 가 (R²=0.88)
 , 3 가
 가 가
 가 가
 가 . 1 GNP 가
 가
 가 1

. 1

가

.

가

.

가

(,

)

(

)

가

.

가

. 2

.

.

< 4- 14>

가	1970-1996 가 ¹⁾	1 GNP ²⁾ (\$)						1970-1996 가
		1970 (A)	1996 (B)	1970-1996 가 ((B- A)/A)	1970 (C)	1996 (D)	1970-1996 가 ((D- C)/C)	
	0.48	2417	23792	8.84	214	424	0.98	0.91
	0.15	2992	32146	9.74	218	329	0.51	0.35
	0.06	2738	28870	9.54	230	501	1.18	0.11
	1.75	985	14350	13.57	70	413	4.90	2.68
	0.28	2505	26280	9.49	234	376	0.61	0.27
	0.12	1585	19880	11.54	189	571	2.02	0.68
	1.87	1126	10160	8.02	49	277	4.65	3.14
	0.08	1998	23314	10.67	155	379	1.45	0.21
	0.68	4011	25735	5.42	284	413	0.45	0.21
	0.20	2035	19600	8.63	183	369	1.02	0.69
	0.41	2036	22413	10.00	183	405	1.21	0.80
	0.51	1690	40940	23.22	169	552	2.27	0.30
	1.10	250	10543	41.17	4	226	55.50	0.39

: 1) < 4-13>

2) 가

: , OECD 가 , 1998

Internet Website ([http:// europa.eu.int/ en/ comm](http://europa.eu.int/en/comm))

, , 1980

2)

가

가

가 .
 1000
 1/ 5 1/ 8,
 . 1 GNP(1996
 \$10640) 1980 , 1000
 (1996 226) 1970
 . 1 1970
 (, 1980; , 1995).

가 가 1 가
 , 가
 가 가
 . 가 1970
 1 GNP 가

가 .

4.

1)

가

. < 4-15>

< 4- 15>

		-	-
		-	- - TEA-21
	- 가	- 가	- 가
		-	- (Road Traffic Reduction Act) - ABC - Voonerf
	- , ,	- , , , , (Road Safety Audit) - - TEA-21	

가

(1)

1971

“

”가

가

가

1988

21

“

”

1998

5

가

(

),

가

(, 1999).

가

가

(, 1999).

(2)

1992 7 92 (BVWP'92)

(53.8% . 1991~2012

2,136 , 2,096 , 303

가

200km/h 3,200km

1991 2010

, 1)

가 , 2)

가 (, 1996).

가 ”

”

. 1992 2

(Nettetal)

(Bundesministerium fuer Raumordng Bauwesen und Staedteban, 1993).

-
-
-
-

(3)

(Road Safety Audit) . 1980 가 (Motorway) (Safety Checking) 1991 (Trunk Roads) . 가 (/ , 1999). 1) , 2) , 3) , 4) . 1990 5,217 1994 3,650 30% . 14:1 (TRL, 1999). , (Road Traffic Reduction Act) 1997 1998 7 가 . . 1990 32%

가 1.6km

가

가

3

6

(, 1998).

(4)

. ABC

가

. ABC

A :

가 가

B :

(District)

C :

ABC

- ISTE
program

- ITS

TEA-21
1998 2003 (Clear Air Act) \$81

TEA-21
가 가
(Swift Rail Development Act) 1998
2001 \$140 ([http:// www.fhwa.dot.
gov/ tea21/](http://www.fhwa.dot.gov/tea21/), 1999).

70%
(LEV: Low Emission Vehicle)
(, 1999).

(1)

< 4-16> 1981 . 1981 1997
 25.3% 가
 74% 가 1981
 13.3% 1997 18.5% 가
 10%
 2000

< 4- 16>

	1981	1986	1991	1997
(km)	1,069	1,805	1,805	1,835
(km)	314,500	334,800	386,300	394,000
(km)	41,790	55,943	72,172	72,816

: 運輸白書, , 1981, 1991, 1998

(2)

(Commission for Transport) 가

5% . 2010
 TGV ICE
 가 . 1981 가 301km
 150km 가
 1997 85km, 20km, 427km,
 471km, 1272km, 248km, 25km
 (< 4-17>).
 , 1991
 Hambrug Frankfurt ICE
 127,000 177,000 가
 27.9% 38.7% 가 (/ , 1998). Muenchen Frankfurt ICE
 가 30% (, 1996).
 TGV 가 1990 31%
 1996 56% 가 .
 가 TGV
 가가 . Madrid Sevilla
 AVE 1993 가 280
 86%가 .
 ICE 2 28% 38% 1
 60% 80% (/ ,
 1998).

< 4- 17>

(: km)

1981	-	-	-	-	301	150	-	451
1983	-	-	-	-	417	150	-	567
1988	-	-	90	-	417	224	-	731
1990	-	-	90	-	699	224	-	1013
1991	-	-	427	-	699	224	-	1350
1992	-	-	427	471	737	248	-	1883
1993	-	-	427	471	1057	248	-	2203
1994	-	-	427	471	1185	248	25	2356
1996	14	-	427	471	1272	248	25	2457
1997	85	20	427	471	1272	248	25	2548

: [http:// europa.eu.int/ en/ comm/](http://europa.eu.int/en/comm/)

3)

1

1980

. 2

1980

1

. 1 1 GNP 가 ,
가 가

. 2 1

, ,

(:

) . 2

(,)

가

1.

가

,

.

2.

1)

(1)

- , 2004) 2 (- , 2010) 가 1 (,
 2 가 가

.

2.6 (1 52

), 8.6 가
가

(2)

가

가

30 60

- , - 2001

40%

,

,

.

2)

(1) (ITS)

'90 ITS 가 3

2010

가

(2)

가
 , , 가
 , 가

3)

, 가
 가
 가

4)

SOC
 (1999) ' 가 ' 2019
 20 SOC
 ' ' 가 (2).

3.

WTO

13

2020 6

가

가

(Intermodalism)

, 가

4.

가 가

21

가

1) 가

가

,

,

,

.

100

4)

.

5)

.

10 가

.

1.

가 . 가

21

. , ,

.

, '60

가

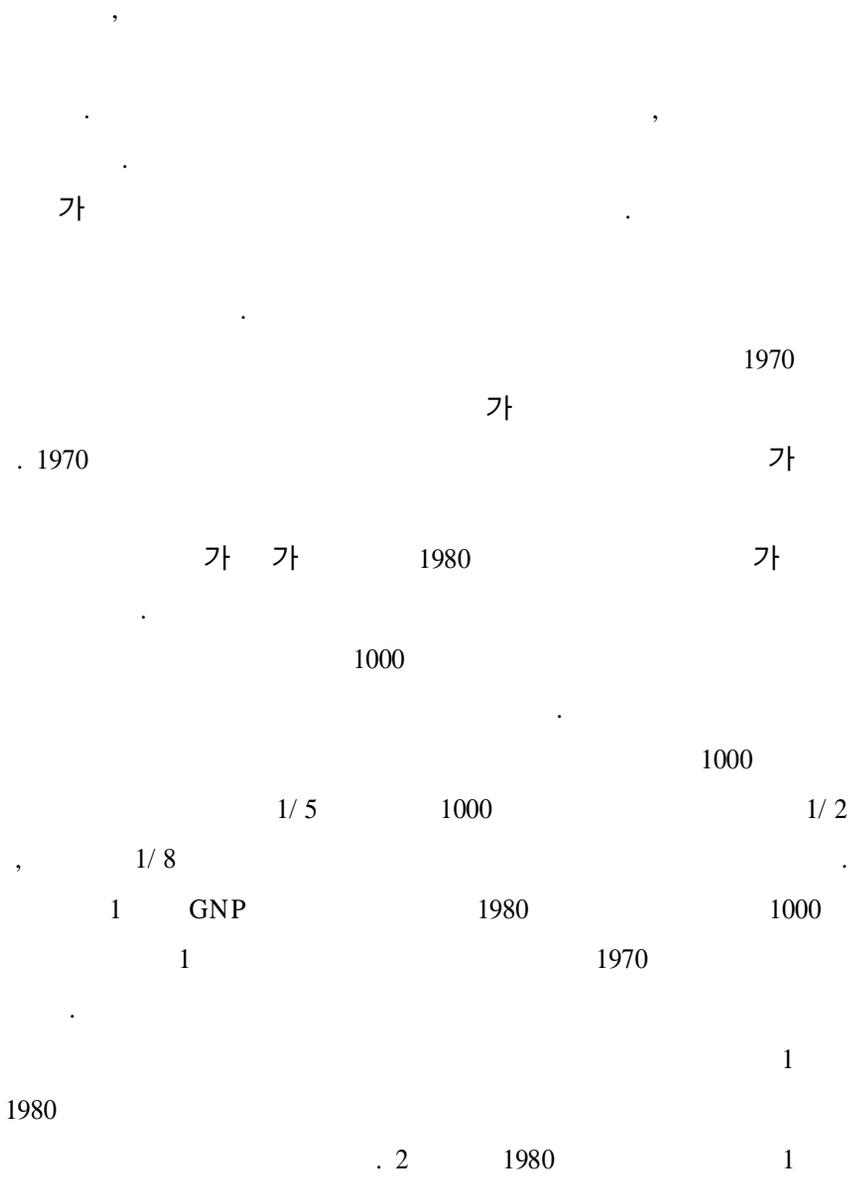
,

6.25

1

5

가 . '80 가 ,
 ,
 '70
 , 가
 가 가
 ,
 가
 가 , 가 , 가 , ,
 가 가 1970 1980
 가 가
 40 ,
 , ,



. 2

가 1980 1 GNP 가

가

가 가

가

(ITS)

21

가

가

가 가

(Intermodalism)

가

가

가

가

가

, 가 가

, ITS

가

10 가

2.

가

1) 21

1

21

4

, 가

SOC

SOC

SOC

2)

O/D

2020

(O/ D)

3)

가

1

가

4)

가

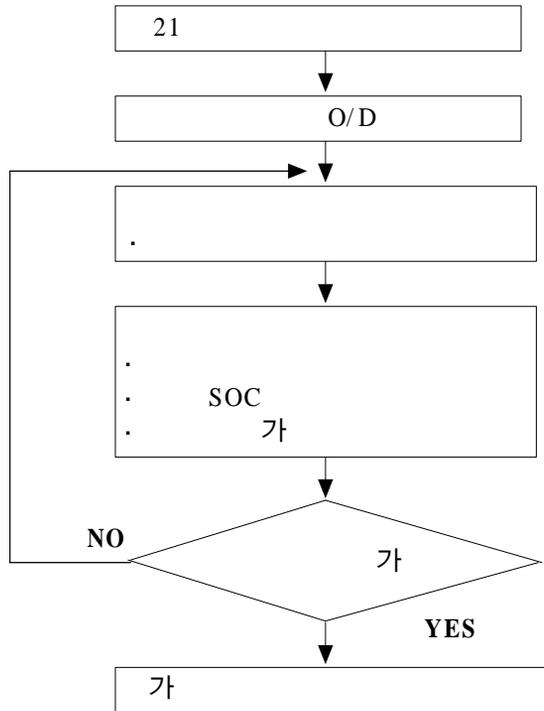
가

가

(AHP; Analytic Hierarchy Process)

5) 가 SOC

가
가 21



< 6-1>

가

()

, 1998

,

, 1999

, 1998

, 가 ITS , 1997

, 가 (1998-2020), 1998

, , 1980

, : , 1994.5

, 가 () , 1998.1

, , 1991

, (

가) , 1991

, , 1997

, , 1998

, , 1994

, , 1998

,

, 1995.2

/ / , 가 ,

1990

/ , 21 가 , 1998

, , 1995

, 21 , 1996

, , 1996.6

, 50 -21 , 1996
 , 21 , 1999.1
 , , 1996.2, pp.80~87
 , , 1982.11
 / , , Workshop
 , 1999.12
 , 21 , 1999.7
 , , 1992
 , 21
 , 1992.3
 , , 1992
 , , 1989
 , , 1998
 , 21 , ,
 , 1998
 21 , 1999(5
)
 , ,1992
 , " , 99 11 26
 , , 1992
 , , 1997
 , , 1995
 , OECD 가 , 1998
 , , 1997
 , 가 21 , 1995
 , 2 5
 , 1968.2

- , 1998
- , 1998
- , 1998
- , 新たな国土幹線交通網形成のための交通施設整備のあり方に関する調査, 平成 8年3月
- , 運輸白書, 1981, 1991, 1998
- , 鐵道は地球を救う, 1990
- , 世界の統計, 1999
- 赤大新介, 新交通機關論 -社會的要請とテクノロジ- -, 1995
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ABSTRACT

A Preliminary Study on the Optimal Modal Split of the National Transportation Systems

Lee, Sang-Keon Lim, Young-Tae Park, Dong-Joo

During the last century, the modal split structure of the Korea transportation system has been shifted from a rail-oriented to a road-oriented structure. The shortage of the infrastructure to accommodate the rapidly increasing travel demand has brought socio-economic losses such as severe traffic congestion and high logistic cost, and thereby weakens the competitiveness of the country. In this context, the objective of this study is to provide a conceptual guideline of the transportation policy which enhances the efficiency of the national transportation system in the 21st century. Firstly, this study diagnoses the historical trend of the modal split structure and analyses the deficiencies and causes of the current modal split structure. Secondly, this study examines the cases of the modal split structure of the advanced countries. Lastly, basic principles for building an efficient and environment-friendly modal split structure of the regional transportation system is proposed.

One of the important feature in the modal split changing trend of

the passenger transportation system is that the dominance of the rail over the road was reversed in the early 1960's. On the other hand, in the freight transportation system, the dominance of the rail over the road was reversed and the marine mode became dominant over the rail from the early 1980's. The most critical deficiency of the regional transportation system is that overall the roads are being used too much in transporting not only passenger but also freight, especially for the mid- and long-distance transportation. This weakness has created direct problems including severe traffic congestion, high logistic cost, and external costs including high traffic accident rate, air pollution, and enormous fuel consumption.

The current modal split of the passenger and freight transportation of the advanced countries is road-oriented, which is similar to the one of Korea. This result has come from the fact that for last several decades more budgets have been spent on the road rather than the rail in order to accommodate the increasing road-oriented demand resulting from the increasing car-ownership. Since mid-1980's, based on the recognition of the socio-environmental issues evoked by the demand-oriented transportation infrastructure supply, the advanced countries have initiated numbers of socio-environmental oriented travel demand management and transportation infrastructure investment strategies. Even if there has been no radical effect yet, a positive effect on the modal split structure is expected for a long term.

From the experience of the advanced countries, it is expected that more budget will be spent on the road than the rail because of the increasing per capita GNP and car-ownership, and thereby the modal split of the road against the rail will be increased. In this context, the

shift of the national transportation policy is required to enhance the efficiency of the transportation system before becoming more road-oriented transportation system.

In the near future a number of changes including the introduction of express rail and light rail system, exploration of Intelligent Transportation Systems(ITS), advance of tele-communication system, and emerging environmental and traffic safety issues are expected. Internationally with the increment of the free trade and acceleration of the economic cooperation in the far-east region, Korea is expected to role as center of intermodalism. Additionally in case of unification between South and North Korea an inter-connecting transportation network between two Koreas is required.

By taking into account these aspects, this study proposes following directions in establishing optimal modal split structure of the regional transportation system. Firstly, total social cost should be minimized by using system-efficient modes in terms of several aspects such as energy efficiency, traffic safety, and environmental effect, etc. Secondly, the existing transportation systems should be utilized efficiently by implementing ITS technologies. Thirdly, public transportation should be activated and the passenger car trips should be reduced.

Followings are the summaries of the main tasks of the next year study which follow this study. Firstly, a number of scenarios of the modal split structure are proposed based on the expected changes in transportation facility supply and demand characteristics. Secondly, the travel demand (i.e. O-D matrix) in 2020 is estimated and the future network is coded in order to run the transportation planning software. Thirdly, the measure of optimality of the modal split structure based

on a number of criteria outlined above is established and a mathematical model which measures the appropriateness of the modal split structure is proposed. Lastly, using the model each modal split scenario is evaluated and the optimal one is chosen, and the strategy of providing transportation infrastructure of the selected modal split structure is proposed.

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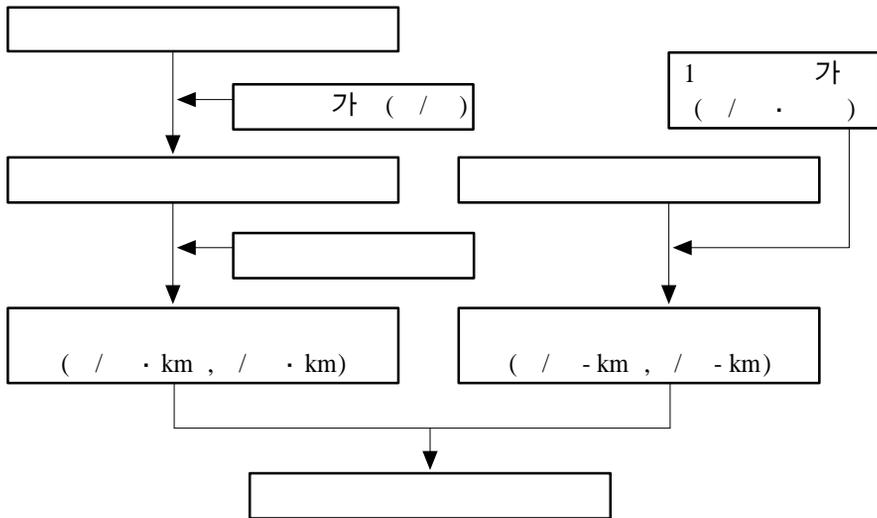
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	(/)	(/)	(/)	(/kW)
가 (/)	302.39	315.06	288.86	72.1

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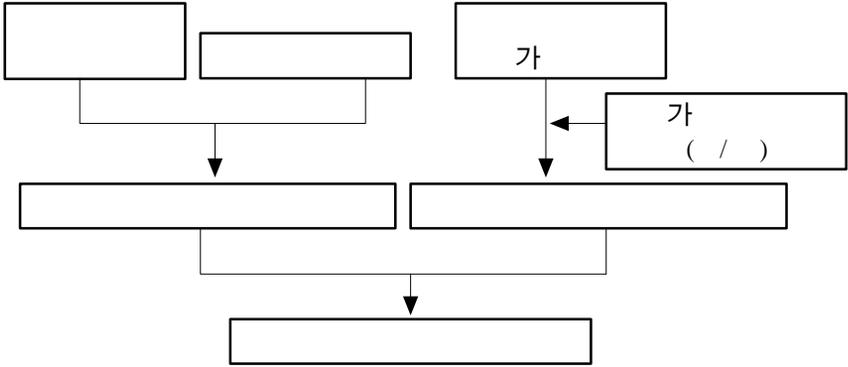
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	가			가		
	(/km)	(/ ·)	(/ · km)	(/km)	(/ ·)	(/ · km)
	54	3,045.5	45.68	43	8,108	96.85
	62		52.45	68		153.15
	32		27.07	32		72.07

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	()	(· km)	(/ · km)
	4,407,404	148,247	29.73
	70,810	45,361	1.70
	137,917	9,052	15.24

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	가 (g/ · km)	(/)	(/ · km)	가 (g/ · km)	(/)	(/ · km)
	195	64,405	12.58	214	64,405	13.79
	79		5.08	41		2.66
	161		10.39	1,168		75.19

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: , Inland Waterways in Korea Pre-feasibility Study, 1997
 , [http:// kr.biz.yahoo.com/ exchange/](http://kr.biz.yahoo.com/exchange/)

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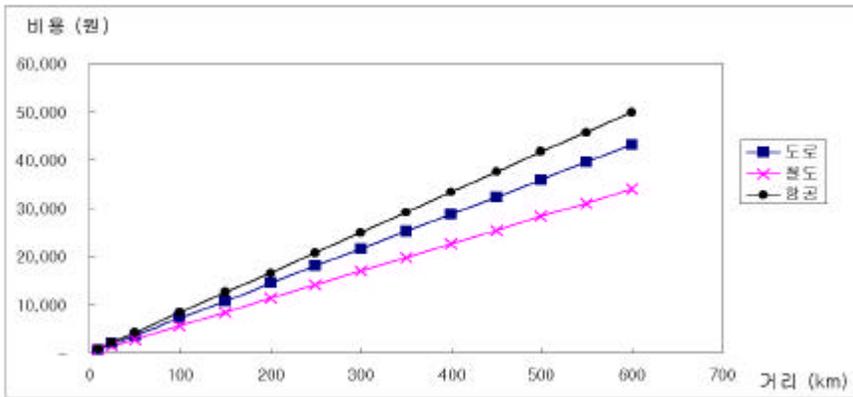
	(/ · km)				(/ · km)		
	26.02	45.68	29.73	12.58	36.61	92.07	13.79
	3.99	52.45	1.70	5.08	4.16	153.15	2.66
	55.94	27.07	15.24	10.39	692.95	72.07	75.19

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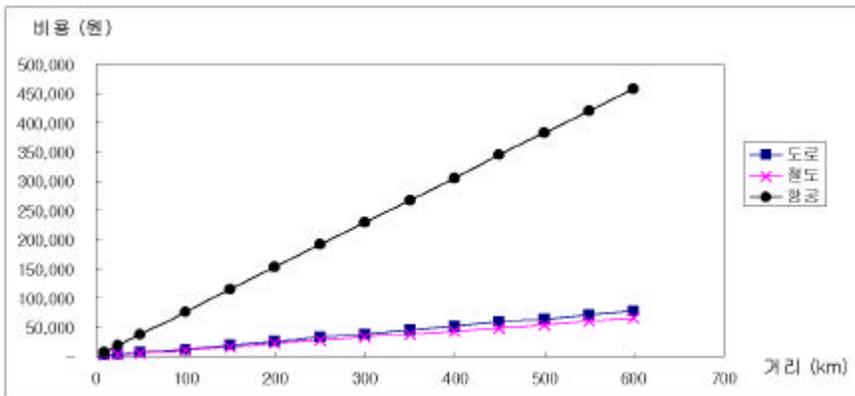
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()		25	50	75	100	150	200	250	300	350	400	450
		1,793	3,585	5,378	7,170	10,755	14,341	17,926	21,511	25,096	28,681	32,266
		1,411	2,822	4,233	5,644	8,466	11,288	14,110	16,932	19,754	22,576	25,398
		2,075	4,151	6,226	8,301	12,45	16,602	20,753	24,903	29,054	33,204	37,355
		3,217	6,434	9,651	12,868	19,302	25,736	32,170	38,604	45,038	51,472	57,906
		2,704	5,408	8,112	10,816	16,224	21,632	27,040	32,448	37,856	43,264	48,672
		19,126	38,251	57,377	76,502	114,753	153,004	191,255	229,506	267,757	306,008	344,260

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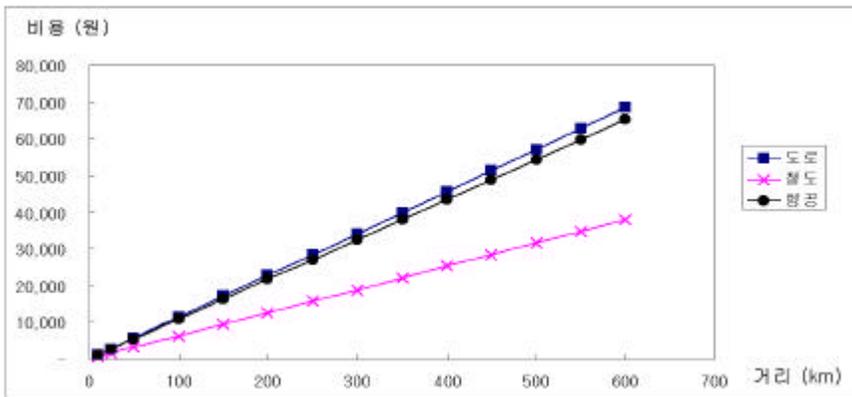
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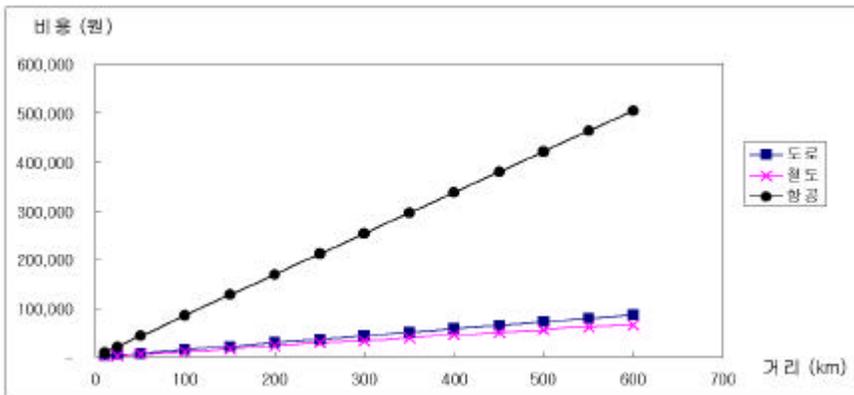
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()		25	50	75	100	150	200	250	300	350	400	450
		2,850	5,701	8,551	11,402	17,103	22,803	28,504	34,205	39,906	45,607	51,308
		1,581	3,161	4,742	6,322	9,483	12,644	15,805	18,966	22,127	25,288	28,450
		2,716	5,432	8,148	10,864	16,296	21,728	27,160	32,024	38,024	43,456	48,888
		3,562	7,123	10,685	14,247	21,370	28,494	35,617	42,741	49,864	56,988	64,111
		2,771	5,541	8,312	11,082	16,623	22,164	27,705	33,247	38,788	44,329	49,870
		21,005	42,011	63,016	84,021	126,032	168,043	210,053	252,064	294,075	336,086	378,096

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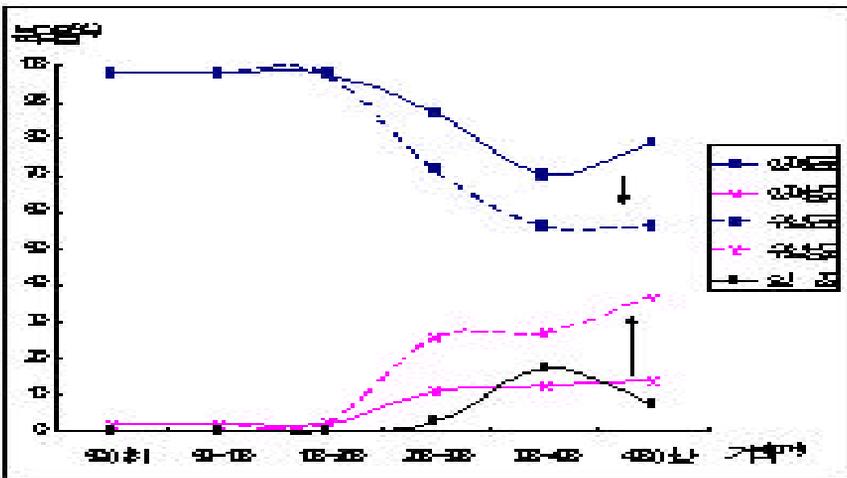
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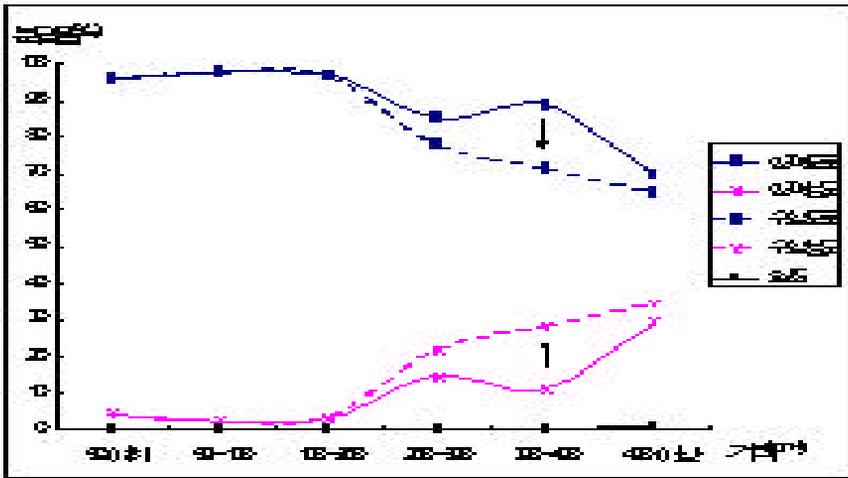
25km, 75km, 150km, 250km, 350km, 450km 가

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()	435,554	427,704	7,850	167,623	165,878	1,745
()	277,701	275,343	2,358	152,310	151,179	1,131
()	157,853	152,361	5,492	15,313	14,699	614

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	(· km)			(· km)		
			가			가
	3,447	862	4,546	206	1,550	691
	4,209	3,180	2,042	1,118	1,709	433
(100)	122	369	45	588	110	63

: 鐵道は地球を救う, 1990
21 가 , / , 1998

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		man- hour			
	552 kcal	347 ·	12,300km ²	592,000	100.0
	447 kcal	249 ·	9,400km ²	418,000	60.0
	105 kcal	98 ·	2,900km ²	174,000	40.0
가	10,700	137,000	72,500	2,400	18,430
가	25 / kcal	1,400	5 / km ² (20)	578,000 / ()	

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2020 2.16 2,192 가
가

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		1997 (A)	2020 (B)	B/A	1997- 2020 가 (%)
()		46,885	52,360	1.12	0.48
()		10,143	21,922	2.16	3.4
	(- km)	236,943	408,545	1.72	2.4
	(- km)	138,189	269,480	1.95	2.9
	(- km)	74,570	324,595	4.35	6.6
	(- km)	4,180,272	9,347,833	2.24	3.6

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	1971	1972 1981	1982 1991	1992 1996	2000 2019*	
	42,855 (56.6%)	110,682 (55.8%)	609,479 (72.9%)	265,405 (58.5%)	1,862,517 (56.3%)	60.0%
	16,816 (22.2%)	38,165 (19.2%)	123,323 (14.7%)	132,876 (29.3%)	940,248 (28.5%)	22.8%
	1,329 (1.8%)	2,724 (1.4%)	8,714 (1.0%)	19,246 (4.2%)	136,690 (4.1%)	2.5%
	14,697 (19.4%)	46,849 (23.6%)	94,589 (11.3%)	36,044 (7.9%)	368,328 (11.1%)	14.7%
	75,697 (100%)	198,391 (100%)	836,105 (100%)	453,572 (100%)	3,307,783 (100%)	100%

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