



Republic of Turkey
Ministry of Transport Maritime Affairs
and Communications



GENERAL DIRECTORATE
of HIGHWAYS

Benchmarking Transport Infrastructure Construction Costs



GENEVA

31 Oct - 01 Nov 2016





OUTLINE

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GENERAL OVERVIEW of HIGHWAY NETWORK

2

ROAD INFRASTRUCTURE DEVELOPMENT

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ROAD INFRASTRUCTURE COSTS STUDIES

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CONCLUSIONS





1

GENERAL OVERVIEW of HIGHWAY NETWORK





ROAD NETWORK IN TURKEY

Type: Village and Forest roads
Responsibility: Special
Provincial Administration

Type: Urban roads
Responsibility: Municipal
Authorities



Type: Motorways, State & Provincial roads
Responsibility: General Directorate of Turkish Highways

The road network excluding urban roads is about 385.000 km in length

STRATEGIC LOCATION OF TURKEY



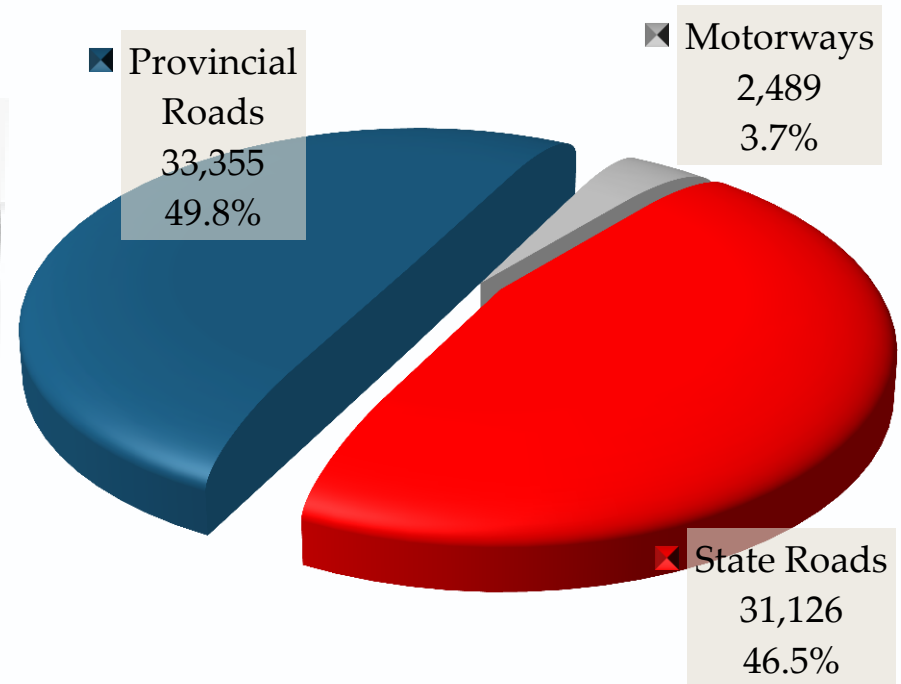
The lands of Turkey are located at a point where the three continents; Asia, Africa and Europe are closest to each other. Turkey has 13000 km of international road network. Within 4 hours flying time, about 1.5 billion people from 56 countries can reach Turkey.



NATIONAL HIGHWAY NETWORK

- Total road network is 66.970 km.
- 37% of total road network (24.813 km) is dual carriageway

Highway Network (Km)



- Total Replacement Value: **67 Billion \$**
- Road Density: **50 km / 100 km²** (Excl. Urban Roads)
- Motorway Density: **2.86/ 1000 km²**



NATIONAL HIGHWAY NETWORK (66.970 km)

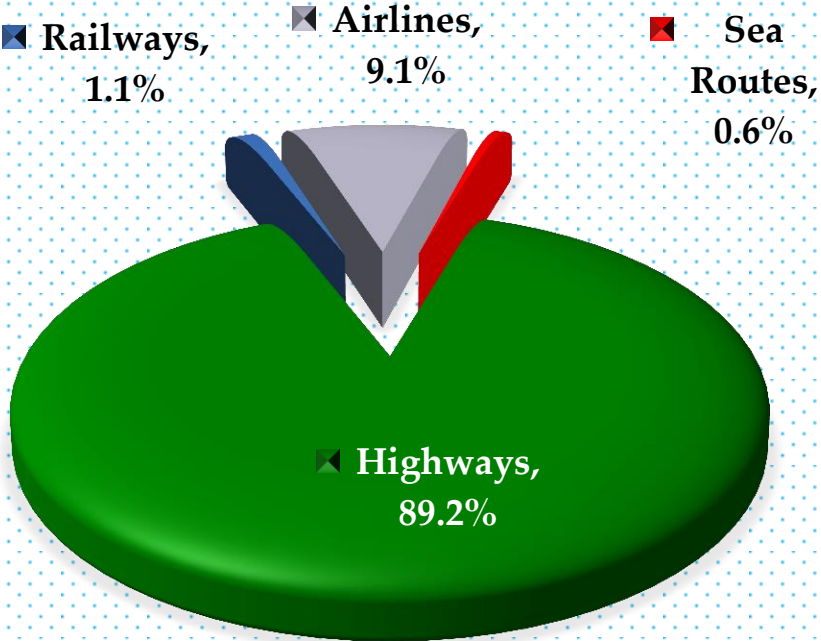
➤ Turkish Road Network under General Directorate of Turkish Highways' responsibility.





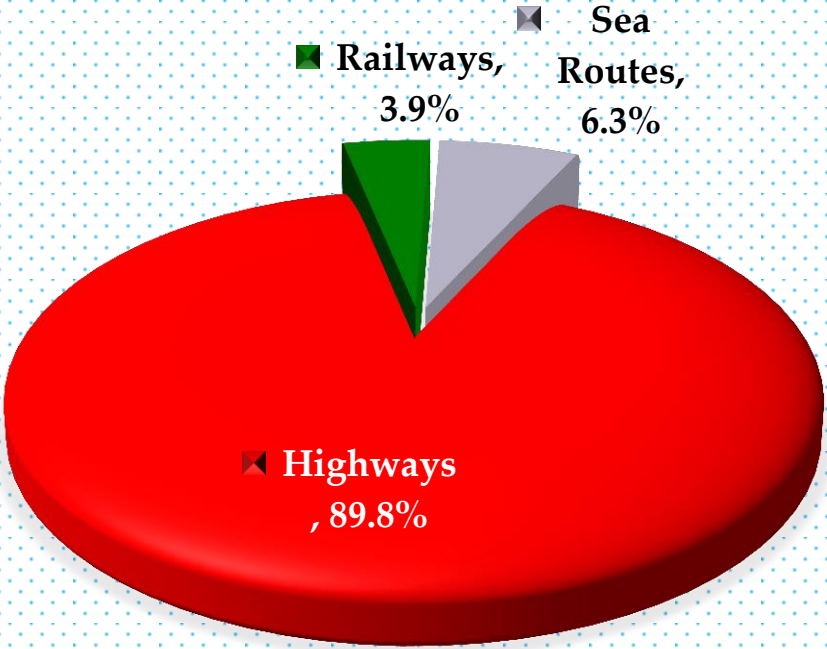
DOMESTIC PASSENGER & FREIGHT TRANSPORT 2015

PASSENGER TRANSPORT



Passenger Transport
Highways: 89,8 %

FREIGHT TRANSPORT

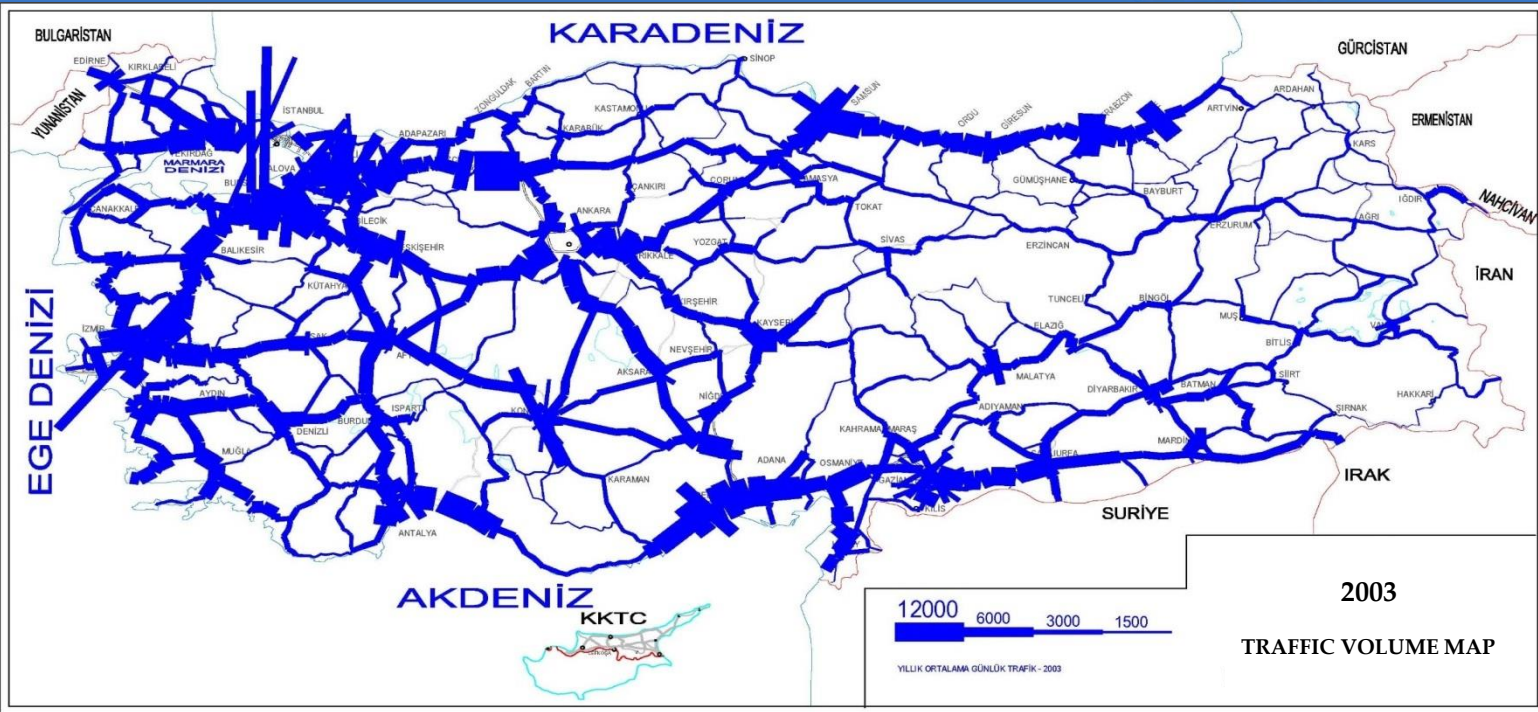


Freight Transport
Highways: 89,5%

TRAFFIC VOLUME
Million Km (2003)

52.349

Total Vehicle-Km

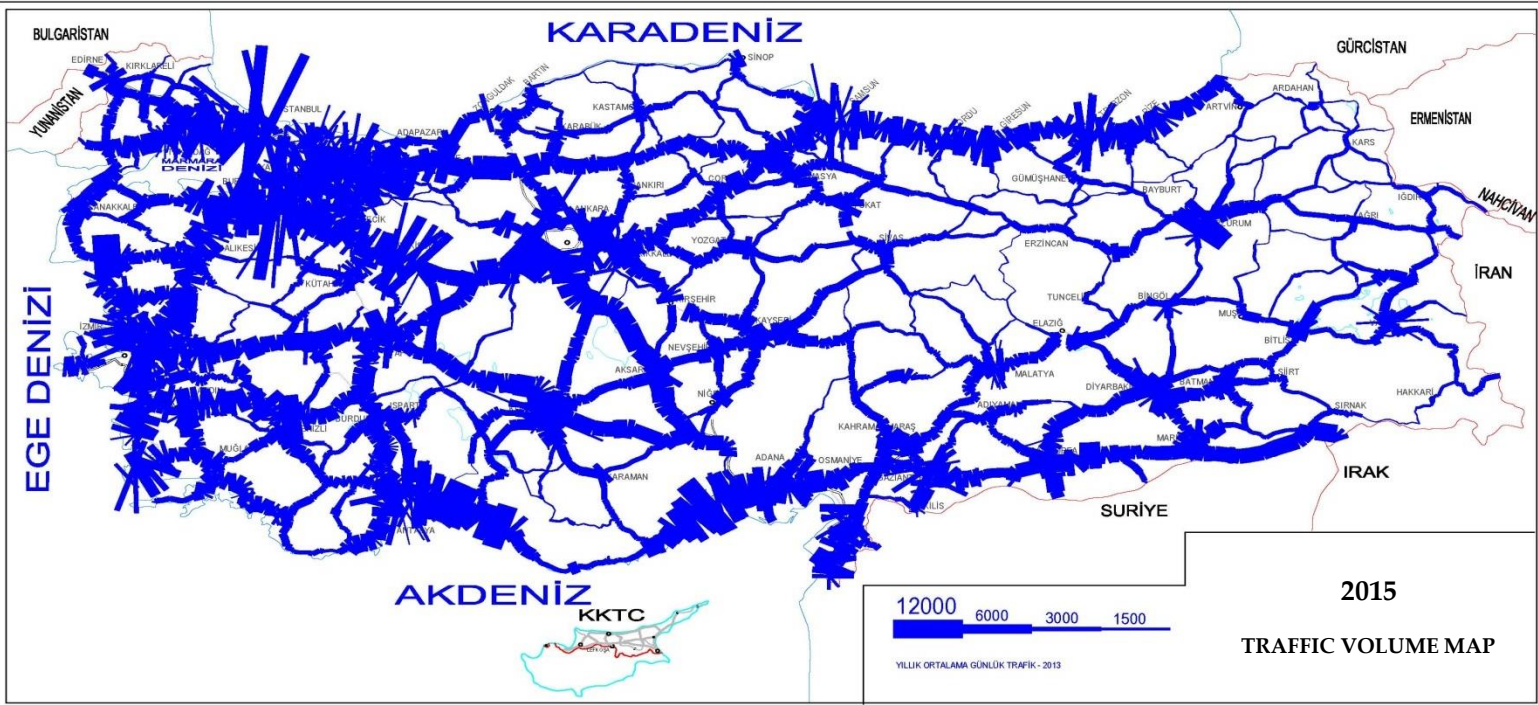


TRAFFIC VOLUME
Million Km (2015)

113.274

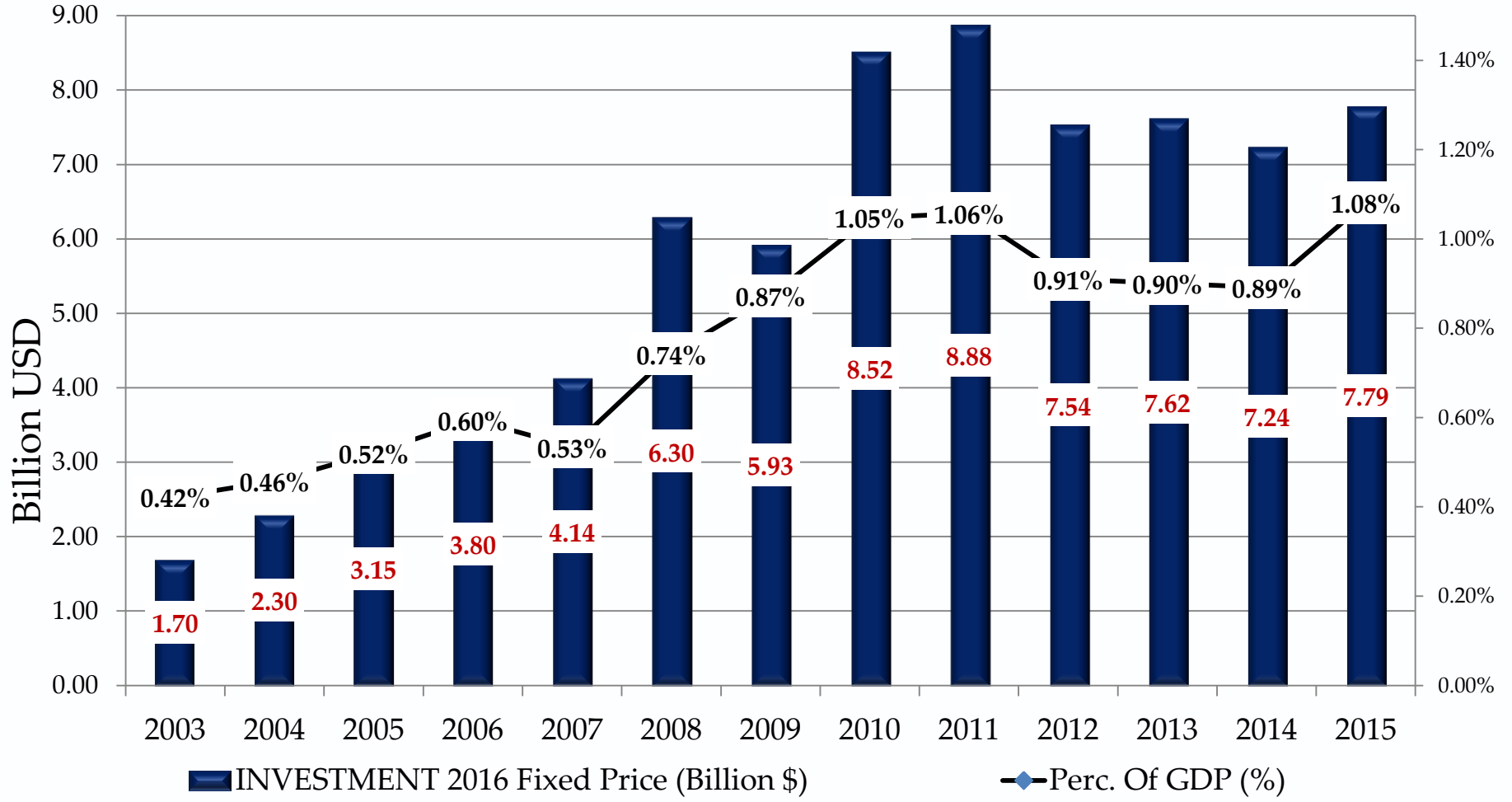
Total Vehicle-Km

116 % increase in
vehicle-km





ROAD INFRASTRUCTURE INVESTMENT EXPENDITURES





2

ROAD INFRASTRUCTURE DEVELOPMENT



**MULTILANE DIVIDED
HIGHWAY NETWORK
(2003)**

HIGHWAY NETWORK: 63.143



1.714 Km
MOTORWAY

4.387 Km
MULTILANE DIVIDED
STATE&PROVINCIAL
ROADS

6.101 Km
TOTAL

**MULTILANE DIVIDED
HIGHWAY NETWORK
(Oct 2016)**

HIGHWAY NETWORK : 66.970



2.489 Km
MOTORWAY

22.402 Km
MULTILANE DIVIDED
STATE&PROVINCIAL
ROADS

24.891 Km
TOTAL

ROAD STRUCTURES –TUNNELS , BRIDGES & VIADUCTS

- Number of Tunnels : 83
- Length of Tunnels: 50 km

2003



- Number of Tunnels : 295
- Length of Tunnels: 306 km

2016



- Number of Tunnels : 93
- Length of Tunnels: 309 km

Under Construction



- Number of Bridges&Viaducts : 5.967
- Length of Bridges&Viaducts: 311 km

2003



- Number of Bridges&Viaducts : 7.983
- Length of Bridges&Viaducts 505 km

2016



- Number of Bridges&Viaducts : 431
- Length of Bridges&Viaducts 65km

Under Construction





MOTORWAY NETWORK



MOTORWAYS IN OPERATION

2.489 Km

Our organization has launched a challenging and ambitious motorway construction program. With regard to this expedited motorway construction program, up to now, a motorway network with a length of 2.489 km has been opened to traffic. Up to date, the total expenditure for motorway projects has been reached to approximately 25 Billion USD.

BOT PROJECTS UNDER CONSTRUCTION



MOTORWAYS IN OPERATION

2.489 Km

BOT PROJECTS UNDER CONSTRUCTION

631.5 Km

2b	GEBZE-ORHANGAZI-IZMIR MOTORWAY (58.5 km of 433 km is in operation)	374.5 Km
3	NORTH MARMARA MOTORWAY KINALI-ODAYERİ SECTION	88 Km
4	NORTH MARMARA MOTORWAY KURTKÖY-AKYAZI SECTION	169 Km



YAVUZ SULTAN SELİM SUSPENDED BRIDGE





TARGET BOT PROJECTS (1.Group)



TARGET BOT PROJECTS (1.GROUP) 1.893 Km

MOTORWAYS IN OPERATION	2.489 Km
BOT PROJECTS (Under Construction)	631.5 Km

- 5 ANKARA-NİĞDE MOTORWAY (INCL. KIRŞEHİR CONNECTION) 330 Km
- 6 KINALI-TEKİRDAĞ-ÇANAKKALE-BALIKESİR MOTORWAY 352 Km
- 7 MENEMEN-ALİAĞA-ÇANDARLI MOTORWAY 76 Km
- 8 ANKARA-KIRIKKALE-DELİCE MOTORWAY 119 Km
- 9 MERSİN-ERDEMLİ-TAŞUCU MOTORWAY 92 Km
- 10 AYDIN-DENİZLİ MOTORWAY 165 Km
- 11 ANTALYA-ALANYA MOTORWAY 187 Km
- 12 ANKARA-İZMİR MOTORWAY 572 Km

TARGET BOT PROJECTS (2.Group)



TARGET BOT PROJECTS (2. GROUP)

3.214 Km

13	DENİZLİ-BURDUR MOTORWAY	130 Km	17	GEREDE-MERZİFON MOTORWAY	336 Km
14	SİVRİHİSAR-BURSA MOTORWAY	231 Km	18	MERZİFON-GÜRBULAK MOTORWAY	950 Km
15	AFYON-ANTALYA MOTORWAY	350 Km	19	ŞANLIURFA-DİYARBAKIR-HABUR MOTORWAY	454 Km
16	DELİCE-SAMSUN MOTORWAY	303 Km	20	RİZE-ERZURUM-DİYARBAKIR MOTORWAY	460 Km



TARGET MOTORWAY NETWORK



	MOTORWAYS IN OPERATION (206.5Km BOT)		2.489 km
	TARGET 2023 BOT PROJECTS (UNDER CONSTRUCTION)	631,5 km	
	TARGET 2023 BOT PROJECTS (1.GROUP)	1.893 km	5.738 km
	TARGET 2023-2035 BOT PROJECTS (2.GROUP)	3.214 km	
TOTAL			8.227 km



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TRANSPORTATION INFRASTRUCTURE COSTS STUDIES





TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

TRANSPORTATION INFRASTRUCTURE COSTS STUDIES DONE IN TURKEY

ROAD CONSTRUCTION COSTS

ROAD MAINTENANCE COSTS

SUPERSTRUCTURES COSTS (Bridges, Tunnels)





TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

TRANSPORTATION INFRASTRUCTURE CONSTRUCTION COSTS

1. ROAD CONSTRUCTION COSTS

ROAD MAINTENANCE COSTS

SUPER STRUCTURE COSTS (Bridges, Tunnels)



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

PURPOSE OF THE STUDY (ROAD CONSTRUCTION COSTS)

1. In order to calculate real (realized) road unit construction costs and the range.
2. In order to find out which parameters are important to specify construction cost.
3. By calculating real cost the investment budget will be determined more realistic.
4. Benefit-cost analysis can be based on the realized road construction, maintenance and operation costs.

Nearly 100 road construction projects completed in last 15 years have been analyzed under this study.



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

PURPOSE OF THE STUDY (ROAD CONSTRUCTION COSTS)

The results of this study will lead to work;

1. rational,
2. cost-effective
3. and also will ensure data for
 - a. planning,
 - b. budgeting,
 - c. productivity,
 - d. strategic
 - e. planning,
 - f. privatization,
 - g. determining performance criterias,
 - h. etc.



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

METHODOLOGY OF THE STUDY

1. MORE THAN 100 PROJECT COMPLETED WITHIN LAST 15 YEARS ARE REGARDED
2. SINCE THE PROJECT WERE VERY DIFFERENT THAN EACH OTHER DEFINITION ON ROAD CONSTRUCTION WERE DEEMED NECESSARY AND WERE DONE
 1. RESURFACING
 2. RESURFACING WITH TREATMENT
 3. PAVEMENT REPLACEMENT
 4. ROAD CONDITIONING
 5. RECONSTRUCTION
 6. NEW CONSTRUCTION
 7. CAPACITY ENLARGEMENT-DIVIDED ROAD CONSTRUCTION



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

METHODOLOGY OF THE STUDY

3. FIRST ANALYSIS WERE HELD BY SPSS 23 TO DECIDE WHICH PARAMETERS ARE IMPORTANT ON COSTS (still continue)

1. PROJECT STANDARDS AS 2X1, 2X2
2. PAVEMENT TYPE AS ASPHALTIC CONCRETE, SURFACE TREATMENT
3. PROJECT LENGTH
4. CONSTRUCTION DURATION
5. BIDDING TYPE
6. PROJECT CONSTRUCTION DEFINITION
7. EXISTENCE OF IMPORTANT STRUCTURE AS BRIDGE, TUNNEL, ETC. AND LENGTH
8. KGM DIVISION
9. TERRAIN TYPE
10. Etc...



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

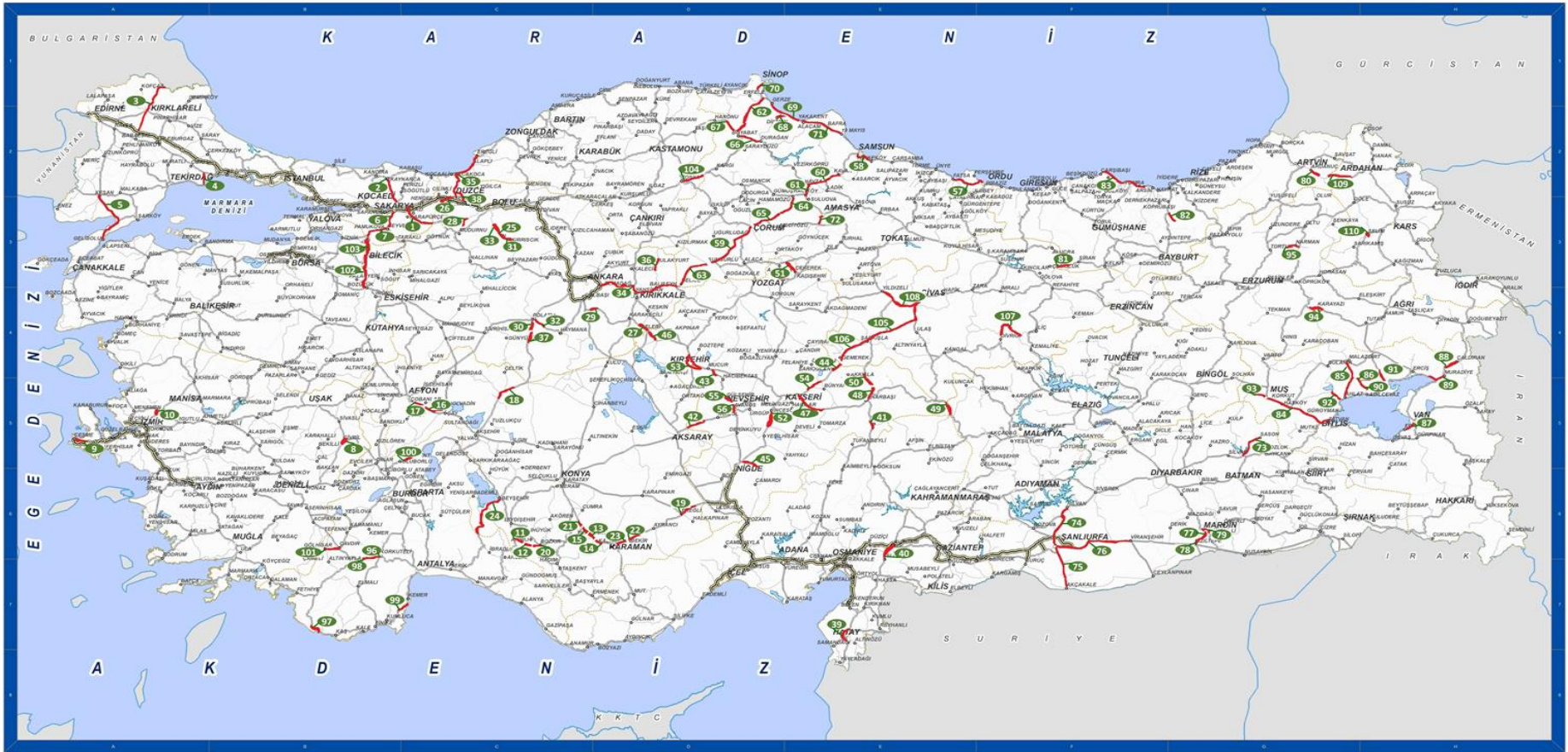
METHODOLOGY OF THE STUDY

4. Multiple regression is applied to our data set with sample size 99.
- The effect of independent variables on dependent variables were analyzed stepwise regression is used since most of the significant value of the variables are bigger than 0.05.
 - 4 variables, whose significant values are less than 0.05 are chosen for our model.
 - These 4 variables are pavement type, superstructures existence (tunnel, bridges and viaducts) and bidding type.



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

LOCATION OF 110 ROAD CONSTRUCTION PROJECTS



G K R Y





TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

FIRST RESULTS

PROJECT CHARACTERISTICS	PAVEMENT TYPE	NUMBER OF PROJECTS	AVERAGE COST (€/KM)	AVERAGE COST (€/LANE×KM)
2x1	SURFACE TREATMENT	30	€ 341.447	€ 170.723
	ASPHALTIC CONCRETE	5	€ 820.280	€ 410.740
2x2	SURFACE TREATMENT	30	€ 314.564	€ 78.641
	ASPHALTIC CONCRETE	34	€ 1.355.003	€ 338.751



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

FIRST RESULTS

PROJECT CHARACTERISTICS	PROJECT DEFINITION	NUMBER OF PROJECTS	AVERAGE COST (€/KM)
2x1	CAPACITY ENLARGEMENT	0	-
	ROAD CONDITIONING-1	1	€ 203.975
	ROAD CONDITIONING-2	1	€ 401.206
	RECONSTRUCTION-1	25	€ 344.648
	RECONSTRUCTION-2	1	€ 1.594.456
	NEW CONSTRUCTION	6	€ 440.829
	PAVEMENT REPLACEMENT-2	1	€ 883.997
2x2	CAPACITY ENLARGEMENT	50	€ 832.486
	ROAD CONDITIONING-1	0	-
	ROAD CONDITIONING-2	2	€ 892.903
	RECONSTRUCTION-1	0	-
	RECONSTRUCTION-2	2	€ 1.190.481
	NEW CONSTRUCTION	7	€ 1.058.021
	PAVEMENT REPLACEMENT-2	3	€ 769.928



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

FIRST RESULTS

PROJECT CHARACTERISTICS	PROJECT DEFINITION	NUMBER OF PROJECTS	AVERAGE COST (€/LANE.KM)
2x1	CAPACITY ENLARGEMENT	0	-
	ROAD CONDITIONING-1	1	€ 101.987
	ROAD CONDITIONING-2	1	€ 200.603
	RECONSTRUCTION-1	25	€ 172.324
	RECONSTRUCTION-2	1	€ 797.228
	NEW CONSTRUCTION	6	€ 220.414
	PAVEMENT REPLACEMENT-2	1	€ 441.998
2x2	CAPACITY ENLARGEMENT	50	€ 208.122
	ROAD CONDITIONING-1	0	-
	ROAD CONDITIONING-2	2	€ 223.226
	RECONSTRUCTION-1	0	-
	RECONSTRUCTION-2	2	€ 297.620
	NEW CONSTRUCTION	7	€ 264.505
	PAVEMENT REPLACEMENT-2	3	€ 192.482



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

CONSTRUCTION COSTS (EURO/KM)							
	PAVEMENT TYPE	GEOMETRIC CHARACTERISTICS	NUMBER OF THE PROJECTS	MINIMUM	AVERAGE	MAXIMUM	STANDARD DEVIATION
CAPACITY ENLARGEMENT	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	27	€ 52.277	€ 317.812	€ 872.368	€ 209.142
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	23	€ 440.131	€ 1.436.669	€ 5.544.668	€ 1.102.179
ROAD CONDITIONING-1	SURFACE TREATMENT	2x1	1	€ 203.975	€ 203.975	€ 203.975	€ 0
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
ROAD CONDITIONING-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 401.206	€ 401.206	€ 401.206	€ 0
		2x2	2	€ 552.029	€ 892.903	€ 1.233.777	€ 482.069
RECONSTRUCTION-1	SURFACE TREATMENT	2x1	25	€ 52.474	€ 344.648	€ 1.169.661	€ 307.436
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
RECONSTRUCTION-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 1.594.456	€ 1.594.456	€ 1.594.456	€ 0
		2x2	2	€ 1.102.273	€ 1.190.481	€ 1.278.690	€ 124.745
NEW CONSTRUCTION	SURFACE TREATMENT	2x1	4	€ 158.262	€ 355.808	€ 545.897	€ 169.088
		2x2	3	€ 117.681	€ 285.329	€ 413.872	€ 151.918
	ASPHALTIC CONCRETE	2x1	2	€ 335.613	€ 610.870	€ 886.127	€ 389.272
		2x2	4	€ 872.778	€ 1.637.540	€ 3.002.928	€ 945.319
PAVEMENT REPLACEMENT-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 883.997	€ 883.997	€ 883.997	€ 0
		2x2	3	€ 459.902	€ 769.928	€ 1.064.285	€ 302.496



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

CONSTRUCTION COSTS (EURO/LANE KM)							
	PAVEMENT TYPE	GEOMETRIC CHARACTERISTICS	NUMBER OF THE PROJECTS	MINIMUM	AVERAGE	MAXIMUM	STANDARD DEVIATION
CAPACITY ENLARGEMENT	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	27	€ 13.069	€ 79.453	€ 218.092	€ 52.285
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	23	€ 110.033	€ 359.167	€ 1.386.167	€ 275.545
ROAD CONDITIONING-1	SURFACE TREATMENT	2x1	1	€ 101.987	€ 101.987	€ 101.987	€ 0
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
ROAD CONDITIONING-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 200.603	€ 200.603	€ 200.603	€ 0
		2x2	2	€ 138.007	€ 223.226	€ 308.444	€ 120.517
RECONSTRUCTION-1	SURFACE TREATMENT	2x1	25	€ 26.237	€ 172.324	€ 584.831	€ 153.718
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
RECONSTRUCTION-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 797.228	€ 797.228	€ 797.228	€ 0
		2x2	2	€ 275.568	€ 297.620	€ 319.673	€ 31.186
NEW CONSTRUCTION	SURFACE TREATMENT	2x1	4	€ 79.131	€ 177.904	€ 272.949	€ 84.544
		2x2	3	€ 29.420	€ 71.332	€ 103.468	€ 37.980
	ASPHALTIC CONCRETE	2x1	2	€ 167.807	€ 305.435	€ 443.063	€ 194.636
		2x2	4	€ 218.195	€ 409.385	€ 750.732	€ 236.330
PAVEMENT REPLACEMENT-2	SURFACE TREATMENT	2x1	0	-	-	-	-
		2x2	0	-	-	-	-
	ASPHALTIC CONCRETE	2x1	1	€ 441.998	€ 441.998	€ 441.998	€ 0
		2x2	3	€ 114.976	€ 192.482	€ 266.071	€ 75.624



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

TRANSPORTATION INFRASTRUCTURE CONSTRUCTION COSTS

1. ROAD CONSTRUCTION COSTS

2. ROAD MAINTENANCE COSTS

IMPORTANT STRUCTURE COSTS (As Bridges, Tunnels, etc.)



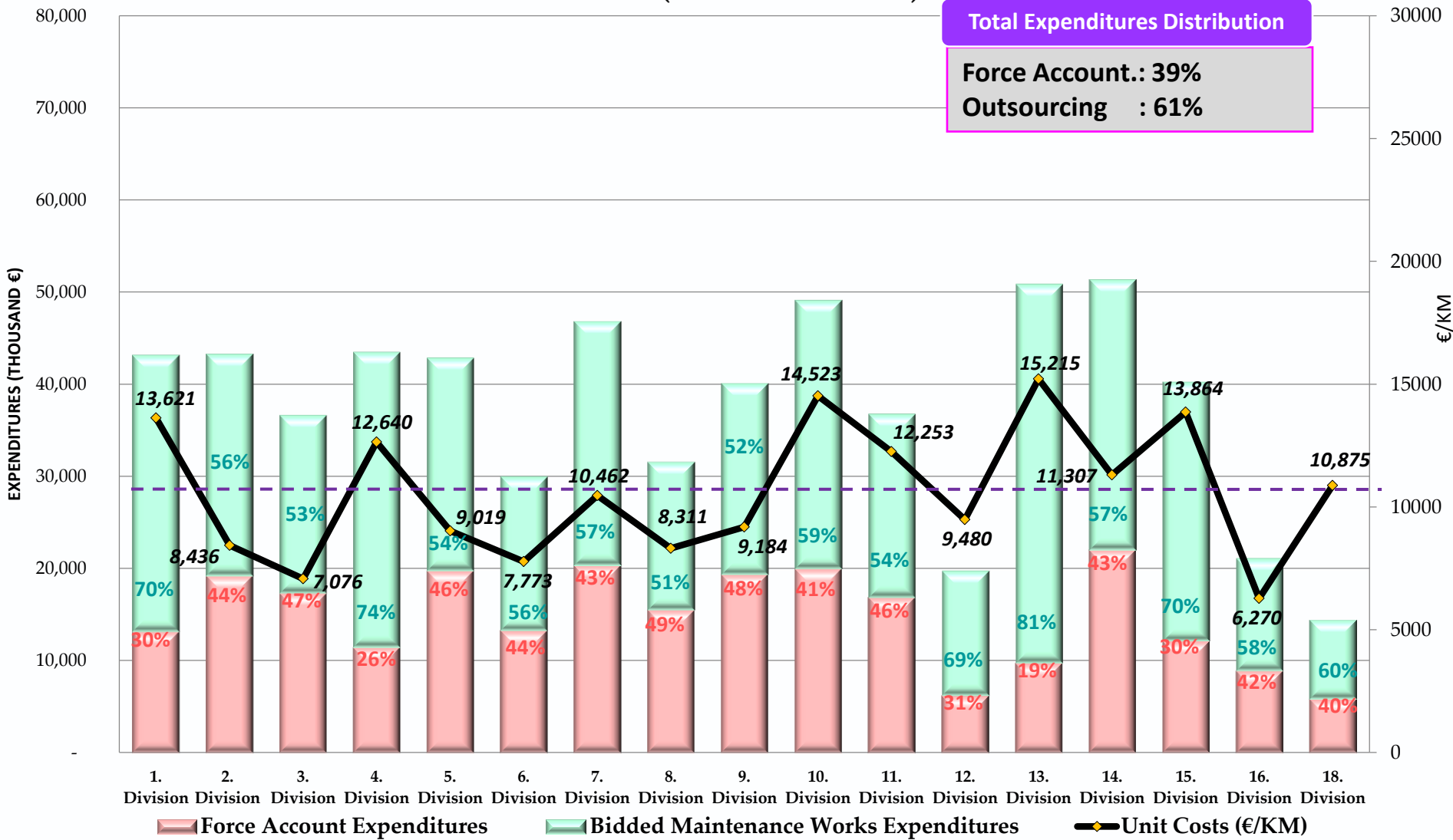
TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

METHODOLOGY TO CALCULATE ROAD MAINTENANCE COSTS

- EVERY YEAR MAINTENANCE COST AND EXPENDITURES ARE CALCULATED FROM ORGANIZATIONAL INFORMATION AUTOMATION SYSTEM AS GIVEN IN FOLLOWING SLIDES
- HOWEVER IT IS DEEMED NECESSARY TO SEPERATE ROUTINE MAINTENANCE AND SOME FOR PERIODICAL MAINTENANCE
- IN ORDER TO MAKE THIS SEPERATION, VERY GOOD DEFINITIONS ARE NECESSARY TO SEPERATE ROUTINE AND PERIODIC MAINTENANCE
- THE GROUP IS ORGANIZED AND STUDIES HAVE BEEN STARTED



ROUTINE ROAD MAINTANANCE EXPENDITURES OF GDH DIVISIONS (with 2016 Prices)





TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

TRANSPORTATION INFRASTRUCTURE CONSTRUCTION COSTS

1. ROAD CONSTRUCTION COSTS

2. ROAD MAINTENANCE COSTS

3. SUPERSTRUCTURE COSTS
(Bridges, Tunnels, etc.)



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

BRIDGE CONSTRUCTION COSTS

- ✓ TOTAL NUMBER OF ANALYZED BRIDGES ARE 156
- ✓ ALL OF THE BRIDGES WHICH WERE ANALYZED, ARE REINFORCED CONCRETE.
- ✓ THE MAIN PARAMETERS WHICH AFFECT BRIDGE COST CONSTRUCTION COST ARE
 - CENTER LEG TYPE (Single Column, Multi Column, Shear Wall, Without Column -Single Clearance),
 - FOUNDATION TYPE (Shallow, Deep Piled),
 - BRIDGE TYPE (Single Beam, Single Slab, Continuous Beam, Pre-stressed Single Beam)



TRANSPORTATION INFRASTRUCTURE COSTS STUDIES

BRIDGE CONSTRUCTION COSTS (€/M²)

BRIDGE TYPE	SINGLE/DOUBLE BRIDGE	NUMBER OF BRIDGES	MIN. €/M2	MAX. €/M2	AVERAGE. €/M2
REINFORCED CONCRETE SINGLE BEAM BRIDGE	SINGLE	3	464	565	518
	DOUBLE	0	-	-	-
	TOTAL	3	464	565	518
REINFORCED CONCRETE SINGLE SLAB BRIDGE	SINGLE	2	449	853	651
	DOUBLE	0	-	-	-
	TOTAL	2	449	853	651
REINFORCED CONCRETE CONTINUOUS BEAM BRIDGE	SINGLE	1	46	464	464
	DOUBLE	0	-	-	-
	TOTAL	1	46	464	464
REINFORCED CONCRETE PRESTRESSED SINGLE BEAM BRIDGE	SINGLE	132	285	2.571	684
	DOUBLE	18	308	1.878	793
	TOTAL	150	285	2571	697



4

CONCLUSIONS





CONCLUSIONS

- It is important that road infrastructure investments are made on time to avoid negative effects on economy.
- The lifespan, maintenance and construction costs of an infrastructure are approximate figures because of the various construction materials, different terrain type, the techniques used and operating conditions,.
- Due to the budget constraints, benchmarking of transport infrastructure construction costs is significant for having realistic construction costs and a stable investment program with no cost explosions.
- Identify suitable methodological approaches, models and tools for gathering and disseminating information about infrastructure construction costs as well as collaboration with potential partners in the public or private sector and on the national, regional and international level are crucial from our point of view.



*THANK YOU FOR
YOUR ATTENTION !*

Mücahit ARMAN (Presented By)
Kamuran YAZICI
Leyla ÜNAL
Fatma ORHAN

General Directorate of Turkish Highways
Ministry of Transport, Maritime Affairs and Communications