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No. 52

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

MINISTRY OF PUBLIC WORKS
AND SETTLEMENT
THE REPUBLIC OF TURKEY

STUDY
ON
MOTORWAY MAINTENANCE, OPERATION
AND
TRAFFIC MANAGEMENT SYSTEM

FINAL REPORT
SUMMARY

JULY 1993

PACIFIC CONSULTANTS INTERNATIONAL
YACHIYO ENGINEERING CO., LTD.

The following foreign exchange rate is applied in the Study:

1992 US$1.00=6,900 Turkey Lire (as of June 1992)

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PREFACE

In response to a request from the Government of the Republic of Turkey, the Government of Japan decided to conduct the Study on Motorway Maintenance, Operation and Traffic Management System in Turkey, and entrusted the study to the Japan International Cooperation Agency (JICA).

JICA sent to Turkey a study team headed by Mr. Tetsuya Siraishi, Pacific Consultants International in association with Yachiyo Engineering Co., Ltd., three times between April 1992 and May 1993.

The team held discussions with the officials concerned of the Government of Turkey, and conducted field surveys at the study area. After the team returned to Japan, further studies were accomplished and the present report was prepared.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between the two countries.

I wish to express my sincere appreciation to the officials concerned of the Government of Republic of Turkey for their close cooperation extended to the Study Team.

July, 1993

Kensuke Yanagiya

Kensuke Yanagiya
President
Japan International Cooperation Agency

July 1993

Mr. Kensuke Yanagiya
President
Japan International Cooperation Agency
Tokyo, Japan

Letter of Transmittal

Dear Mr. Yanagiya

We are pleased to submit to you the final report on the Study on Motorway Maintenance, Operation and Traffic Management System (OMM System) in Turkey.

This study has been conducted by Pacific Consultants International in association with Yachiyo Engineering Co., Ltd. based on a contract with JICA, from March 1992 to July 1993. Throughout the study, we have taken into full consideration the present situation in Turkey, and have recommended the OMM System in the scheme of Japan's technical cooperation.

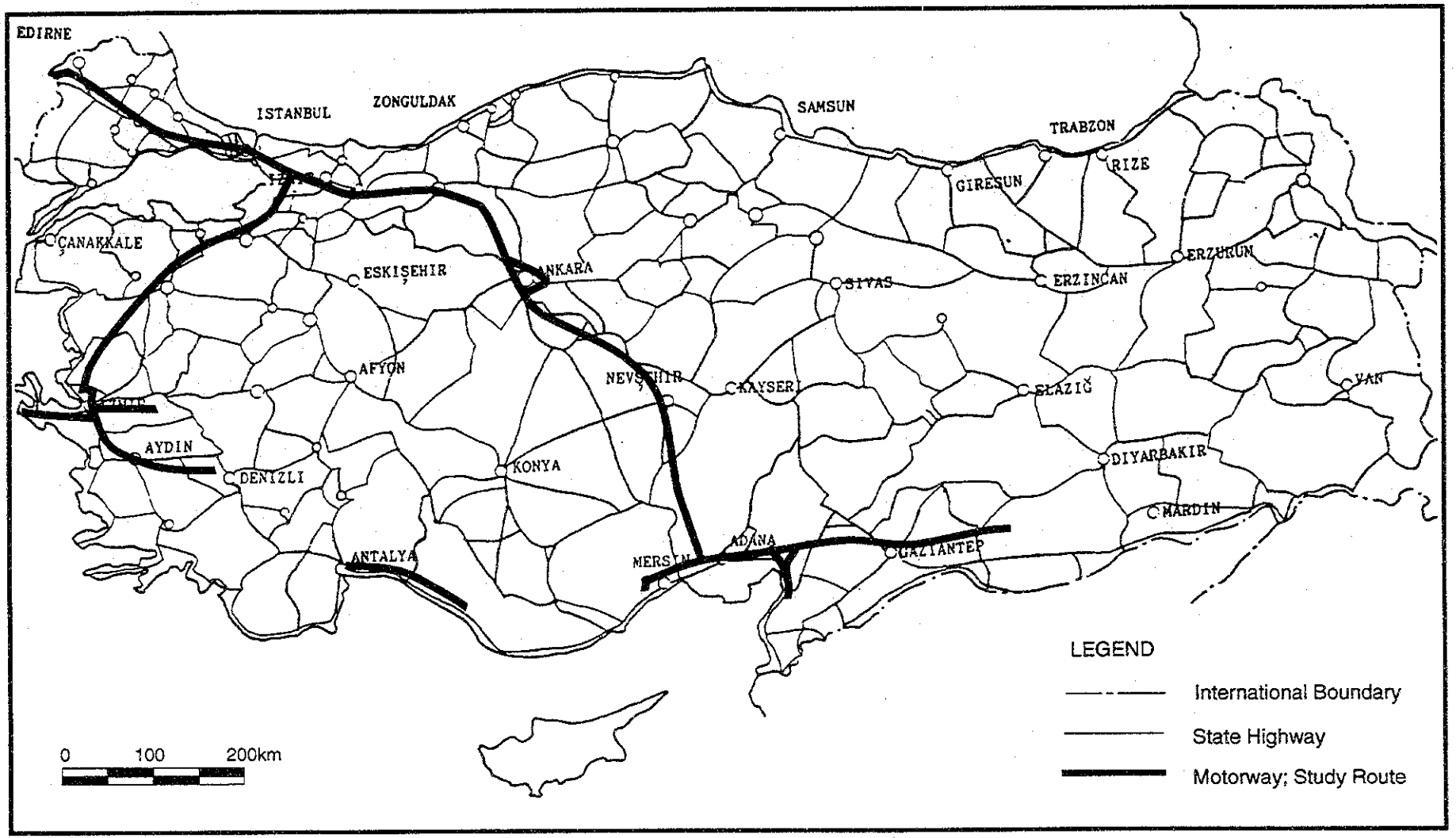
We wish to take this opportunity to express our sincere gratitude to your Agency, the Ministry of Foreign Affairs in Japan. We also wish to express our deep gratitude to the officials concerned of General Directorate of Highways (KGM), the Ministry of Public Works and Settlement in Turkey for their close cooperation and assistance during our study.

Finally, we hope that this report will be effectively used for the promotion of the OMM System in Turkey.

Very truly yours,

T. Shiraishi

Tetsuya Shiraishi
Team Leader
Motorway Maintenance,
Operation and Traffic Management System
Pacific Consultants International in Association
with Yachiyo Engineering Co., Ltd.



LOCATION MAP

Republic of Turkey

Study on

Motorway Maintenance, Operation

and

Traffic Management System

Synopsis

(1) Objectives of the Study

- To formulate a basic plan of the motorway maintenance, operation and traffic management system (motorway OMM system) for the long term plan of 3,000 km motorway network.

- To prepare a short-term implementation program and operation manual of the motorway maintenance, operation and traffic management system within 1,500 km motorway network.

(2) Basic Plan of the Motorway Maintenance, Operation and Traffic Management System

1) Goals of Motorway OMM System

The Motorway OMM system has three goals, which are identified as ensuring "traffic safety", "smooth traffic flow", and "user's comfort" by an efficient and economical system operation.

2) Organization

Two new divisions, Division of Motorway Maintenance, Traffic Management and Control and Division of Toll Management and Motorway Revenues are proposed to be created for the motorway OMM system under the present Department of Motorways of KGM headquarters.

And under the existing Regional Divisions concerned of KGM, Main Maintenance Center and Maintenance Offices are proposed to be established. A main maintenance center is located for the motorway length of 200 to 500 km and responsible for the control and planning of actual maintenance and operations and toll collection services. In each main maintenance center, a traffic control room is located to generally control traffic management. Maintenance office is located for every 50 to

70 km motorway section to execute daily field operations such as traffic patrol and maintenance work in each section. In each maintenance office, a traffic operation room is located to carry out field work of traffic control and management and to assist the traffic control room.

3) Basic Plan for Traffic Management and Operations

Generally, as the traffic volume increases, the traffic management with higher quality system is required for the operation. In consideration of efficiency of investment for establishing traffic management system, it is rational to deploy personnel, facilities and equipment to each motorway section corresponding to the traffic volume in the section.

Thus, the following three levels of service are set up based on the traffic volume as follows:

Service Level 1:	>10,000 pcu/day/lane	-	Traffic congestion is expected
Service Level 2:	6-10,000 pcu/day/lane	-	Traffic congestion is possible
Service Level 3:	< 6,000 pcu/day/lane	-	Traffic congestion is unlikely

Note: Critical value by service level based on TEM (Trans European North-South Mortorway).

For the 3,000 km motorway network, application of the proper service level for each section is specified and quality of service to be provided in each section, which is reflected in personnel, facilities and equipment therein, are determined based on the traffic volume forecast, climatic conditions, locations of long tunnels and bridges, record of natural disaster along the route as seen in Table 5.3 on page 19 of this summary report.

In order to enable efficient and systematic traffic management and operations, comprehensive flows of information and communications are clarified and roles and functions of traffic control room is proposed as the core of the operations. The traffic control room is the center to control motorway traffic flow, to receive report of traffic accident, to conduct control in emergency, and to request assistance to hospitals, fire stations or traffic police as required. The maintenance offices with a traffic operation room are to carry out field related activities such as the provision of traffic patrols, first-aid assistance, law enforcement and traffic accident investigation.

4) Basic Plan for Maintenance and Operation

In order to provide motorway maintenance service on the specified level of services, a basic plan is formulated to enable timely and adequate service on inspection, maintenance and repairs for the 3,000 km motorway. The basic plan includes the following:

- Communications (instruction, response, duty, decision and coordination) system among headquarters, regional division office, main maintenance center and maintenance offices, and extent of activity and responsibility of each office.
- The number and types of equipment required at each main maintenance center and maintenance office.
- Data base and management system consisting of as-built drawings and design documents of road structures and facilities, records of extraordinary incidents and maintenance works, etc.
- Planning to operate motorway maintenance for timely execution.

For further details, reference is made to 5.7 of this summary report.

5) Operation System during Unusual Conditions

In order to maintain user's safety and smooth traffic flow under unusual conditions due to man-made accidents such as traffic accidents, spilled loads etc., or natural accidents such as fog, heavy rain, earthquake, etc., the following proposals are made on the traffic management system:

- Disaster prevention system to control collection and dissemination of information among disaster prevention task forces, main maintenance center and maintenance offices.
- Planning and implementation of traffic control and maintenance work to recover from disaster.

The summary of the proposal is indicated in 5.8 of this summary report.

6) Traffic Safety Plan

Based on the principle to minimize damage to motorway users and property, traffic safety plan including the following components is recommended.

- Improvement plans for safe road environment consisting of restriction on intrusion of animals and pedestrians, installation of warning signs on sharp curves or steep vertical grades, and installation of warning signs on severe weather conditions
- Dissemination of information on traffic safety and safe driving practice
- Accident analysis and reporting system consisting of preparation of motorway accident investigation form, establishment of accident reporting system and creation of accident analysis team

(3) Short Term Implementation Program

1) Implementation Program of Traffic Management and Operations

For the short term plan of 1,500 km motorway network, an implementation program with its organization for traffic management and operation system is proposed as follows (Reference to Figure 6.1 in this summary report):

- Traffic Control Room

  The traffic control room located at each main maintenance center is the core of the traffic management and operation system. It accommodates a computer system and associated equipment as well as staff to operate the system and to plan for countermeasures to be taken when incidents occur.

- Traffic Operation Room

  The traffic operation room located at each maintenance office is to gather and distribute data from/to roadside equipment and to monitor information so as to promptly respond to incidents. Another important function of the traffic operation room is to back up the functions of the traffic control room in the case of communication interruption between the traffic operation room and the traffic control room.

- Information Collection System (on traffic data and traffic accidents)

  Emergency telephone, vehicle detector, weather observatory, CCTV system for traffic surveillance, vehicle measurement equipment, patrols and information from toll gates

- Information Processing and Decision Making System

  All the information collected by the above system is transferred to and processed at the traffic control room where judgment and decision are made for countermeasures for accidents, assistance to drivers, implementation of detouring, provision of special traffic restrictions, etc., corresponding to the traffic situation.

- Information Dissemination System

  Information dissemination equipment for variable message signs located along motorway is controlled by the traffic control room and the road traffic information is transferred to motorway users. For the inquiry by telephone call, response services by means of both direct personal response and tape recording are provided.

- Execution and Enforcement

  Traffic control measures such as speed limit reduction during an adverse weather condition, closure of a shoulder, closure of a lane, and total closure of a section of motorway must be executed in a coordinated manner by both KGM and the traffic police.
  The traffic control room has a major responsibility for overseeing such activities.

To support the above system operation, installation standard for various system equipment is given corresponding to the three service levels and operation manual for traffic patrol and traffic management during unusual situations is prepared in a separate volume.

2) Implementation Program of Maintenance and Operations

The organization for maintenance and operations is proposed and an operation manual is prepared for the following work items:

- inspection
- road cleaning

- vegetation control
- snow and ice control
- repairs of traffic safety facilities
- maintenance of pavement
- maintenance of bridges
- maintenance of tunnels
- maintenance of other structures
- maintenance of cut & fill slopes

For further details, please refer to Operation Manual in a separate volume of this report.

(4) Cost Estimate

Estimation of the cost to develop the motorway OMM system is made for the following items:

- procurement and installation of traffic management equipment and procurement of equipment for maintenance operations
- operation of traffic management and maintenance
- maintenance of equipment and facilities

As the result, the total project investment is estimated at US.$. 371 millions, and the annual operation cost in 1966 (proposed year of inauguration) is estimated at US.$.102 millions.

(5) Financial Evaluation

The Government of Turkey has so far obtained financial resources for the construction of motorways through KOI (abbreviation of Turkish name of the organization, Public Partnership Fund in English translation), a financial agency for public work development, mainly from contractors' credit. In this system, KOI is to receive 90% of the total toll revenue as the investment fund for motorway development including payoffs to contractors and management of toll revenues. KGM, who is responsible for operations of motorway OMM system, is to receive the remaining 10% of the toll revenue. However, detailed allocation of expenditures and responsibilities for establishing and operating the OMM system on a long term basis seems not to have been clearly defined. Under these circumstances, in order to clarify items which are necessary to maintain and operate OMM system of an international standard on a financially sound basis, a base case is set up with basic assumptions

given below and other several cases derivative from this base case are analyzed for the review of financial situation of this project.

1) Assumptions for Base Case

- The total project investment of US.$.371 millions is borne by KGM.
- The system corresponding to the above investment is assumed to start operation in 1996 and the project life is assumed 15 years since then.
- The toll revenue forecast is made based on traffic volume forecast by JICA study team and 10% of the toll revenue is assumed to be allocated for OMM operation.
- The toll rate is assumed fixed at the present rate converted in US. currency for the duration of project life.

2) Result of Financial Analysis of Base Case

The OMM account continues to show red balance during the total project life.

3) Results of Financial Analysis of Derivative Cases

- The toll share of 20 % will be required for OMM operation to ensure about 10 % of internal rate of return (IRR) without changing other basic conditions. About 10 % of IRR is generally considered moderate for a government project financing.
- The toll share of 15% for OMM operation will ensure about 10 % of internal rate of return if the total project investment cost mentioned above is borne by KOI.
- The toll revenue forecast adopted herein should be understood to involve some 20 or 30 % error. If the actual toll revenue is 10% larger than the forecast, the IRR will be improved by about 5%.
- KGM is a large governmental organization with 33,000 employees. About 4,400 personnel is required for the motorway OMM operation. If a half of the required personnel is managed to obtain by the conversion of existing employees, the toll share for OMM operation may be decreased by about 2 %. The similar discussion is also possible on the equipment and facilities. Thus, KGM's effort on such self-reliant basis will also be required.

(6) Recommendation

- The Government of Turkey is recommended to review more carefully the present financial framework for the motorway development and operations and reach a more practical and balanced framework coordinating the matter among KOI, KGM, Ministry of Finance and Customs and all other authorities concerned if any.

- The KGM are recommended to try their best to transfer duty and responsibility of the main maintenance centers to maintenance offices as promptly and widely as possible through the accumulation of actual operation and systematically programmed training of employees.

- Next to the effective utilization of existing personnel, privatization of the system operations should be positively studied by KGM. Toll collection services, the privatization of which is now considered extremely difficult by KGM may also be carried out by private companies if a workable inspection system by KGM is properly introduced and a proper insurance or guarantee system is arranged.

Table of Contents

1. Ovjectives of the Study and Study Area

1.1 Objectives of the Study

The overall objectives of the study are as follows:

1) To formulate a basic plan of the motorway maintenance, operations and traffic management system (motorway OMM system) for the future 3,000 km motorway network.

2) To prepare a short-term implementation program and operation manuals of the motorway maintenance, operation and traffic management system within the 1,500 km motorway network.

3) To pursue the transfer of technology from the JICA Study Team to the Turkish counterpart personnel during the motorway OMM system study.

1.2 Study Area

The study area covers the motorway network (totaling about 3,000 km) in the Republic of Turkey. In view of linkage with the international motorway network, the study takes into account existing and planned motorway networks of the surrounding countries.

2. General Background of the Republic of Turkey

2.1 Socioeconomic Conditions

The population of the Republic of Turkey reached 56.5 million in 1990. The State Institute of Statistics Prime Ministry in the Republic of Turkey foresees an annual population growth rate of 2.2% and estimates the population of Turkey to be 70.1 million by the year 2000, and 87.2 million by 2010.

Turkey's per capita GNP was approximately US$2000 in 1990. The target average annual growth rate of GNP is expected to be 7.0 % under the sixth five-year program (1990-1994). Attempting to moderate the considerable regional differences in income is one of the major issues in Turkey's economic policy.

2.2 Road Network

Turkey serves as the geographic connection between Europe, the Middle East and Eastern Europe. The main highways crossing Turkey are the following European Highways,

E5 (D-100 & D750 in Turkey) from Romania and Bulgaria to Syria, E24 (D-550R D-400) to Iraq, and E23 (D-300 & D-200) to Iran.

At the end of 1990, the total length of Turkey's road network was 59,128 km including 31,149 km of state highways and 27,979 km of provincial roads. In 1990, the road passenger movement was 135 billion passenger kilometers. The movement of cargo was 66 billion ton kilometers. The State Road Network is illustrated in Figure 2.1.

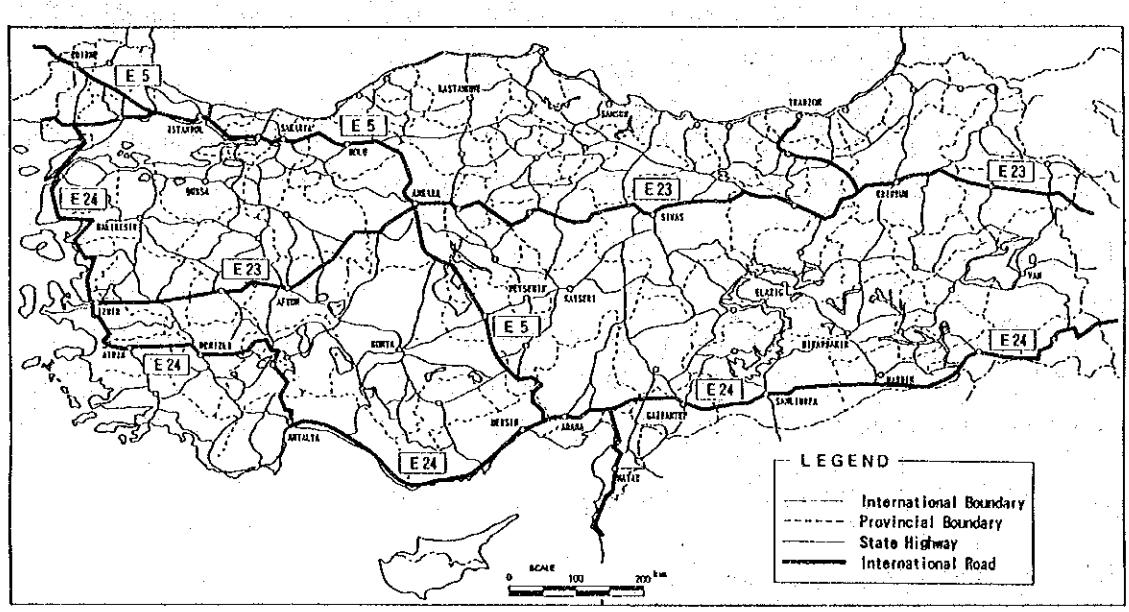


Figure 2.1 State Highway Network

2.3 Motorway Network and Traffic Projection

Within the Trans European North-South Motorway (TEM) concept Turkey is responsible for maintaining 3,000 km of international routes within its borders. On the long term KGM plans to construct 11,000 km of motorways, which includes the TEM route. Construction of 1,500 km has started, and 901 km of this route was opened for traffic as of 1992. KGM gave the 3,000 km Motorway Network plan high priority in the sixth five-year program (1990 - 1994), and is scheduled to be completed by the year 2000. Refer to Figures 2.2 to 2.4.

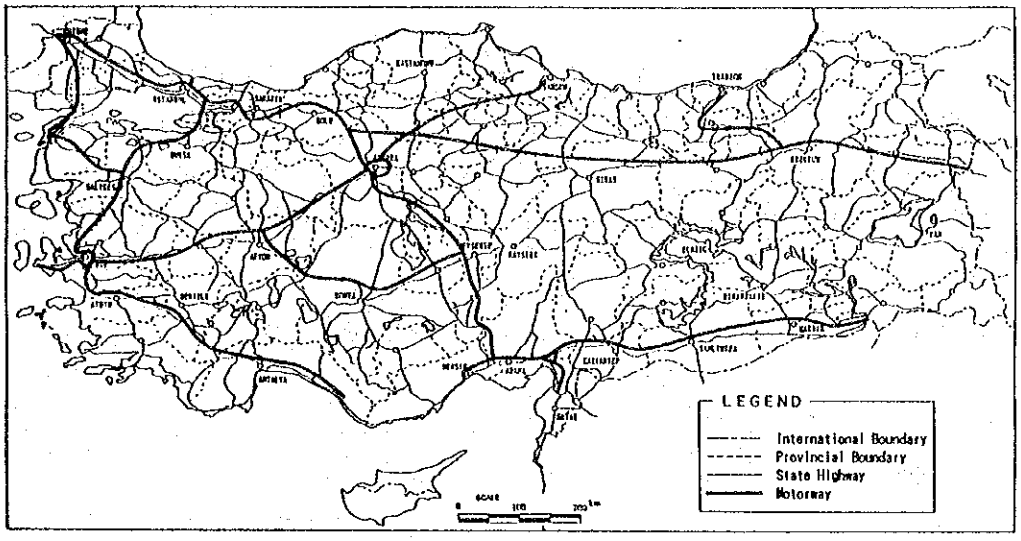


Figure 2.2 Motorway Network 11,000 km Conceptual Plan

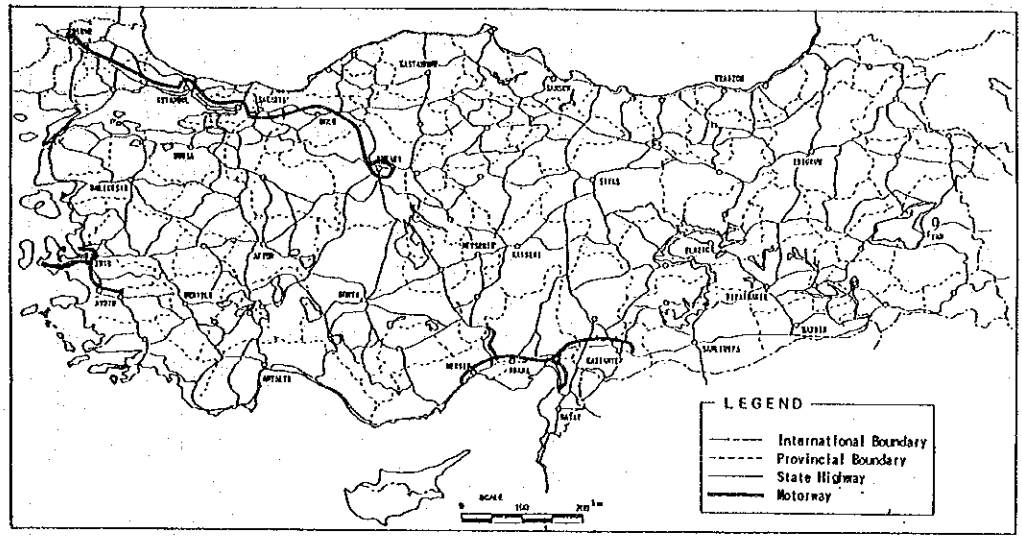


Figure 2.3 Motorway Network 1,500 km Plan

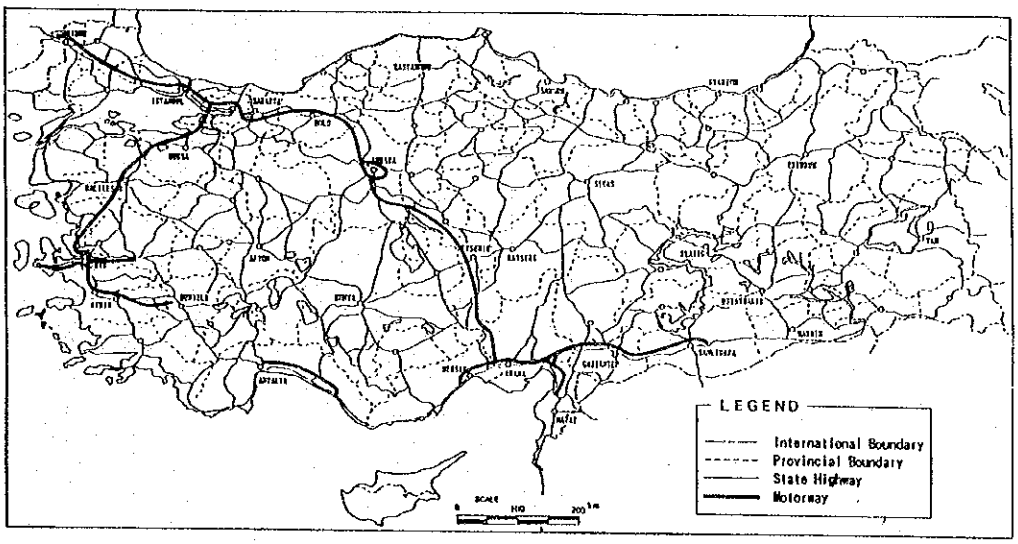


Figure 2.4 Motorway Network 3,000 km Plan

Traffic forecasts were made to establish standards for road maintenance and traffic management services. Future traffic volumes were estimated based on current traffic volumes, by multiple regression analysis with GRDP and population as parameters, and the following diversion rate assumptions: passenger cars 60 %, buses 70 %, and trucks 80 %. Refer to Table 2.1.

Table 2.1 Future Traffic Volumes of Motorways

Location Name	Distance (km)	Traffic Volume in 2000			Traffic Volume in 2010		
		Truck	Bus	Total (Inc'd car)	Truck	Bus	Total (Inc'd car)
Edirne - Babaeski	73.0	3,000	700	8,500	4,800	1,400	15,700
Babaeski - Cerkezkoy	90.0	3,500	1,300	10,000	5,400	2,500	18,600
Cerkezkoy - Catalca	54.0	8,000	2,100	30,800	12,300	4,000	58,700
Catalca - Istanbul	69.5	34,800	9,700	69,600	52,500	18,500	123,500
Istanbul - Kandira	87.5	16,700	5,400	44,800	25,600	10,300	82,400
Kandira - Hendek	67.8	11,000	4,800	23,300	16,800	9,200	41,300
Hendek - Caydurt	100.9	5,400	2,400	13,100	6,600	3,500	19,600
Caydurt - Ankara	262.2	3,200	1,200	7,400	4,000	1,700	11,000
Ankara - Nigde	-	2,020	290	3,500	2,500	420	5,030
Nigde - Pozanti	-	1,910	370	3,560	2,500	560	5,160
Pozanti - Tarsus	59.6	5,100	610	7,380	6,250	900	10,150
Izmir - Aydin	126.0	3,350	1,710	19,900	7,130	4,700	58,300
Aydin - Buhurkent	-	3,340	1,330	18,300	7,120	3,660	53,370
Buhurkent - Denizli	-	2,390	1,040	9,600	5,080	2,870	27,300
Izmir - Zeytinler	43.6	1,340	1,860	32,200	2,850	5,100	98,600
Zeytinler - Cesme	27.9	720	430	12,100	1,520	1,200	37,000
Izmir - Salihli	-	8,000	1,560	21,600	17,000	4,280	17,000
Izmir - Manisa	-	3,800	1,840	26,200	8,100	5,000	77,000
Manisa - Balikesir	-	3,700	730	7,600	5,670	1,400	13,500
Balikesir - Gebze	-	6,400	1,240	12,600	9,800	2,400	22,000
Mersin - Tarsus	58.6	6,980	660	20,800	11,700	660	45,000
Tarsus - Toprakkale	110.5	8,150	750	20,700	13,700	750	43,800
Toprakkale - Gaziantep	144.8	6,890	730	12,600	13,220	1,840	272,000
Gaziantep - S. Urfa	-	7,800	500	11,000	15,000	1,260	23,000
Toprakkale - Iskenderun	90.4	4,600	300	7,900	7,750	300	15,500
Antalya - Manavgat	-	3,260	470	13,200	5,500	470	29,500
Manavgat - Alanya	-	2,250	360	6,100	3,800	360	12,700

3. Existing Conditions of Road Maintenance, Operations and Traffic Management and Operations

3.1 Organization

At the end of 1991 the General Directorate of Highways (KGM) maintained and operated 30,843 km of state highways, 26,956 km of provincial roads and 376 km of Motorways.

KGM's Regional Divisions 17 in Istanbul, 1 in Izmit, 2 in Izmir, 4 in Ankara and 5 in Mersin are responsible for maintenance and traffic management of the motorways. The Regional Divisions 1 and 17 maintain and operate 137 km and 155 km of the total 476 km of motorways respectively.

3.2 Issues on Motorway Maintenance and Operations

Issues relating to the current practice of motorway maintenance and operations are described as follows:

1) Newly opened motorways such as the Istanbul 2nd Bosphorus Bridge and peripheral road and Tarsus/Yilankale section should be fully maintained and operated as soon as possible. KGM is presently only undertaking traffic patrolling and minimal maintenance due to the warranty period of the recent construction.

2) The number and procurement of equipment for the maintenance and operations of all motorway sections should be what is appropriate considering the privatization of maintenance of road surface, guardrails, lighting, drainage and vegetation, removal of damaged cars caused by accidents and engine problems, slopes, asphalt overlays, bridge repairs, etc.

3) Maintenance manuals should be prepared and furnished to the personnel concerned for inspection, pavement and repairs, road cleaning, bridge repairs, snow and ice removal, and others.

3.3 Issues on Traffic Management and Operations

Current issues relating to traffic management and operations being conducted on the motorways are as follows:

1) Accident Detection

Especially in case of highly congested traffic, detection of a traffic accident within a few minutes and immediate action to remove or minimize the impact of the accident are

indispensable. After detection and confirmation of the accident the motoring public should be provided with accurate information and a logical diversion route. Establishment of a system to provide immediate communications of the accident to public radio and TV is an effective tool to reduce the impact of traffic accidents.

Under the current traffic patrol system it takes approximately two hours to make a normal circuit, thus it could conceivably take the two hour maximum to detect a problem on the motorway. Also, the traffic patrol itself may become tied up with an accident, disabling it from performing its function.

The existing system in Division 17 requires that someone drives out to the variable message signs, and activate them in the field, which hampers immediate action after detection and confirmation of a traffic accident.

2) Improper Use of Emergency Telephones

Better education and reduction of unauthorized public access to telephones may help to solve the current problem of improper use of emergency telephones on the motorways.

3) Motorway Safety/Traffic Safety

The following is recommended to improve safety conditions on the motorways:

- Pedestrians should be prevented from access to the motorway, by continuous and well-maintained fencing and enforcement of "No Pedestrians on the Motorway".
- Special bus stops should be developed.
- Parking of vehicles other than for emergency reasons should be prohibited.
- Oversized vehicles should be prohibited.
- Establishment of minimum and maximum acceptable speed limits should be promoted.
- Provision of well maintained guardrails, traffic markings and reflectors is required.
- Establishment of an accurate and up to date database describing all accidents on the motorway for adequate assessment of safety issues is recommended.
- Investigation of the effect of adverse weather on traffic conditions is recommended.
- Detection and removal of vehicles which are broken down.

4) Coordination

A communication network that allows for the immediate flow of information regarding travel restrictions and problems on motorways within, between and outside Divisions can help provide maximum service to the motorway users and is of great value.

5) Toll Collection System

The potential of the existing toll collection system which utilizes a magnetic card system is not being fully utilized. Establishment of an adequate administrative organization and communication cable network is required to improve the situation.

4. Traffic Survey and Analysis

A traffic survey was conducted on the first and second peripheral roads in Istanbul to ascertain the present conditions of traffic control and information dissemination in the Istanbul area, the results of which are described here after.

4.1 Count Surveys

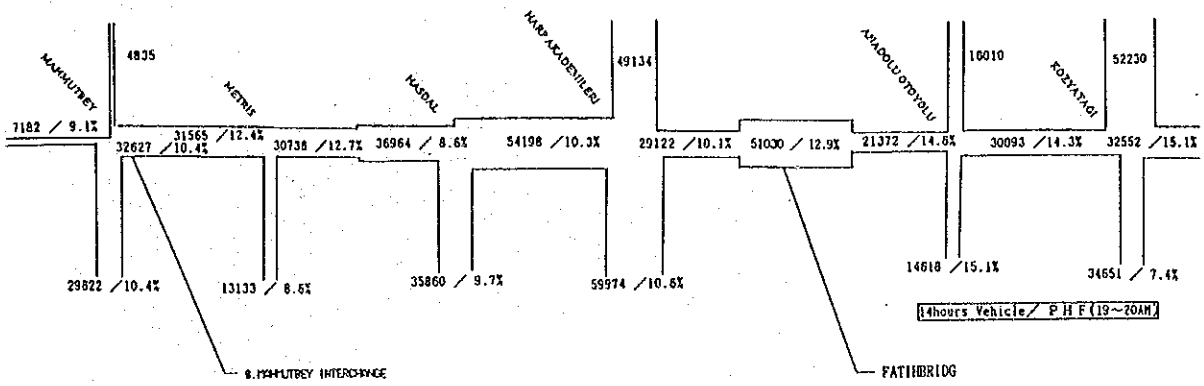
Traffic Count Surveys were conducted at selected interchanges on the 1st and 2nd Peripheral Road. Results of the traffic flow survey are shown in Figures 4.1 and 4.2.

4.2 Origin and Destination Surveys

Origin and Destination Surveys were carried out at the 1st and 2nd Bosphorus Bridges. The number of vehicle trips using the 1st Bosphorus Bridge and the 2nd Bosphorus Bridge amounted to 155,105 and 62,267 vehicles/day respectively. Figure 4.3 and Table 4.1 show the origin - destination results for both bridges.

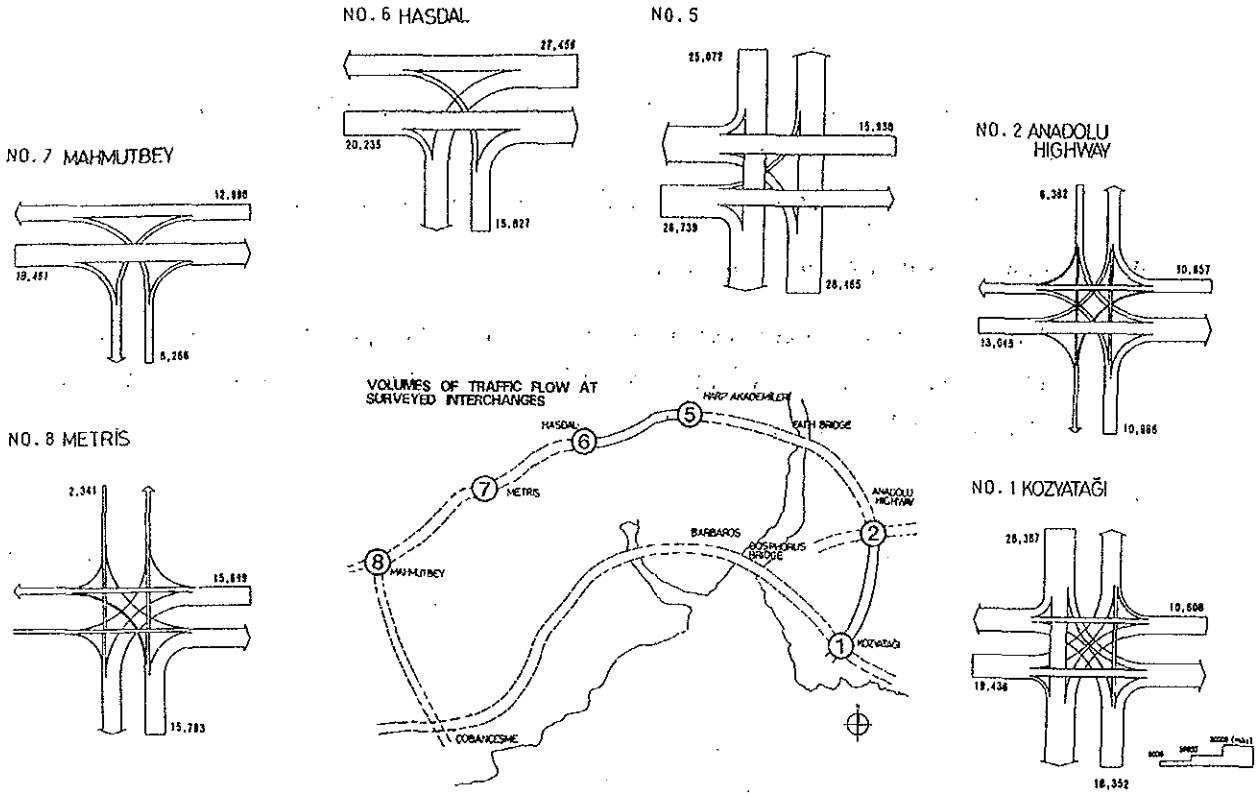
4.3 Travel Speed Surveys

Travel speed surveys were conducted on the 1st Peripheral Road, 2nd Peripheral Road, and several major roads in the Istanbul area. Results of the survey are shown in Figure 4.4 and Table 4.2.



Source: JICA Study Team

Figure 4.1 Traffic Flow



Source: JICA Study Team

Figure 4.2 Traffic Volumes at Interchanges (14 hours)

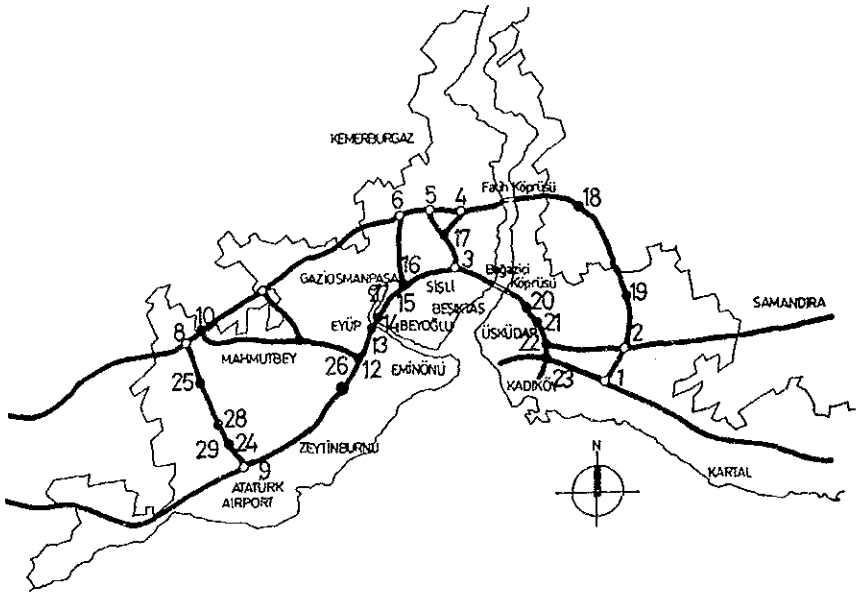


Figure 4.3 Origin Destination Survey Interchange Number

Table 4.1 O-D Table for the Total Bridge Crossing

Zone	1	2	18	19	20	21	22	23	
3	7,827	6,941	777	2,306	8,867	15,878	5,437	9,630	
4	14,430	5,839	2,335	6,102	3,978	8,268	4,185	4,239	
5	452	123	0	116	0	0	0	0	
6	436	119	87	174	93	0	29	0	
7	378	210	116	436	0	97	64	158	
8	3,472	1,333	669	1,250	251	551	397	258	
9	1,485	881	174	233	837	863	438	503	
10	216	152	58	58	0	187	116	97	
11	468	332	174	368	313	322	32	287	
12	719	928	0	245	419	1,701	451	516	
13	951	448	29	87	451	548	322	258	
14	825	1,099	178	790	866	1,092	386	219	
15	7,665	3,230	872	3,655	931	2,873	716	570	
16	1,818	1,369	239	1,163	1,481	4,371	1,836	1,063	
17	2,277	535	262	868	612	1,317	702	1,256	
24	152	0	0	0	64	129	0	0	
25	588	332	87	320	0	319	287	0	
26	4,408	5,178	632	1,200	1,991	5,050	2,071	2,075	
27	1,192	126	0	123	354	1,086	934	451	
28	1,188	420	87	320	129	303	93	187	
29	1,659	471	116	420	158	303	174	97	
Total	52,604	30,065	6,893	20,234	21,786	45,258	18,672	21,860	217,372
					20,033	42,183	17,069	20,275	99,560

Source: JICA Study Team

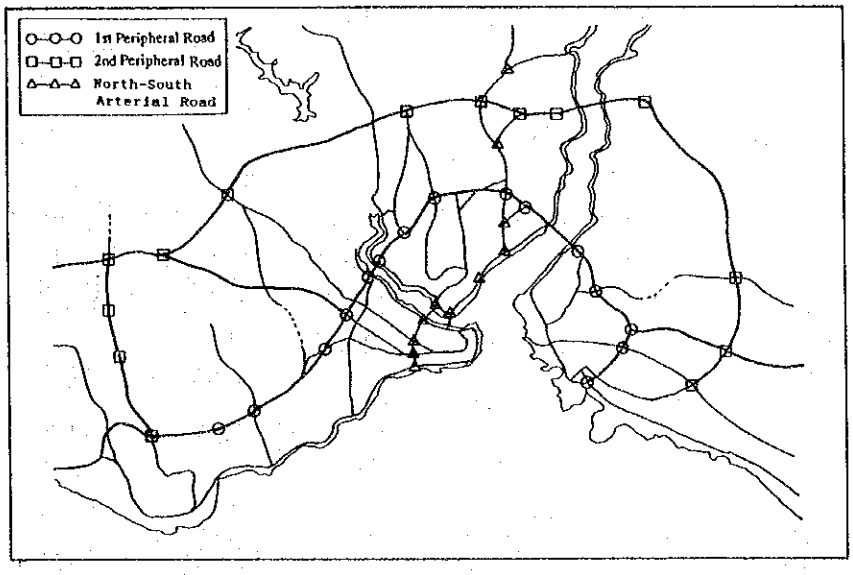


Figure 4.4 Travel Speed Survey Route

Table 4.2 Summaries of the Travel Speed Survey

(1) 1st Peripheral Road

Start Time	From Anatolia to Europe			From Europe to Anatolia		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
7:30	41.1	73.5	11.8	41.7	87.8	18.3
8:30	39.6	72.7	13.7	39.2	91.1	19.4
10:00	51.5	88.9	15.1	51.8	80.9	23.7
11:00	49.7	92.3	17.3	59.0	86.7	13.2
13:30	60.5	81.8	36.0			
14:15				61.9	88.9	18.5
15:00	60.9	88.6	26.5	39.7	79.1	6.6
16:00	61.5	79.9	28.4	45.0	90.0	9.2
17:30	37.4	84.0	6.2	32.8	72.0	8.9
18:30	32.4	72.0	13.2	36.2	67.5	12.2

(2) 2nd Peripheral Road

Start Time	From Anatolia to Europe			From Europe to Anatolia		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
8:00	70.1	92.0	44.7			
9:00				76.2	101.4	31.8
10:30	85.4	106.3	59.5			
11:30				77.6	107.5	36.6
15:30	88.5	106.6	65.1			
16:30				78.2	105.7	35.3
17:30	86.1	109.4	64.5			
18:30				59.7	80.7	16.9

(3) North-South Arterial Road

Start Time	From North to South			From South to North		
	Average (km/h)	max. (km/h)	min. (km/h)	Average (km/h)	max. (km/h)	min. (km/h)
8:00	19.1	37.5	12.3			
9:00				20.4	41.4	5.6
10:30	22.6	45.0	10.2			
11:30				28.7	53.3	14.3
15:30	25.2	36.9	18.3			
16:30				17.2	33.4	3.9
17:30	18.3	34.7	9.6			
18:30				17.5	40.0	6.9

Source: JICA Study Team

5. Basic Plan of the Motorway OMM System

5.1 Definition and Functions of the Motorway OMM System

The Motorway OMM system has three goals, which are identified as ensuring "traffic safety", "smooth traffic flow" and "users' comfort" by an efficient and economical system operation.

The motorway OMM system is defined in terms of two basic functions, "Traffic Management and Operations" and "Motorway Maintenance and Operations". The various components constituting these functions are identified, the tasks performed under these components are discussed to provide a basic plan of the motorway OMM system taking into account that the motorway networks in Turkey will be developed to approximately 3,000 km in length (Figure 5.1).

The functional roles of the motorway traffic management and operations are indicated as follows:

- Maintaining safe and smooth traffic flow on the Motorway.
- Preventing unusual conditions such as traffic accidents and traffic congestion which affect the traffic flow.
- Recovering from traffic accidents and traffic congestion to normal traffic flow as quickly as possible.

The functional role of motorway maintenance and operations is defined as systematic activities to preserve and repair a system of motorways with its elements to its designed or accepted configuration. Included in these activities are such services as inspections, maintenance and repairs of road structures and facilities, snow and ice control, and maintenance of roadside rest areas.

5.2. Basic Concept

1) Basic Concept for Establishing Traffic Management and Operations

Establishing traffic management and operations levels are dictated by organizational activity and the utilization of special facilities to improve the movement of traffic. It is obviously most important to eliminate existing problems and issues. It also must take into account social and economic needs, as the results of traffic congestion, traffic accidents, or road closures can have a dramatic impact on the vitality of a city or region. In these cases, the introduction of facilities to alleviate these problems can be of the utmost importance. Traffic accidents and the potential for loss of human life must weigh heavily on decisions for the provision of traffic management and operations facilities, almost irrespective of the cost.

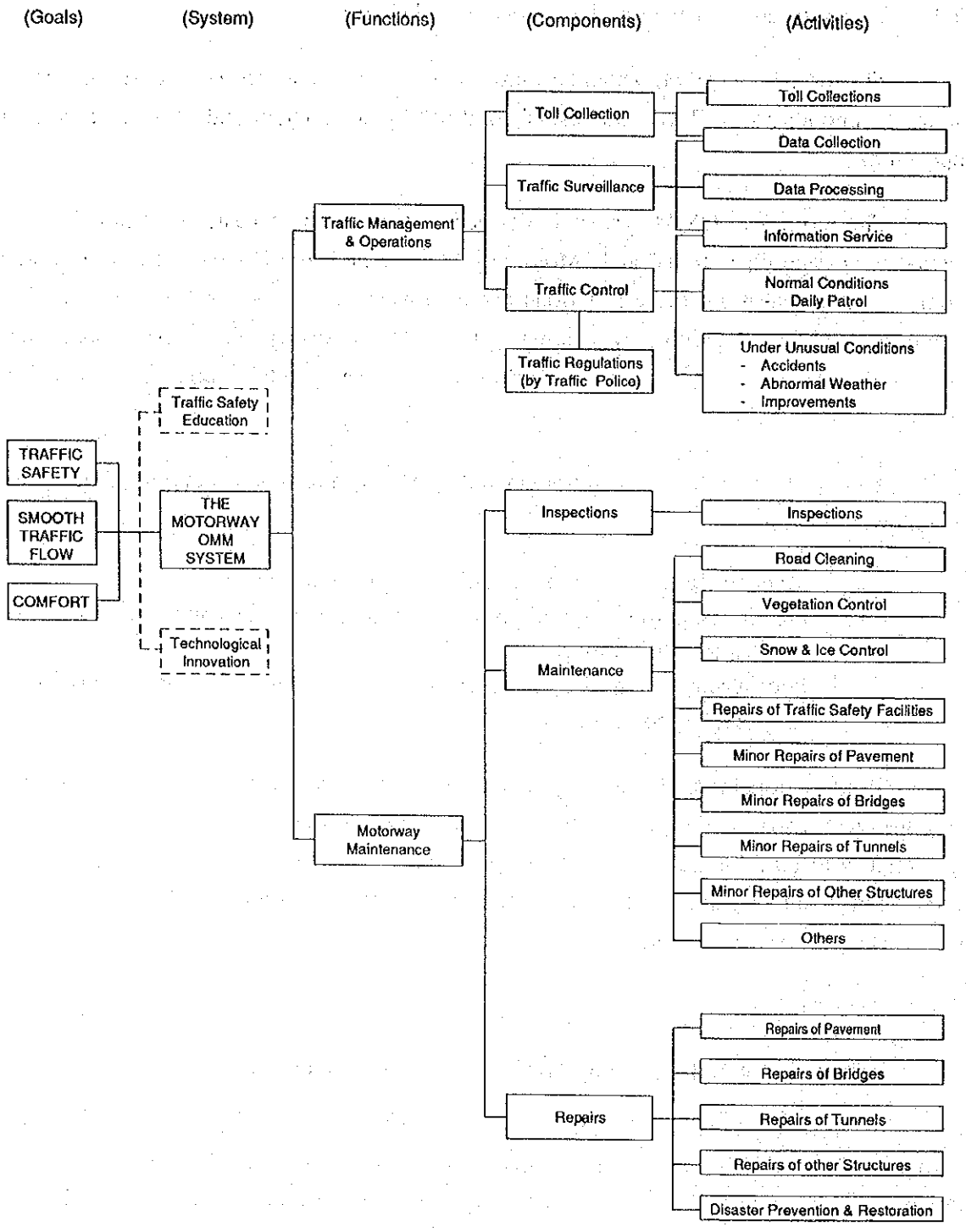


Figure 5.1 Definitions and Functions of the Motorway OMM System

As a matter of practicality, however, the implementation of traffic management and operations systems is a costly venture, and it would be best to stage and prioritize the implementation of a system, so that KGM can get the largest benefit for the money spent.

Because of this fact, several different service levels have been established for the provision of traffic management and operations on motorways. This multiple service level method allows the logical implementation of traffic control devices where they are needed, and provides the best use of KGM's budget. This method of staging serves to reduce the financial burden on KGM by providing only those facilities that are needed.

2) Basic Consideration on Establishing Motorway Maintenance and Operations

It is a focused subject for KGM how to maintain and operate the motorway in an efficient and economic manner, considering the future increase in motorway length. If the budget were not provided appropriately for motorway maintenance and operations, eventually extra investment would be needed at several times larger than the original construction cost due to expensive repairs and reconstruction. KGM is responsible for establishing an organization and providing necessary personnel, facilities, equipment, material and budget. A consideration whether the work should be done directly by force account or on contract basis is necessary to determine the number of KGM personnel required by the quality and quantity of the motorway maintenance works. It is also important to establish a training system for KGM personnel, and a system to keep as-built drawings, design documents and construction records of the relevant motorway structures for the use for motorway maintenance and operations.

5.3 Organization

The future concept of 10,000 km of motorways may require an independent motorway authority. Until that time, KGM must determine how best to manage the 3,000 km motorway system for a long-term plan. It is recommended that KGM look to strengthen the existing organization, and do so in a manner similar to that used by motorway organizations of other similar countries. By strengthening its existing organization, KGM can proceed in a more practical direction following the basic government policy of not creating new agencies at all if possible.

The conceptual organization structure for the motorway OMM system is shown in Figure 5.2.

The proposed main tasks of the motorway OMM system by the level of offices are shown in Table 5.1.

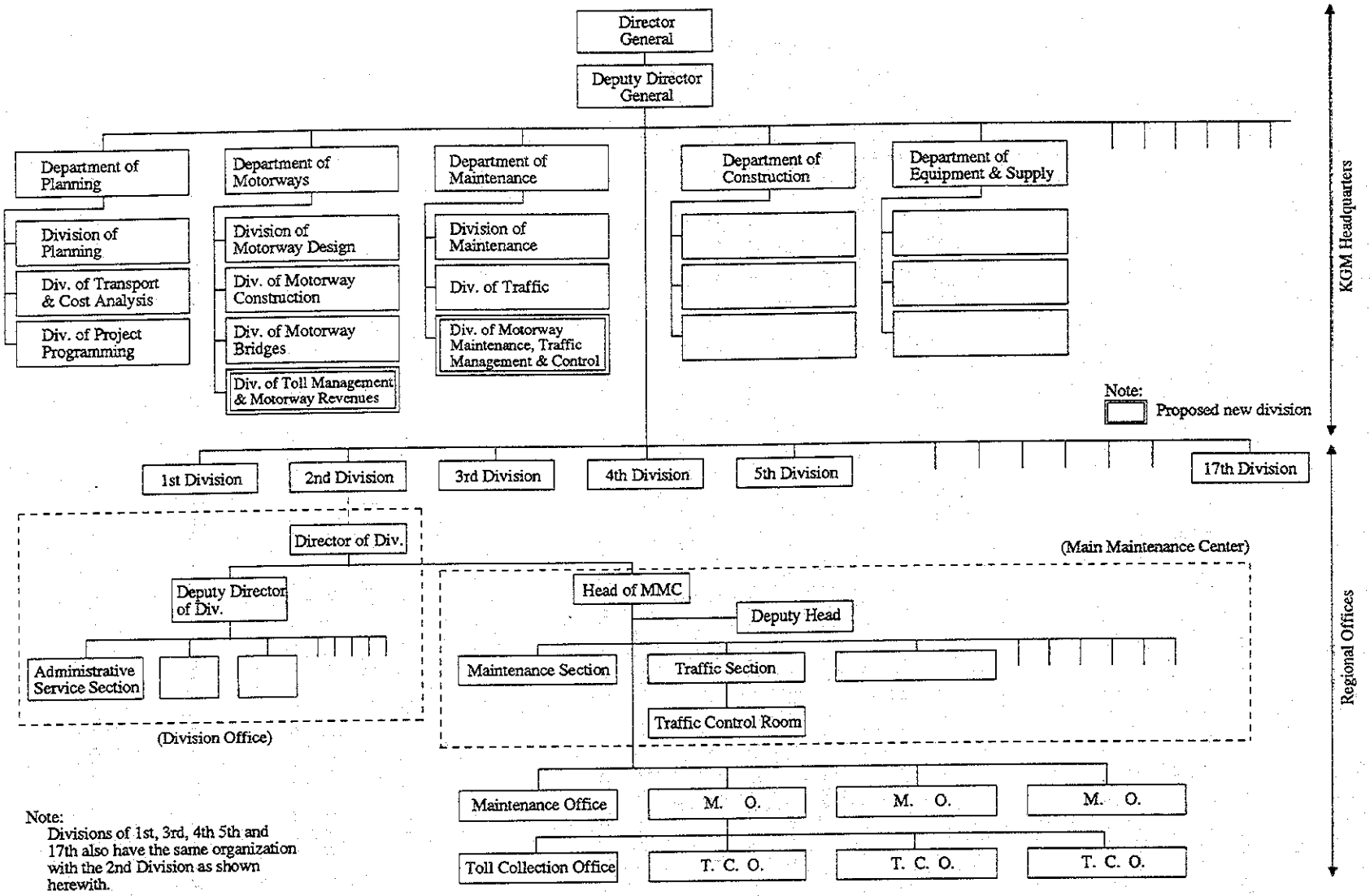


Fig. 5.2 Conceptual Organization Chart for OMM System

Table 5.1 Main Tasks of Motorway OMM System and its Responsible Office

Main Tasks	Activities	Responsible Office				
		Headquarters	Regional Division Office	Main Maintenance Center	Maintenance Office	Toll Collection Office
1. Planning and Programming	a. Planning	○				
	b. Implementation programming	○				
	c. Estimation of toll revenue	○				
	d. Redemption study	○				
2. Traffic Engineering and Safety	a. Setting of standards and management level	○				
	b. Road and traffic engineering development and research	○				
	c. Traffic forecasts	○				
	d. Implementation of traffic survey	○		○		
	e. Statistical data processing			○	○	
3. Traffic Management and Operations	a. Basic planning	○		○		
	b. Traffic operations			○	○	
4. Maintenance and Operations	a. Setting of standards	○				
	b. Supervision and consultation works			○		
	c. Maintenance and operations				○	
5. Toll Collections	a. Basic planning	○				
	b. Data processing			○		
	c. Toll collections					○
6. Coordination and Public Relations	a. Coordination with relevant agencies	○		○		
	b. Response activity	○		○		
7. Administration	a. Personnel management, salary, welfare, etc.	○	○			

5.4 Service Level of Traffic Management and Operations

When the "Service Level" of traffic management and operations is discussed, it is necessary to consider two factors. The first factor is organizational structure and the second is utilization of facilities in relation to existing conditions, future traffic demands, social demands and economic aspects.

The adoption of a comprehensive traffic management and operations system will involve major costs. Therefore, the discussion of the economic aspects of the system is necessary.

In order to avoid large capital investments and high operations costs, recommended service levels for a traffic management and operations system on the motorways must be reviewed based on traffic volumes and other countries' experience. Each of these levels is applied to a particular section of the motorway in response to its special characteristics such as traffic volumes, natural and physical conditions, and locations where long tunnels or bridges exist. Also, for any particular section of motorway, the service level can be upgraded gradually as conditions change. The upgrading of service levels by section according to their changing needs can help to reduce the immediate financial impacts on the KGM.

Service levels are important in how they can help determine the type of traffic management and operations system required to help remedy particular situations.

Service levels are normally predicated on the occurrence of predictable traffic congestion on the motorway where traffic volumes exceed specific thresholds.

Service Level 1:	> 10,000 pcu/day/lane	-	Traffic congestion is expected
Service Level 2:	6,000 - 10,000 pcu/day/lane	-	Traffic congestion is possible
Service Level 3:	< 6,000 pcu/day/lane	-	Traffic congestion is unlikely

Note : Critical value by service level based on TEM

According to the above-mentioned discussion, three service levels for a traffic management and operations system have been identified to match the different requirements along the Motorway. The proposed Service Levels 1 - 3 are shown in Table 5.2.

Table 5.2 Service Level for Traffic Management and Operation System

Service Level	Characteristics of Applied Sections	Objectives	Purpose of Facilities Installation	Facilities/Equipment
Level 3	• Traffic volume lower than 6,000 pcu/day/lane.	1) Providing road users with a means of communications for reporting incidents or to request informations. 2) Establishing a sophisticated communications network among the related agencies.	1) Information gathering and dissemination on representative sections having high traffic incidents or severe weather conditions. 2) Gathering traffic conditions statistical data.	1) Permanent Facilities Traffic Guide Devices, Traffic Safety Devices, Data Processing Facilities, Communications Cable, Roadway Lighting, Power Sources. 2) Communication Facilities Emergency Telephones, Exclusive Telephones, Wireless System 3) Measurement Facilities Vehicle Height Checkers, Axle Weight Scales 4) Traffic Information Gathering Facilities Traffic Detectors, Meteorological Information Facilities 5) Motorist Information Facilities Variable Message Signs, Radio Broadcasts
Level 2	• High traffic volumes and occasional traffic congestion. • Traffic volumes 6,000 - 10,000 pcu/day/lane.	In addition to 1) and 2) above: 3) Upgrading of the traffic flow monitoring function. 4) Upgrading of the information dissemination function to road users. 5) Providing road users with road conditions and traffic problem informations.	In addition to 1) and 2) above: 3) Traffic flow monitoring by CCTV at representative points and the information gathering/dissemination.	In addition to the facilities/equipment above: * CCTV system
Level 1	• High traffic volumes causing significant traffic congestion. • Traffic volumes greater than 10,000 pcu/day/lane.	In addition to 1) through 5) above: 6) Strengthening the function of traffic surveillance, incident detection and information dissemination.	In addition to 1) through 3) above: 4) Facilities installation with spacing at even smaller intervals to deal with the greater levels of traffic congestion and high probabilities of traffic incidents, and prompt information dissemination.	Facilities/equipment are the same as Service Level 2.

5.5. Basic Plan for Traffic Management and Operations

In accordance with the previous discussion of service levels, the basic plan for traffic management and operations on the future 3,000 km motorway network in Turkey is made as follows.

1) Segmentation of the Future Motorway Network

The conditions considered for defining the segments of the future motorway network according to specific service levels and additional safety facilities required for special conditions are as follows:

- future traffic volumes
- historic weather conditions along the Motorway
- locations of motorway with long tunnels (more than 500m)
- locations of motorway subject to closure because of natural disasters

Based on the information mentioned above, the future motorway network should be divided into 27 clearly defined segments. These proposed segments are shown in Table 5.3.

2) Application of Service Levels

Following the previous discussions relating to segmentation of the future motorway network, specific recommended service levels corresponding to each segment can be determined. The results of these recommended service levels are shown in Figures 5.4 and 5.5, and in Table 5.3. They also illustrate how these recommended service levels can be used to help determine a staging plan for providing OMM facilities on the motorways.

3) Traffic Management and Operations System Information Flows

(1) Outline of Information Flows

The conceptual information flows are illustrated in Figure 5.5. Each traffic control room should have a jurisdiction of approximately 200 - 500 km. Traffic control room jurisdictions on the future motorway network are proposed as shown in Figure 5.6. These recommended locations, however, could be revised according to conditions caused by administrative organizational requirements.

Table 5.3 Segmentations and Applications of Service Level on Motorway Networks

Section No.	Section	Distance (Km)	Traffic Volume (x 1,000 pcu/day)		Weather Condition	Long Tunnel	Record of Natural Disaster	Service Level	
			2000	2010				Short Term (1,500 km)	Long Term (3,000 km)
A-1	Edirne - Babaeski	73.0	-36	-36	Fog	-	-	3	3
A-2	Babaeski - Cerkezkoy	90.0	-36	36-60	-	-	-	3	2
A-3	Cerkezkoy - Catalca	54.0	36-60	60-	-	-	-	2	1
A-4	Catalca - Istanbul	69.5	60-	60-	-	-	-	1	1
A-5	Istanbul - Kandira	87.5	60-	60-	-	*	-	1	1
A-6	Kandira - Hendek	67.8	36-60	60-	Fog	-	-	2	1
A-7	Hendek - Caydurt	100.9	-36	36-60	Fog, Snow/Ice	*	Landslide	3	2
A-8	Caydurt - Ankara	262.2	-36	-36	Fog, Snow/Ice	-	-	3	3
B-1	Ankara - Nigde	-	-	-36	Snow/Ice	-	Snowfall	-	3
B-2	Nigde - Pozanti	-	-	-36	Rain, Snow/Ice	-	Flood, Snowfall	-	3
B-3	Pozanti - Tarsus	59.6	-36	36-60	Rain, Snow/Ice	-	Flood, Snowfall	3	2
C-1	Izmir - Aydin	126.0	36-60	60-	-	*	-	2	1
C-2	Aydin - Buharkent	-	-	60-	-	-	-	-	1
C-3	Buharkent - Denizli	-	-	36-60	-	-	-	-	1
D-1	Izmir - Zeytinler	43.6	36-60	60-	-	-	-	2	1
D-2	Zeytinler - Cesme	27.9	-36	36-60	-	-	-	2	1
E-1	Izmir - Salihli	-	-	60-	Rain	-	-	-	1
F-1	Izmir - Manisa	-	-	60-	-	-	-	-	1
F-2	Manisa - Balikesir	-	-	36-60	Rain	-	Snowfall	-	2
F-3	Balikesir - Gebze	-	-	36-60	-	-	Landslide	-	2
G-1	Mersin - Tarsus	58.6	36-60	60-	-	-	Snowfall	2	1
G-2	Tarsus - Toprakkale	110.5	-36	36-60	-	-	Snowfall	3	2
G-3	Toprakkale - Gaziantep	144.8	-36	36-60	Rain	*	-	3	2
G-4	Gaziantep - S. Ulfa	-		36-60	-	-	-	-	2
H-1	Toprakkale - Iskendern	90.4	-36	36-60	Rain	-	-	3	2
I-1	Antalya - Manavgat	-	-	36-60	Rain	-	-	-	2
I-2	Manavgat - Alanya	-	-	-36	Rain	-	-	-	3

Notes : 1. Service level of the short-term program includes 1,500 km of motorways, and traffic volumes in the year 2000.
2. Service level of the long-term plan includes 3,000 km of motorways, and traffic volumes in the year 2010.
3. Distance (-) shows that section distance is not yet determined.

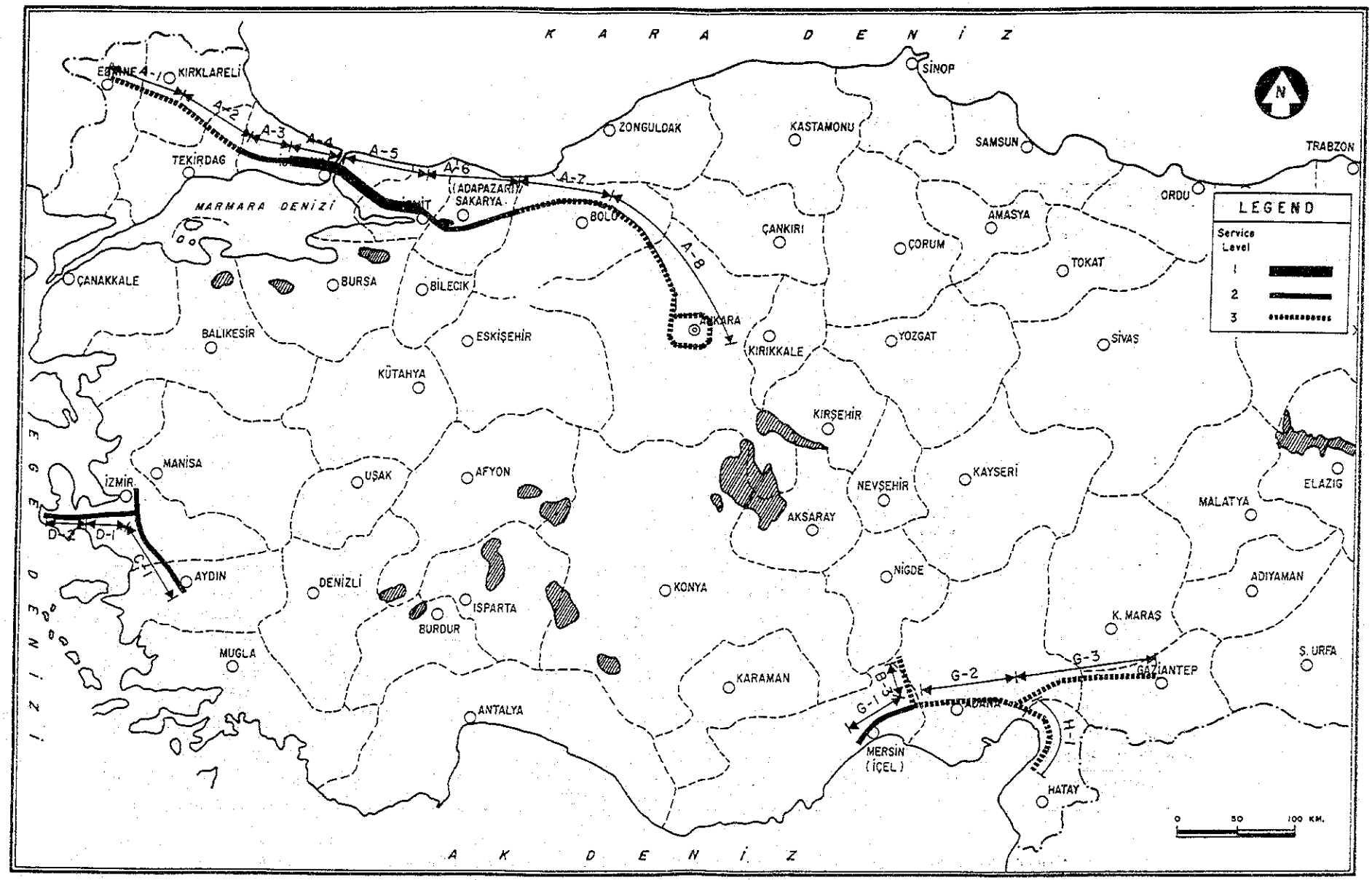


Figure 5.3 Application of Service Level (Short-term)

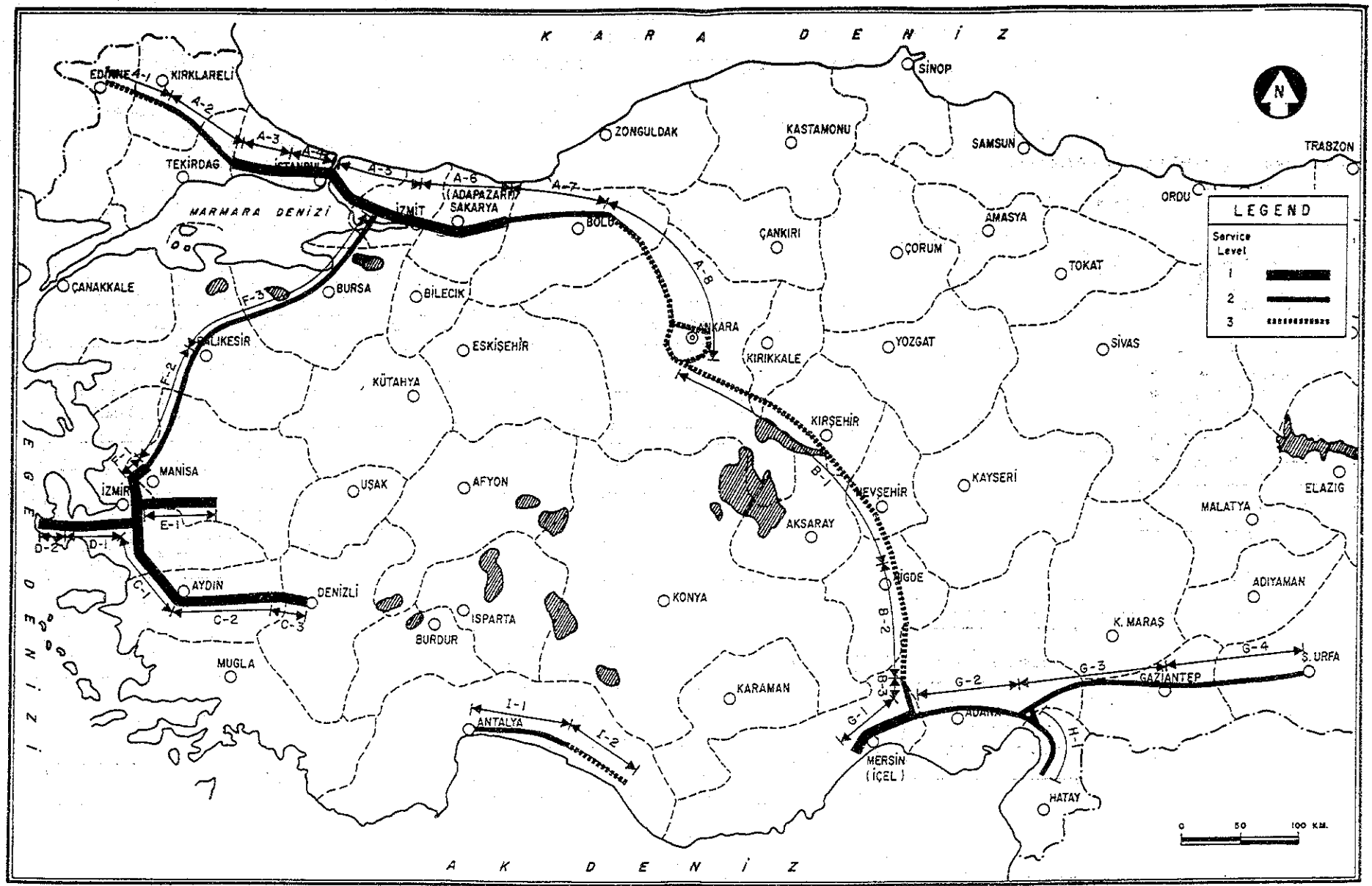


Figure 5.4 Application of Service Level (Long-term)

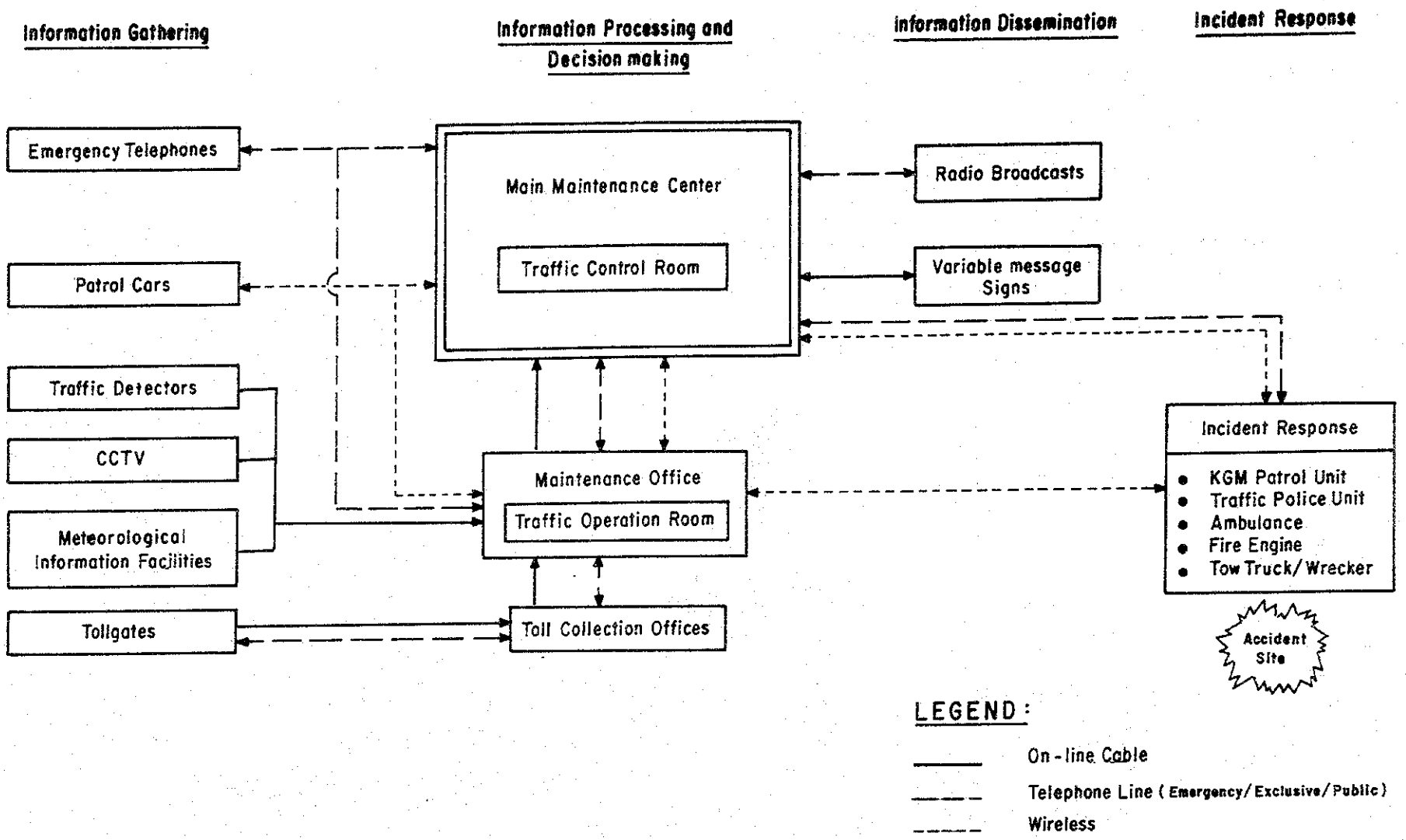


Figure 5.5 Outline of Information Flows

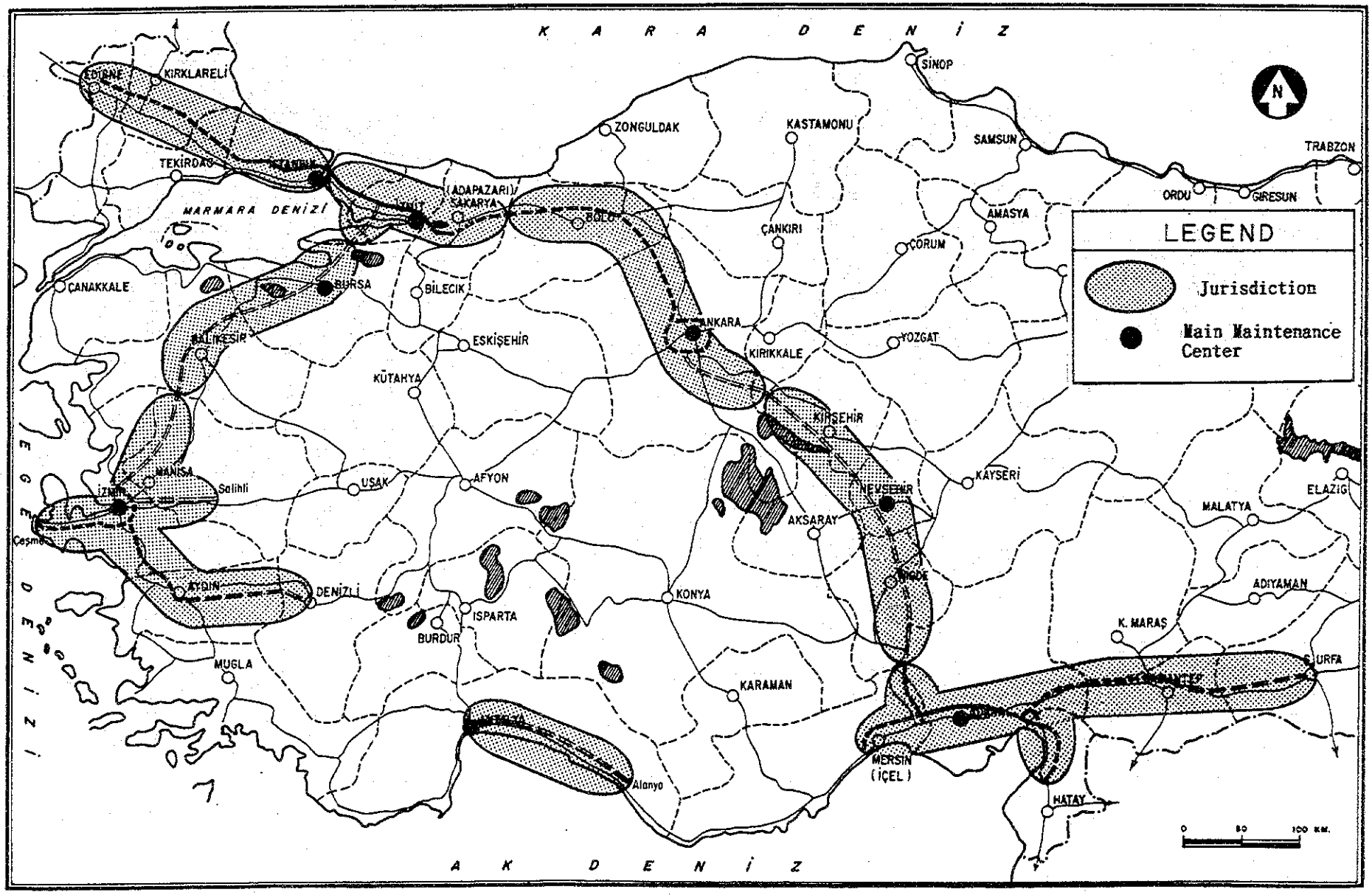


Figure 5.6 Jurisdictions of Main Maintenance Center with Traffic Control Room

The maintenance offices having a traffic operations room are intended for carrying out field related activities such as the provision of traffic patrols, first-aid assistance, law enforcement (together with the traffic police stationed at the maintenance office) and traffic accident investigation. The traffic operations rooms are located in maintenance offices and are typically spaced at about every 50 - 70 km.

(2) Roles of the Traffic Control Room (TCR)

(a) Responsibilities and functions

TCR is the "nucleus" to which patrolling personnel will report actual motorway or incident conditions, and from which instructions are given to patrolling personnel for actions to take during an emergency or incident. TCR is also the base from which requests for assistance from hospitals, fire departments or traffic police are sought. And the TCR is operated on a 24-hours basis.

The proposed specific tasks and responsibilities in the TCR are listed below.

- Contact with patrol cars on duty
- Reception of emergency telephones
- Consultation and contact with other agencies
- Operation of graphic display panel and CRT displays
- Operation of terminal equipment
- Monitor traffic management during an emergency or incident
- Dispatch request to patrol units

(b) Information/communication flow at the TCR

Each traffic control room is to be managed by a chief of TCR and a deputy who will be on duty on a 24-hours basis with three shifts. Both the chief and deputy will control a team of traffic control officers who will be on active duty at the control panel or console. The team of traffic control officers are to report to the chief or deputy and to receive instructions from them. For major incidents or an emergency, consultation with the manager of traffic and maintenance, section and neighboring TCR are necessary (Figure 5.7). For minor incidents, the traffic control officers may directly summon help from hospitals, fire departments or the towing companies.

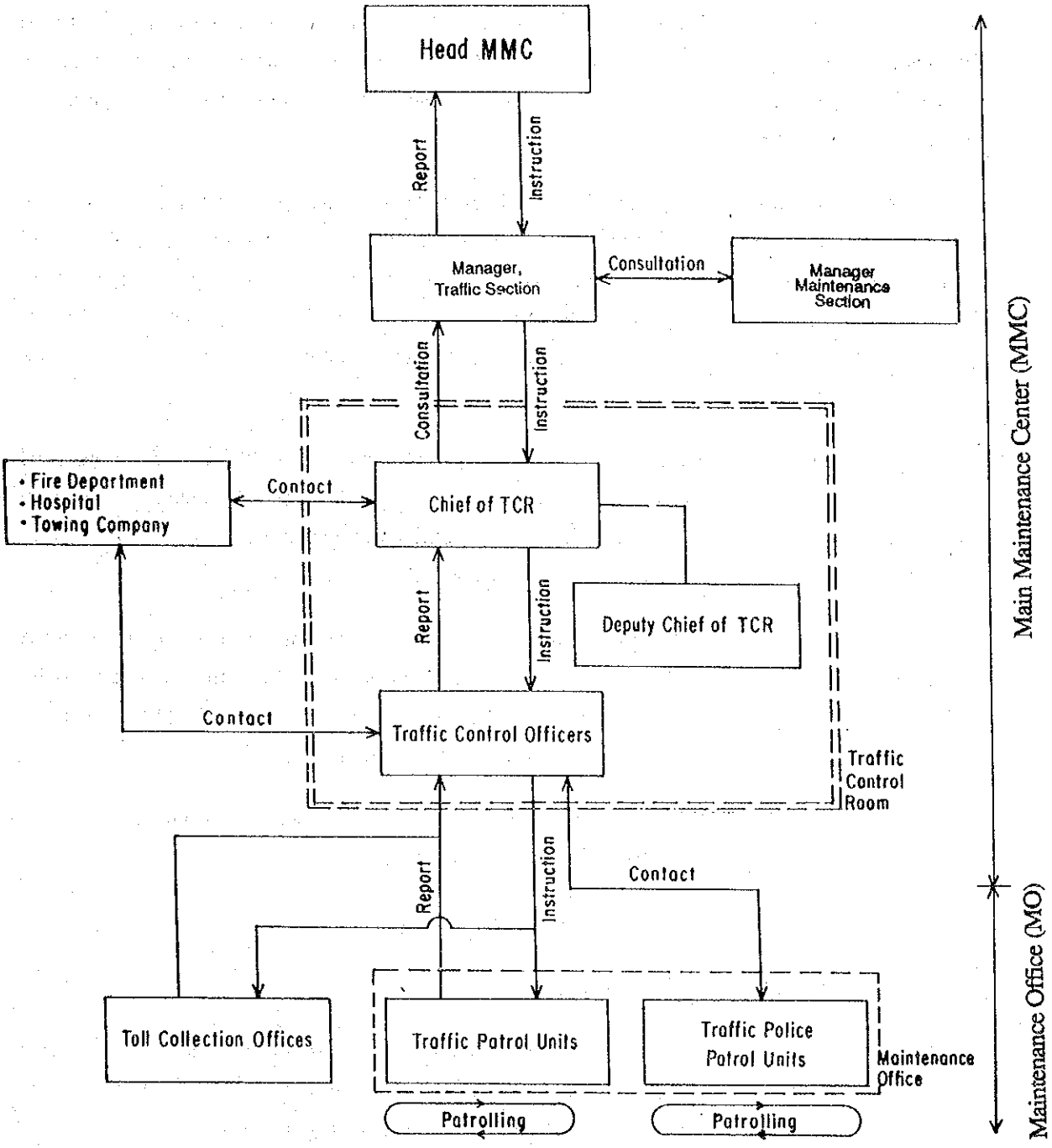


Figure 5.7 Information/Communication Flow at TCR

5.6 Service Level of Motorway Maintenance and Operations

The objective of motorway maintenance and operations is to maintain the road structures and relevant facilities as originally designed, constructed and subsequently improved in an acceptable range. The service level or the level of service is a scale or target to indicate how satisfactorily the above objective is achieved by the proposed maintenance and operations for the motorway users.

Road structures and facilities have their own inherent life span. When they approach this life limit, the cost for maintenance and repairs increases accordingly. But, the actual maintenance and operations must be carried out within certain limitations of the budget. There is also a limitation in the manpower to be mobilized for work. Therefore, it is practical to set up some different degrees in the service level when actual maintenance and operations are planned.

However, from its nature a motorway is required to have a superior function compared with other categories of roads, especially with respect to speed, comfort and safety. Although there is a large difference in traffic volume and areal characteristics amongst the motorway sections, the same functions is equally required overall the motorway.

Consequently it would be practical for the motorway maintenance to set up two or three different service levels for the various motorway sections throughout the fully developed 3,000 km motorway system corresponding to the traffic volume, importance of the routes in the road network and other governing factors for particular maintenance items.

Once such service levels are reasonably established, they would become a useful tool for planning of the maintenance organization and activities.

5.7 Basic Plan for Motorway Maintenance and Operations

1) Flow of Motorway Maintenance and Operations

In order to keep the motorway maintenance and operations within an acceptable service level, its components have to be carried out in a regular and systematic manner. This manner must be consistent with the requirements of its organization and in accordance with the established procedures. These procedures have to be consistent with any operation. Whilst the details may vary slightly between various tasks, the overall procedural routine must be followed. This routine must be free form unnecessary interference. The work flow is portrayed in Figure 5.8.

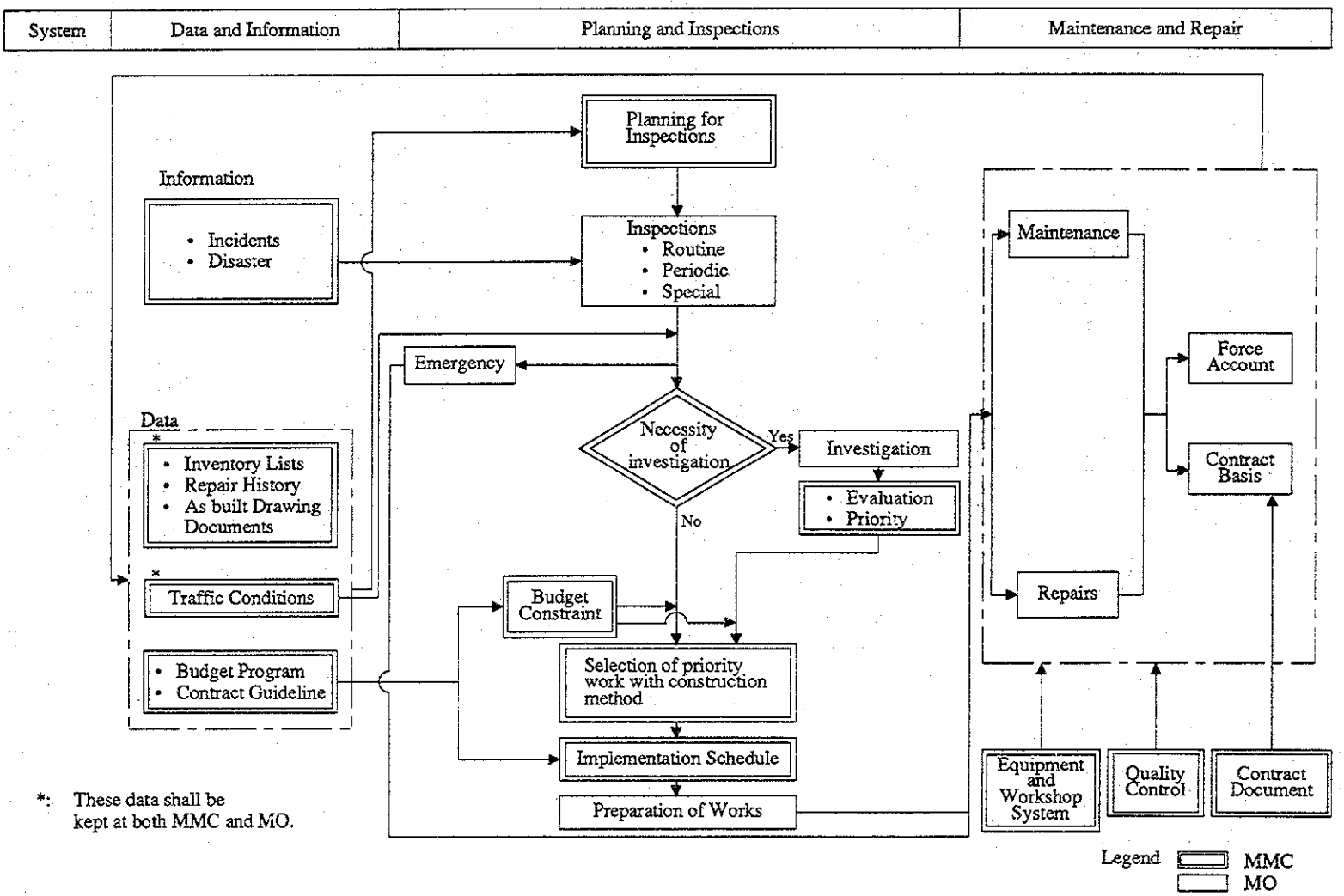


Figure 5.8 Flow Chart of Motorway Maintenance and Operations

2) System to Operate Motorway Maintenance

(1) Maintenance Operating System

Motorway maintenance covers various activities related to inspections, maintenance and repairs, which require quick response and appropriate treatment to keep the motorway always open to traffic.

KGM should be responsible for the activities of motorway maintenance by force account or on contract basis, depending on the nature of the work.

The following matters shall be materialized to implement the above for the objective of motorway maintenance and operations:

- Communications (instruction, response, duty, decision and coordination) system among headquarters, regional division office, main maintenance center and maintenance office
- Extent of activity and responsibility of each office

Maintenance on a contract basis should be gradually increased to cope with an increase of maintenance work volume and due to budget constraint for KGM personnel and to promote technical advances of contractors or concession companies.

(2) Equipment and Workshops

The number and types of maintenance equipment required at each main maintenance center and maintenance office are closely related to maintaining intended service levels for the motorway section, weather conditions, types of major road structures and traffic volume. A consideration whether the work will be done by force account or on a contract basis is also necessary for such determination.

(3) Data Base and Management System

A data base and management system is indispensable for the motorway maintenance. One of the most important activities is to collect reliable data, in particular, to collect and keep as-built drawings and documents including design reports and documents, construction records and historical records. These records must include inspector's observation of an extraordinary incident, the work carried out, and the interference to traffic, particularly in relation to

vehicular accident and the causes for them to occur. This function is to determine any previous incident that may relate to the present condition. Various inventories for road structures and facilities shall be developed to maintain the motorway properly.

3) Planning to Operate Motorway Maintenance

Motorway maintenance consists of many types of works for which the scope and scale are profound and vague. Therefore, it is important to prepare a detailed work plan for each category of work in advance so that the implementation of the similar works will be carried out effectively. Since inspections, maintenance and repairs are performed on the motorway open to public traffic, it is necessary that the coordination should be effectively done between the MO and MMC, among the engineers and chief in the MO, and the manager and head in the MMC. It is also necessary that a notice should be forwarded to the traffic police office in advance and that public announcement activities are made to motorway users.

5.8 Operation System during Unusual Conditions

Incidents to disrupt the smooth flow of traffic on the motorway can be distinguished into "man-made accidents" (traffic accidents, vehicle breakdowns, fallen objects, spilled loads, fire, road maintenance activities) and "natural accidents" (unusual weather such as heavy snow, fog, strong wind, heavy rain and earthquakes).

These accidents pose threats to the safety of road users and are potential causes of traffic accidents. Appropriate and prompt measures for handling such accidents are therefore important in order to avoid loss of life and property damage.

The initial disaster countermeasure is to prevent as far as possible the occurrence of traffic accident, or slope slips, for example in the case of concentrated rainfall. Next, if disaster has occurred, measures are to be taken to prevent the spread of damages and prevention of secondary incidents. This can be achieved by activating the communication system and passing the information quickly to the traffic control room and users, assessing the nature and seriousness of the incident and deciding the appropriate countermeasure to take.

In principle, disaster prevention systems define three levels of warning as 'Alert', 'Warning' and, 'Emergency' in accordance with the seriousness of the disasters.

The entire resource of the organization is mobilized to cope with the disaster. A disaster prevention task force will be positioned in the main maintenance center and

maintenance office. The principal tasks in the main maintenance center are collection and dissemination of information, and planning and execution of the measures to deal with traffic control and maintenance work to recover from disaster will be done by the maintenance office.

5.9 Traffic Safety Plan

The traffic safety plan mainly covers two basic functions of accident prevention and minimization of damages to road users and property. The three principal factors affecting the occurrence of traffic accidents are;

a. Traffic and road conditions
b. Drivers
c. Vehicles

Countermeasures considered for traffic accidents must take into account both prevention and minimization of injuries to road users. Accident analysis is not necessarily directly related to these two facets, but should be closely related to proposals for future traffic safety plans and measures.

As first step for traffic safety measures for the motorway in Turkey, safety measures based on driver's viewpoint such as psychological and physiological factors is recommended. Accordingly, the recommended traffic safety measures are as follows:

a. Improvement plans for safe road environment
b. Public dissemination of information on traffic safety and safe driving procedures
c. Establishment of an accident analysis and reporting system

6. Short Term Implementation Program

The Short Term Implementation Program for 1,500 km motorway length will establish the requirements for implementing a complete motorway maintenance, operations and traffic management system for the motorway segments, already open or soon to be opened, in KGM's 1st, 2nd, 4th, 5th and 17th Regional Division.

6.1 Planning and Engineering

6.1.1 Traffic Management and Operations

1) System Configuration

The traffic management and operations system for the motorway has four major functions, namely information collection, information processing and decision making, information dissemination, and execution and enforcement of the decisions.

The structure of the system configuration is shown in Figure 6.1.

2) Traffic Control Room and Traffic Operation Room

The traffic control room is located at the main maintenance center and is the core of the traffic management and operations system. It accommodates a computer system and associated equipment as well as staff to operate the system and to plan for countermeasures to be taken when incidents occur. The computer system is operated by the judgment of staff.

The traffic operations room is located in each maintenance office. Its purpose is to gather and distribute data from/to roadside equipment and to monitor information so as to promptly respond to incidents. Another important function of the traffic operations room is to back up the functions of the traffic control room (to some extent) in the case of communications interruption between the traffic operation room and the traffic control room.

3) Connection of Roadside Equipment

Figure 6.2 illustrates the location of the roadside equipment and how this equipment is connected and operated.

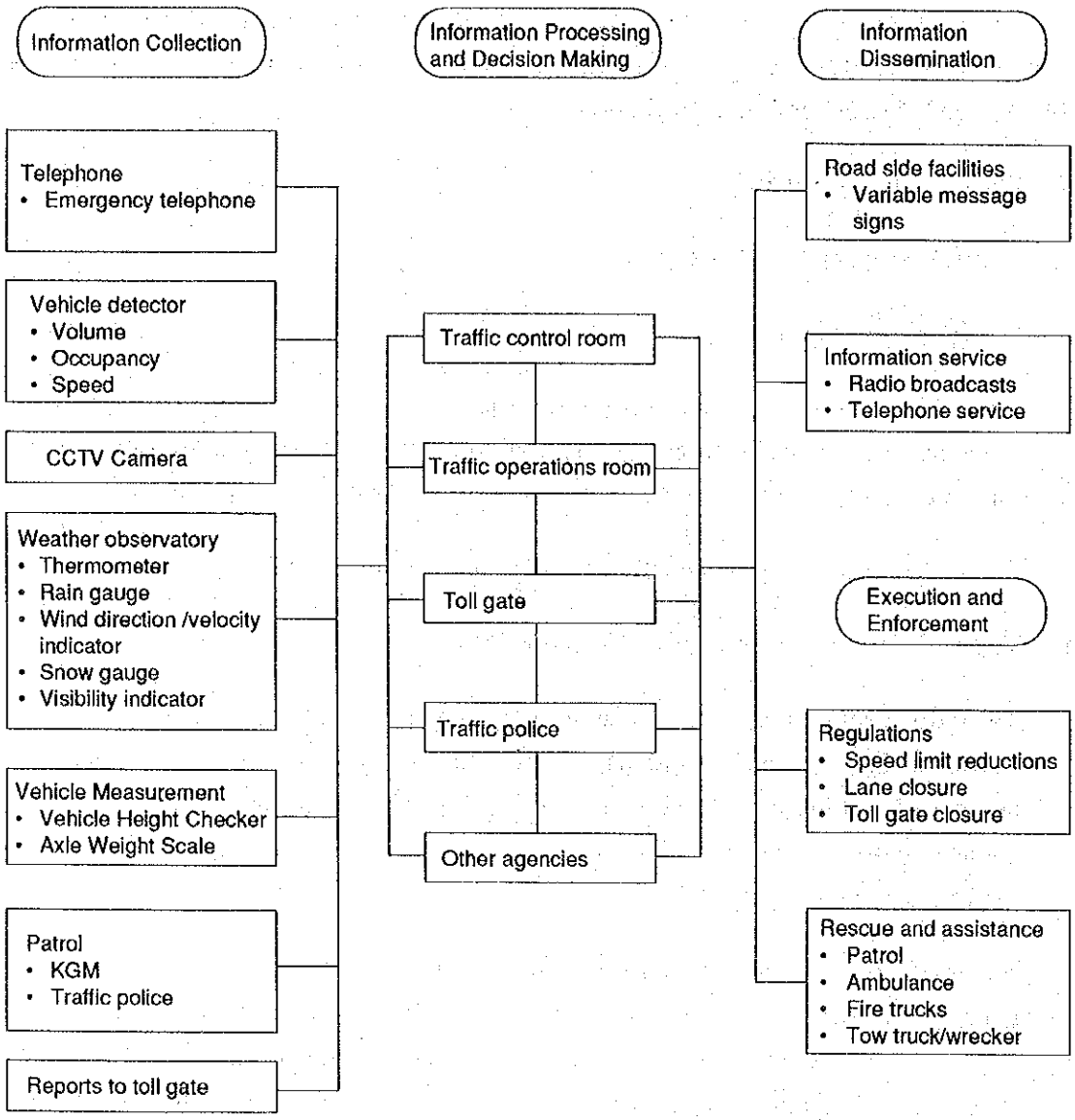


Figure 6.1 Traffic Management and Operations System Structure

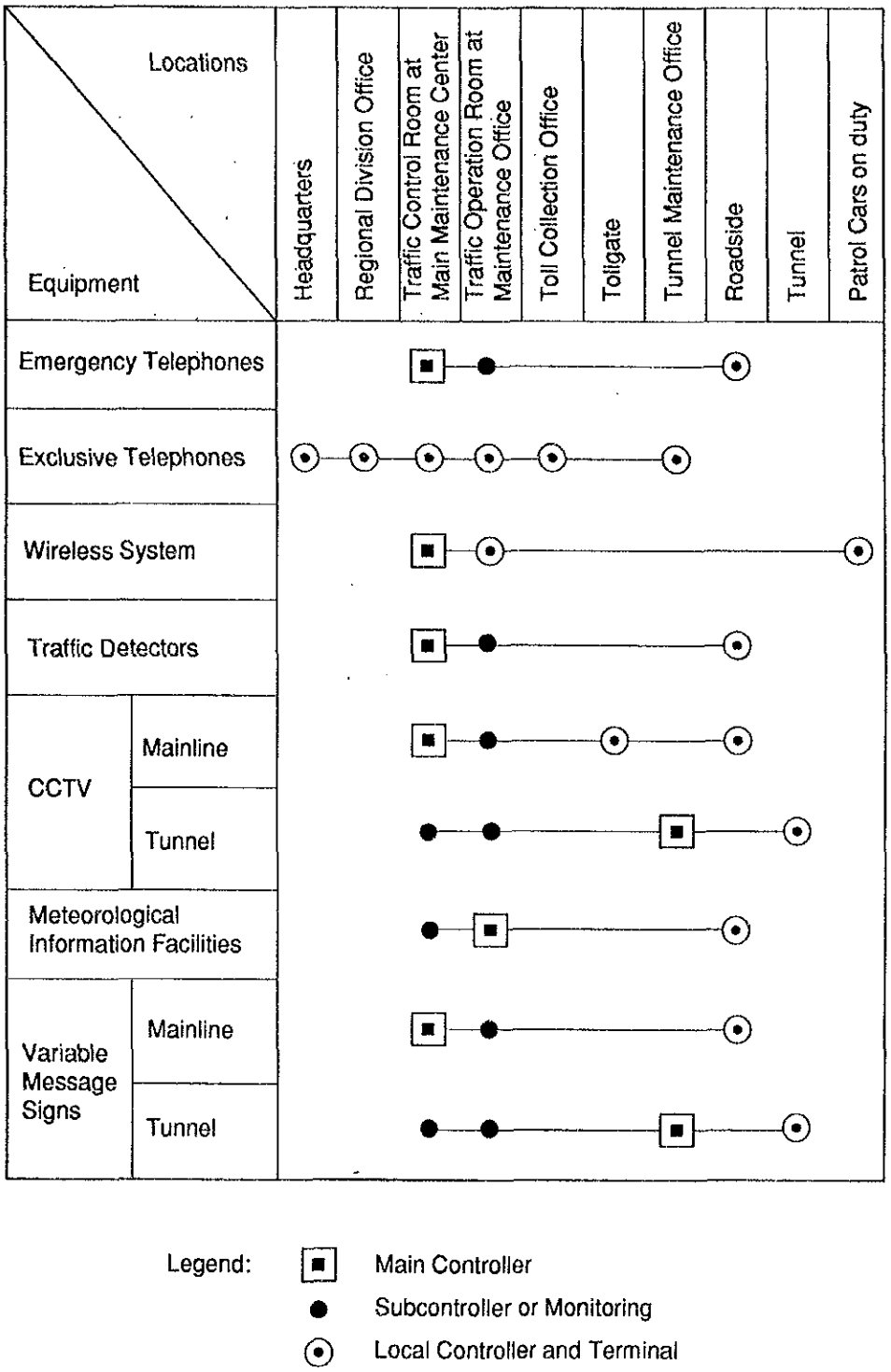


Figure 6.2 Connection of Roadside Equipment

4) Installation Standards

As mentioned above, a traffic management and operations system consists of various facilities and equipment on the roadside and at various locations within the motorway management organization as well as a communication network.

These facilities and equipment are installed differently in different segments of the motorway to reflect the appropriately designated traffic management and operation service level. Table 6.1 shows the general guidelines for installation standards for various facilities and equipment on the motorway, according to service level.

5) Proposed Traffic Management and Operations System

Based on the installation standards of the traffic management and operation system, the traffic management and operations system installation plans on the 1,500 km motorway networks are proposed. Figure 6.3 shows the facilities installation plan on EDIRNE-ISTANBUL motorway (proposed other section plans are shown in the main report). All of the proposed roadside equipment are shown schematically in the figures at their appropriate locations.

6) Preliminary Engineering Design

(1) Emergency Telephone

(a) Function and System Configuration

Emergency telephone system consists of roadside telephones along the motorway, emergency telephone central controller, and emergency telephone receiving desk in the traffic control rooms.

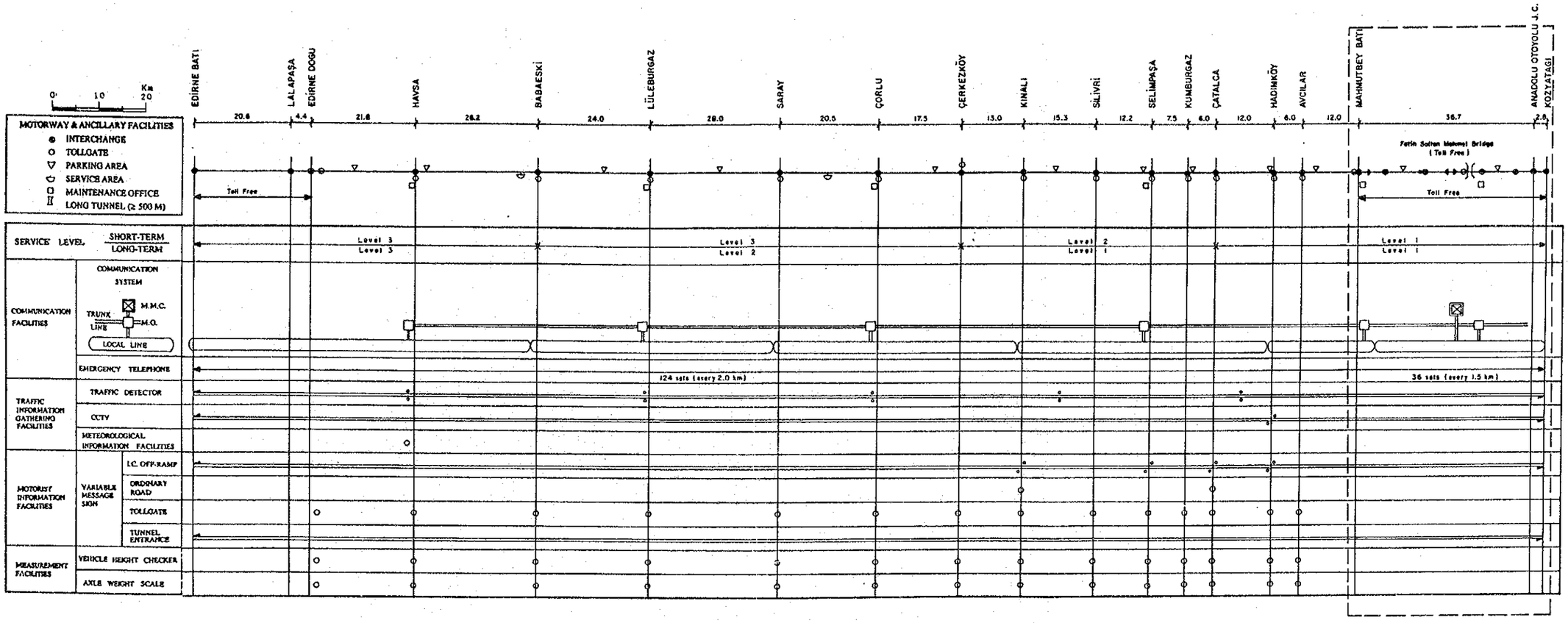
Monitoring equipment is provided to the maintenance office to monitor the call from the telephone within its jurisdiction and to receive a call when it is not attended to by the operator in the traffic control center due to multiple calls or malfunction of the equipment at the traffic control center.

(b) Installation Standards

Emergency telephones are installed at intervals of 2.0 km on both sides of the road (1.5 km in metropolitan area) depending on the existing system.

Table 6.1 Installation Standards

Facilities/Equipment			Service Level		
			Level 1	Level 2	Level 3
Communication Facilities	Emergency Telephones		• 2.0 km intervals on both sides (1.5 km in metropolitan area). • 200 m interval in tunnel (≥1,000 m), or vicinity of the exits (<1,000 m).		
	Exclusive Telephone & Wireless System		• Exclusive telecommunication circuit between Main Maintenance Center, Maintenance Office and Toll Collections Office. • Wireless communication system between Main Maintenance Center, Maintenance Office and patrol cars.		
Measurement Facilities	Vehicle Height Checkers		• In front of each tollgate entrance.		
	Axle Weight Scales		• In front of each tollgate entrance.		
Traffic Information Gathering Facilities	Traffic Detectors		• On both sides of motorway at points of frequent traffic congestion, large variations in traffic volumes and at locations necessary for the collection of traffic volume statistical data for traffic control. • Particularly, they should be installed at intervals of 1.0 km on the 1st peripheral road of Istanbul to detect the extent of traffic congestion.	• Points of large variations in traffic volumes and at locations necessary for the collection of traffic volume statistical data.	• Representative locations of the jurisdiction of maintenance offices with traffic operation rooms for collection of traffic volume statistical data.
	CCTV		• At toll barriers and junctions, locations with merging/diverging of traffic flows and in sections having traffic congestion and high traffic accidents. • Locations of severe weather conditions.	• Representative locations for traffic flow observation having high traffic accidents and severe weather conditions.	-
	Meteorological Information Facilities		• Representative locations with severe weather conditions.		
Motorist Information Facilities	Variable Message Signs	I.C. Off-ramp	• Prior to major I.C. off-ramps		-
		Ordinary Road	• Prior to intersections on principal trunk roads connecting to the motorway.		-
		Tollgate	• At each entrance booth at the tollgates.		
		Tunnel Entrance	• Prior to each long tunnel (≥500 m) entrance.		
	Radio Broadcasts		• To all areas from broadcasting stations with information for respective areas.		



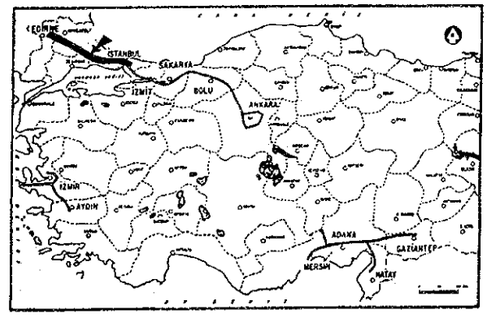


Figure 6.3 Proposed Traffic Management & Operation Facilities Installation Plan on EDIRNE-ISTANBUL Motorway

(2) Vehicle Detectors

(a) Function and System Configuration

Vehicle detectors are used to automatically detect up-to-date traffic information such as volume, occupancy and speed on the motorway. Detector data is transmitted to the traffic control room, and are then processed collectively in such a manner that traffic management officials can continuously monitor the traffic situation and react promptly when administering the necessary first aid countermeasures.

The vehicle detector system consists of vehicle detectors installed along the motorway, detecor data processors at the traffic operation room and a central computer system at the traffic control room.

There are two types of vehicle detectors in wide use, those being loop and sonic detectors. The loop detector is recommended for use on the motorway because the motorway is wide with three or more lanes in each direction. The type of loop detector recommended is the single loop type.

(b) Installation Standards

Vehicle detectors are mainly installed in all through lanes at representative locations between interchanges to determine traffic volumes and speed. For this purpose, loops are installed about 500 meters upstream of an off-ramp taper. For other purposes such as congestion detection on the first peripheral road in Istanbul, detectors should be placed at intervals of approximately one (1) kilometer in the congestion prone area.

(3) Meteorological Information Facilities

Weather observatory system consists of an air temperature thermometer, a road surface thermometer, a rain gauge, an anemometer, a visibility meter and a snow gauge all located at the outdoor observation station, with a weather observation panel including a dot recorder at the traffic operation room.

(4) Closed Circuit Television System (CCTV System)

(a) Function and System Configuration

The CCTV system consists of a camera and camera controller at the site, a slave remote control unit at the traffic operations room, and a master remote control unit, operator console and monitor TVs at the traffic control room. The video signal taken by the camera is transmitted to the traffic operations room and the traffic control room over the fiber optic cable.

(b) Installation Standards

CCTV cameras are installed at the following strategic locations:

- Sections or locations where recurrent congestion is frequent or expected such as interchanges in large cities.
- In tunnels.
- Sections or locations where incidents or accidents are expected to occur due to heavy weaving traffic, poor geometric design, frequent adverse weather conditions, etc.
- Other places like toll gates where monitoring of the motorway is required.

(5) Variable Message Signs (VMS)

(a) Function and System Configuration

Variable message signs (VMS) are visual communication facilities which are installed at strategic points on the motorway to give the drivers important information such as congestion, accidents, road conditions and detour recommendations. The information (message) displayed at the terminal is determined automatically by computer or by manual operator.

Variable message sign system consists of the variable message signboard and controller installed on the motorway or access road, slave remote controller located at the traffic operation room or tunnel maintenance office, and a master remote controller and operator console located at the traffic control room.

The widely used signboard is categorized into two types; the scroll type and the matrix type. The matrix type of sign can be divided into two types such as the Lamp (Light Bulb) Matrix and the LED (Light Emitting Diode) Matrix.

The LED matrix type is recommended for variable message sign placed before interchange off-ramps, intersections on principal trunk roads connecting to the motorway and at the entrance of long tunnels. The matrix type was selected because of the possibility of requiring many different message and need to provide good legibility.

(b) Installation Standards

Variable message signs are typically installed at the following locations:

- before interchange off-ramp (200 ~ 300 M)
- before intersection on principal trunk road connecting to the motorway (100 ~ 200 M)
- at entrance booth at tollgate
- before entrance for a long tunnel (150 ~ 200 M)

The message to be displayed consists of a combination of words and phrases describing the location, cause, and the result of the traffic incident, in addition to the instructions to the drivers. The messages will be displayed in the Turkish language. And the priority message should be established according to the ranking.

(6) Radio Broadcasting

As the radio broadcasting system for traffic information makes use of the existing commercial and public broadcasting system, only a microphone and a transmitter to broadcasting stations are necessary and are provided in the traffic control room.

(7) Transmission System

(a) Function and System Configuration

The basic function of transmission system is to transfer information from one location to another. A transmission system consists of a three tier hierarchy including a trunk line transmission system, a local line transmission system and

an access line transmission system. Figure 6.4 shows the three tier hierarchy of transmission system.

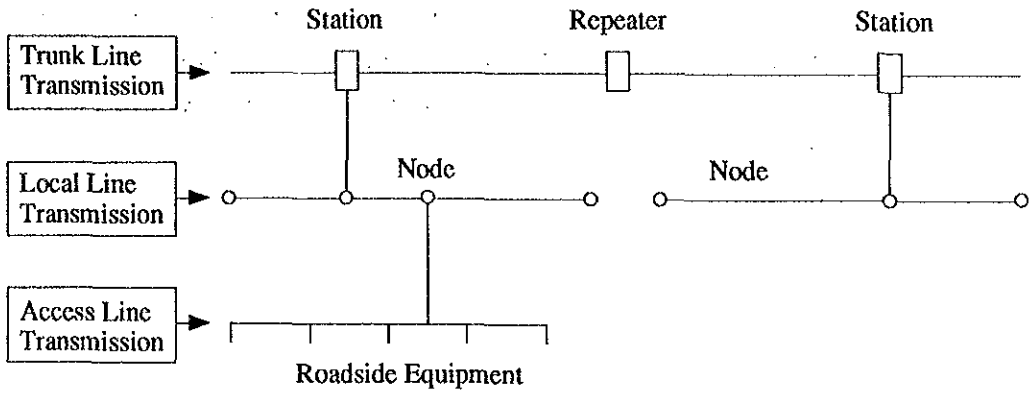


Figure 6.4 Three Tier Hierarchy of Transmission System

(b) Installation Standards

(i) Trunk Line Transmission System

The trunk line transmission system technologies according to digital method is recommended. Two alternatives for trunk line transmission system are compared to select the most suitable system such as metallic cable system and fiber optic cable system. The fiber optic system has many advantages over a metallic cable system such as better transmission quality, capacity, and longer transmission distance without a repeater.

Therefore a fiber optic transmission system is recommended for the motorway in those areas where CCTV will be installed. The remaining segments of motorway can be served with metallic cable until CCTV is installed.

(ii) Local Line Transmission System

Depending on the coverage length (about 50 km) of a local line transmission system, a metallic cable system is recommended for the motorway.

(iii) Access Line Transmission System

Because of short transmission distance, a metallic cable system is recommended for the motorway.

(8) Wireless System

The system consists of the radio control equipment installed in the traffic control room and the maintenance offices, base station equipment including an antenna at the base station, and mobile units installed in patrol cars.

(9) Exclusive Telephone System

The exclusive telephone system consists of digital exchanges of various capacities placed at headquarters, division offices, main maintenance centers, maintenance offices and toll collection offices, and telephone sets, etc.

(10) Central Computer System

(a) Function

There are six fundamental functions located at the central computer facility including information collection, terminal equipment control, the man-machine interface, countermeasures formation, reporting recording, systems operations monitoring and data communication.

(b) Hardware Configuration

The computer system consists of a central processing unit (CPU), peripherals such as a magnetic disk, magnetic tape unit, printer and CRT display, a graphic display panel, a control desk and interface units for connection to a central controller for variable message signs and detector data processors.

Figure 6.5 depicts the hardware configuration of the traffic control room and traffic operation room respectively.

(c) Software Configuration

The software is defined as the internal programs or routines prepared to simplify programming and computer operations. These internal programs fall into several categories, the total of which facilitates the efficient use of the computer. These programs are the operating system, utility programs and application programs. The last two are controlled by the operating system.

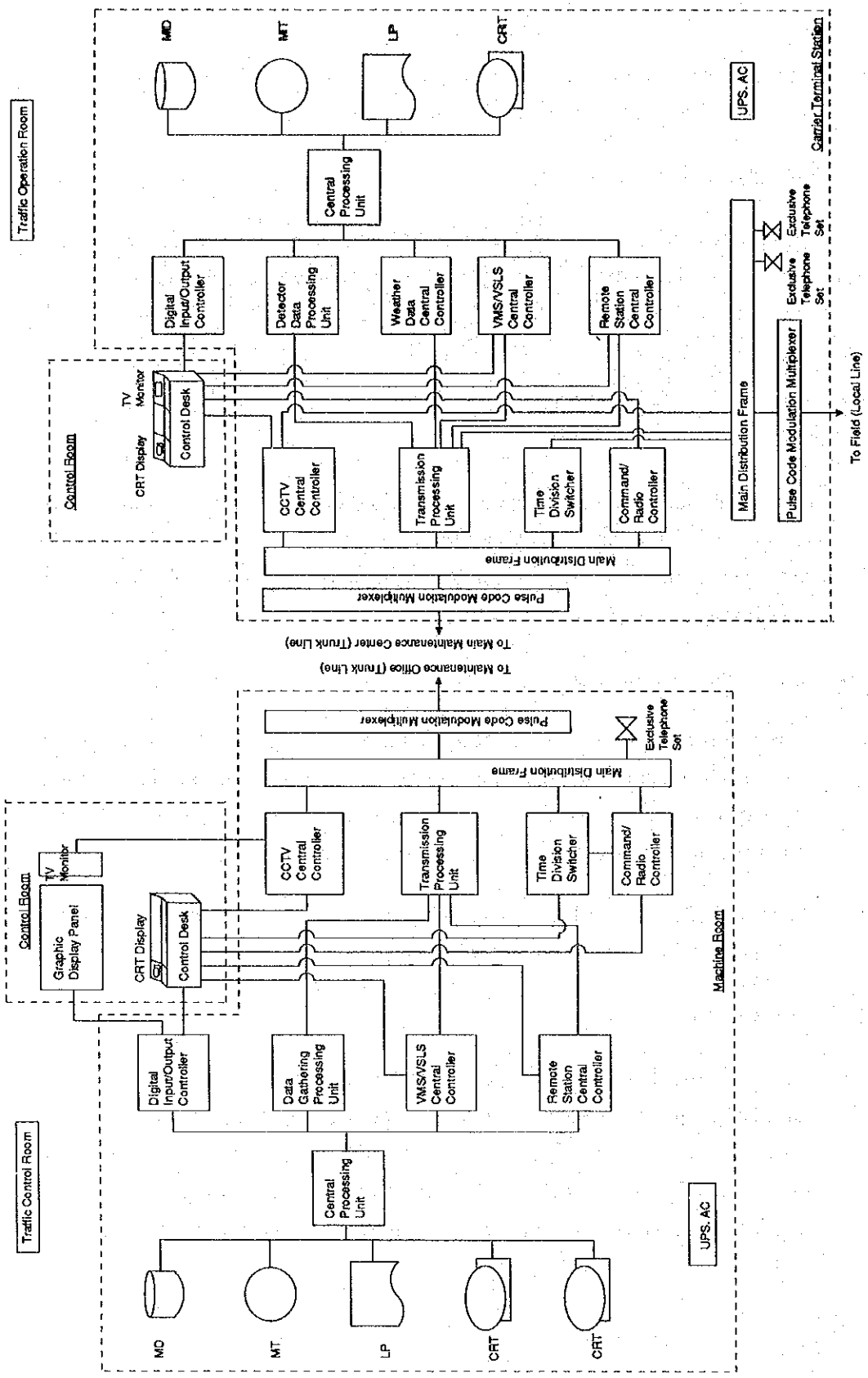


Figure 6.5 Hardware Configuration of Traffic Control Room and Traffic Operation Room

(11) Uninterruptible Power Supply

Uninterruptible power supply system consists of a generator, a constant voltage and constant frequency power supply, a changeover switch, batteries and rectifier.

(12) Measurement Facilities

The installation of measurement facilities is intended to preserve the motorway structure and prevent danger to traffic by intensifying control of oversize vehicles which are ever-increasing in size and weight.

The measurement facilities are a vehicle height checker and an axle weight scale. Vehicle height checkers are installed to enforce vehicle height regulations for all vehicles in entrance ramps prior to the tollgates and axle weight scales are installed at each entrance to the tollgates to check for violations of the maximum allowable axle weight of vehicles.

(13) Data Processing System Related to the Magnetic Card Toll Collection System

The data processing system related to the magnetic card toll collection system will be responsible for handling a significant amount of data including many different types of items. The system consists of data transmission, data storage, data protection and data processing.

6.1.2 Motorway Maintenance and Operations

1) Planning of Motorway Maintenance

Motorway maintenance and operations programs shall be made for annual, monthly and weekly basis, considering priority for the work, available resources, past work records, road inventories, road structure inventories, traffic volumes, meteorological data, etc.

2) Implementation of Motorway Maintenance

Motorway maintenance shall be conducted, in careful consideration of traffic regulations, traffic safety and circumstances along the motorway, since the motorway is open to public traffic and underground public utilities occupy a part of the motorway.

The following tasks are considered for the implementation of motorway maintenance.

- Coordination with police office
- Safety during maintenance and repairs
- Public announcement
- Coordination with offices in charge of underground utilities
- Meeting with and instruction to road maintenance units

3) Traffic Control Measures and Impact During Motorway Maintenance

(1) Traffic Control Measures

The date, time-frame, construction methods and proposed traffic control measures shall be analyzed for the motorway maintenance activities based on traffic volumes, numbers of traffic lanes and detours.

(2) Environmental Impacts

Smooth construction activities will be considered in an effort to minimize noise and vibrations during the maintenance and repairs.

4) Tasks of Motorway Maintenance

(1) Inspections

Roadway inspections are one of the most important activities which are necessary for KGM to recognize the conditions of the motorway section as well as its traffic conditions.

There are three (3) types of inspections as follows:

Routine Inspection

Routine inspections cover inspections of damages and unusual conditions on the motorway.

It also covers the traffic conditions to the road structures that are tied to traffic safety and smooth flow.

This inspection is normally done visually from a moving patrol car, is augmented occasionally by observations on foot and normally utilizes two or more trained inspectors. One is engineer and the other is non-engineer.

Periodic Inspection

Periodic inspection is the detailed inspection of road structures and facilities such as asphalt pavement, drainage, bridges and slopes, and is normally done on foot. Periodic inspections are conducted by specially trained inspectors team, made up of both engineers and non-engineers.

Special Inspection

Special inspection is a supplementary inspection conducted in addition to the routine and periodic inspections described above, as required due to possible damage due to storms, heavy rain or other unusual conditions.

(2) Maintenance and Repairs

(a) Road Cleaning

Road cleaning involves removing dirt and trash from the road and adjacent facilities to eliminate traffic obstructions.

(b) Vegetation Control

Vegetation control consists of planting new growth, maintaining established vegetation, and removing hazardous vegetation so that grass, plants and trees may well be maintained so that a pleasing ambiance can be provided for drivers.

(c) Snow and Ice Control

The purpose of snow and ice control is to maintain safe and stable traffic flow during the winter.

Inspection

Snow and ice inspections by maintenance patrol cars should be conducted when snowfall and icing are predicted from the weather forecast.

Snow and ice control operations

Snow & ice control work varies depending on weather, road and traffic conditions. The administrative structure shall reflect conditions to conduct effective snow & ice control. Snow & ice control shall be divided into three (3) stages: warning, dispatch for operations, and emergency.

The warning stage of snow & ice control is set when snowfall or motorway icing is anticipated by weather forecast. While monitoring road surface conditions, necessary personnel shall be called to prepare for dispatch.

The dispatch stage of snow & ice control occurs when snowfall or motorway icing is forecasted or has occurred.

The emergency stage of snow and ice control occurs when traffic congestion due to heavy snowfall lasts many hours despite snow removal efforts.

(d) Repairs of Traffic Safety and Management Facilities

Traffic safety and management facilities are directly related to traffic safety and management. The following are the facilities to be maintained and repaired:

- Guardrail & guard pipe
- Anti-dazzle plate
- Traffic sings
- Roadway lighting
- Traffic markings
- Delineator
- Kilometer post

(e) Maintenance and Repairs of Pavement

Asphalt concrete pavement has been adopted for all sections of the motorway except the tollgates position in Turkey. There are two (2) types of asphalt pavement maintenance, those being identified by routine inspection and periodic inspection (or investigation).

Minor repairs of pavement identified by routine inspection consist of pothole repair, crack sealing and patching of small damaged area and adjustments of roadway surface differences.

Repairs of pavement by overlay or replacement are required as identified by periodic inspection or investigation due to cracking and rutting caused by heavy traffic and asphalt deterioration. An evaluation method shall be established to determine the thickness and scheduling of overlay or replacement required, based on measurement and analysis of the existing pavement roughness, cracking ratio, skid resistance and depth of rutting.

(f) Maintenance and Repairs of Bridge

Minor repairs to bridges include curb, railings and necessary repainting.

Repair of superstructures and substructures is needed due to the damage caused by heavy traffic, accidents, weathering, scoring, etc.

Replacement and strengthening of bridge slabs, expansion joints and bearings based on the identification and evaluation of causes and defects are also required due to the damage caused by heavy traffic, accidents, weathering, etc.

(g) Repairs of Tunnels

Repairs of lining, portal, interior wall and ceiling slab, leakage prevention and ventilation are required to restore the condition of tunnels from damages caused by earth pressure, water penetration, heavy traffic, accidents, etc.

(h) Repairs of Other Structures

Repair of drainaged structures and other facilities is needed to protect the road structures.

The repairs and restoration of slope failures in cut and fill sections are accomplished by employing slope protection methods such as retaining walls, concrete cribs, mortor spraying, anchorages, vegetation, etc.

(i) Disaster Prevention & Restoration of Damages Caused by Unforeseen Natural Disasters

Slope failures, and pavement and structure damages are often caused by heavy rainfall or earthquakes. Slope failures are normally related to heavy rainfall or inadequate drainage of the surface and seepage water. The work includes both preventive and restoration works.

5) Vehicles and Equipment

Maintenance and repairs will require vehicles and equipment listed in Table 6.2.

Considering weather conditions of snowfall and temperatures, the required number of vehicles and equipment is estimated for the force account works of the motorway maintenance and operations including the traffic management and operations (refer to Table 6.3).

Table 6.2 Major Vehicles & Equipment Required for Maintenance & Repairs

Motorway Maintenance	Major vehicles and equipment required
1. Inspections	• Sedan car
2. Road cleaning	• Road cleaner • Sprinkler truck • Unimog truck • Truck • Traffic sign truck
3. Traffic safety facilities	• Road lift vehicles • Truck • Portable welding machine
4. Vegetation control	• Pick up • Truck
5. Snow and ice control	• Truck with snow plow • Unimog with attachment • Chemical sprayer • Loader • Sprinkler truck
6. Asphalt	• Dump Truck • Asphalt plant • As cutting machine • Roller • Generator • Compressor • Grader • Unimog truck
7. Bridge	• Welding machine • Compressor • Truck • Maintenance gantry
8. Tunnel	• Compressor • Road lift vehicle • Welding machine
9. Restoration for traffic accident	• Towtruck • Traffic sign truck

Table 6.3 Required Vehicles and Equipment for the Motorway of 1,500 km

Vehicles and Equipment	Number Required (Unit)*					
	Regional Division					Total
	1	2	4	5	17	
Total	166	137	214	291	265	1,074

* Attachment and minor equipment are not included.

6.2 Organization

1) Organization Setup

The existing organization of the KGM Headquarters will be improved based on the recommendation discussed in Section 5.3, for the OMM system of 1,500 km motorway. The following new divisions are recommended to be created in the headquarters organization;

- Division of Motorway Maintenance, Traffic Management and Control; and
- Division of Toll Management and Motorway Revenues.

The recommendation also includes the improvement of the regional division offices for the motorway OMM system of 1,500 km motorway.

A summary of the organization, or three tier organization setup corresponding to the 1,500 km motorway networks is shown in Figure 6.6.

2) Total Personnel Required

Based on the above mentioned organization for the OMM system of 1,500 km motorway, the total personnel required is approximately estimated in Table 6.4.

Table 6.4 Total Personnel Required for OMM System 1,500 km

Motorway Length No. of M.O.	Group	Number of Personnel	
		MMC	MO
1,542.3 km/28	• Traffic Management	129	648
	• Maintenance	371	1,092
	• Toll Collection	0	1,408
	• Administration	145	604
	Total	(645)	(3,752)

6.3 Cost Estimation

1) General

The purpose of the cost estimate herein is to determine the cost of implementing a complete motorway maintenance & operations and traffic management system for the "short term implementation program" for approximately 1,500 km sections of the motorway in the Republic of Turkey.

The cost to develop and operate the system of maintenance & operations and traffic management & operations is comprised of three elements, as follows:

- The installation cost for traffic management and operations, and existing and new equipment cost for maintenance and operations to develop the initial system;

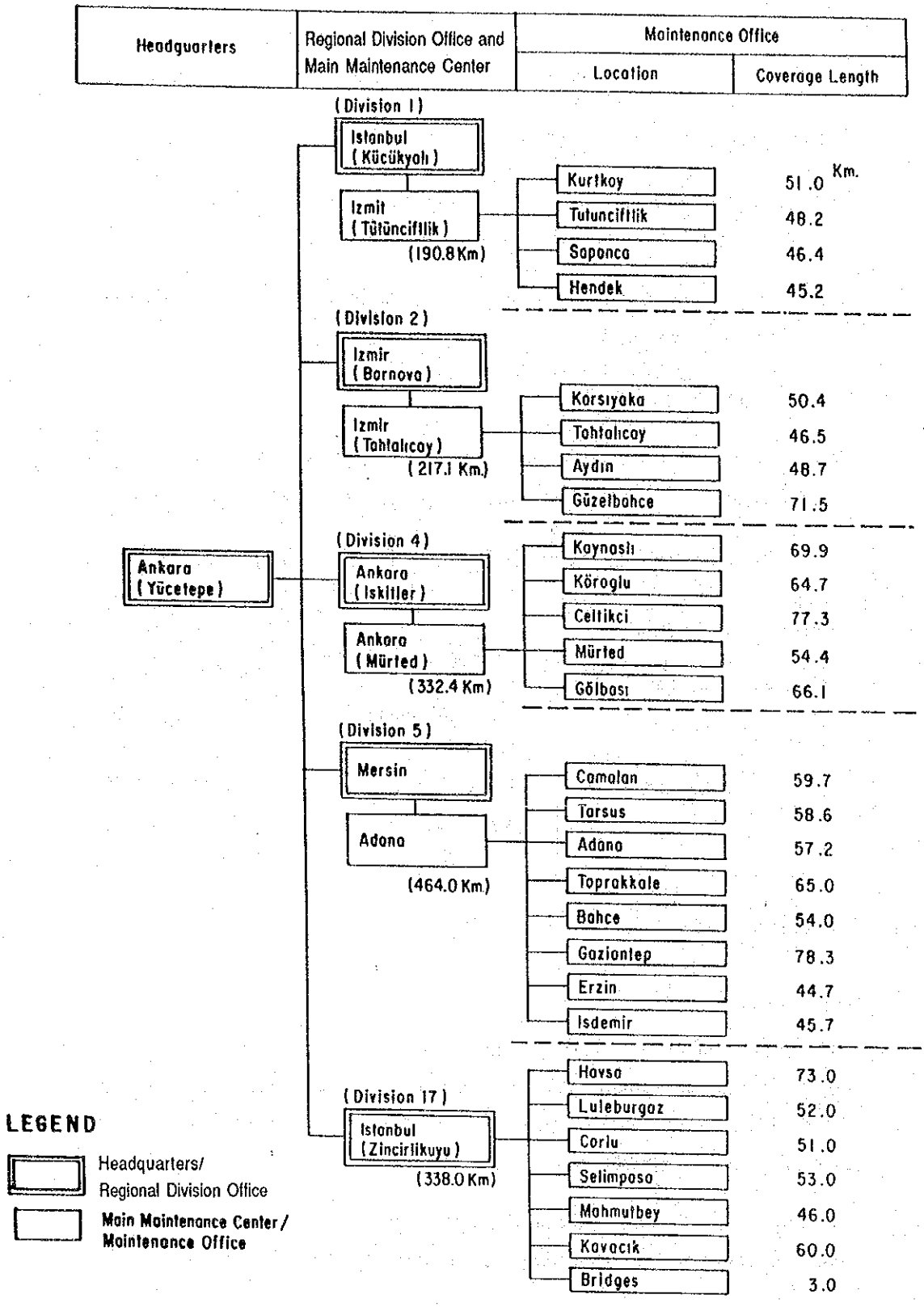


Figure 6.6 Three Tier Organization Setup for Motorway OMM System

- The cost for traffic management and maintenance operations; and
- The cost to operate and maintain the facilities and equipment on an annual basis.

2) Traffic management and operations

(1) Construction Cost

The construction cost including facilities and equipment cost and installation cost is estimated for the recommended system configuration, consisting of the following items:

a) Information gathering system
b) Information processing system
c) Motorist information system
d) Measurement system
e) Communications system

It should be noted that this construction cost does not include costs of office building, air-conditioning system and generator.

The unit costs of the equipment are estimated based on the information from available sources in foreign countries, as this kind of equipment is not available in Turkish market and has to be imported. The imported equipment cost includes the customs and tax.

(2) Operation and Maintenance Cost

The operations and maintenance cost of the system includes the following items:

- Electricity
- Maintenance of the system

3) Motorway Maintenance and Operations

The cost estimates for the motorway maintenance and operations are made up of the following items:

(1) Personnel Cost
(2) Vehicles and Equipment
(3) Fuel and Lubricant Cost
(4) Spare parts and Repair Cost

(5) Pavement Cost
(6) Long Span Bridges
(7) Electricity Cost
(8) Traffic Markings
(9) Water Cost
(10) Salt Cost
(11) Works on Contract Basis
(12) Others

All other motorway maintenance costs for traffic safety facilities, bridges, other structures, architectural facilities, etc. are estimated as 20 % of the costs of items (3) - (11).

4) Summary of Cost Estimation

The summary of cost estimations is shown in Table 6.5, based on the previously discussed items. Reference shall be made to the notes of Table 6.5.

6.4 Evaluation

1) General

The Government of Turkey has a plan to adopt a repayment system to cover all costs involved in motorway construction and operation by toll revenue and to establish a balanced budgetary system for motorway development in Turkey. However, the present financial resources for motorway construction are obtained through KOI mainly from contractors' credit. In the motorway projects, KOI act as agency which handle the investment fund for motorways including payoffs to contractors and management of toll revenues. Ninety (90) percent of toll revenues from motorways is designated to KOI and 10 percent is allocated to KGM for motorway maintenance and operations. However, detailed allocation of expenditures and responsibilities for establishing and operating OMM system on a long term basis seems to have not been clearly defined. Under these circumstances, it would be helpful to visualize here approximate cash flow on the KGM account for establishing and operating the proposed OMM system for a relatively long term. A financial study is conducted to examine the viability regarding establishment and operations of the proposed OMM system based on several assumptions and cases as described below.

Table 6.5 Summary of Cost Estimates

(Unit: 1,000US$)

Items	Regional Division 1		Regional Division 2		Regional Division 4		Regional Division 5		Regional Division 17	
	Installation Cost	Annual Operation Cost	Installation Cost	Annual Operation Cost	Installation Cost	Annual Operation Cost	Installation Cost	Annual Operation Cost	Installation Cost	Annual Operation Cost
1. Traffic Management & Operations	48,516	2,426	49,684	2,484	54,012	2,700	82,121	4,106	73,850	3,692
(1) Information Gathering System and Measurement System	7,797		7,627		7,721		12,739		14,484	
(2) Information Processing System	10,523	2,426	10,523	2,484	12,462	2,700	18,277	4,106	14,400	3,692
(3) Motorist Information System	6,833		6,542		1,745		6,106		9,886	
(4) Communication System	23,363		24,992		32,084		44,999		35,080	
2. Motorway Maintenance & Operations	10,523	23,446	6,850	27,717	13,553	38,692	15,718	57,499	16,434	41,542
(1) Personnel, Oil & Lubricant Cost	-	9,447	-	9,259	-	9,909	-	17,072	-	13,859
(2) Vehicles & Equipment	10,523	-	6,850	-	13,553	-	15,718	-	16,434	-
(3) Parts & Repair	-	737	-	480	-	949	-	1,100	-	1,150
(4) Maintenance & Repair (Force Account)	-	300	-	296	-	753	-	274	-	643
(5) Maintenance & Repair (Contract Basis)										
• Asphalt/Periodic (1st)	(Evy	9 y) 5,293	-		-		-	-	- (Evy	6 y) 8,401
(2nd)	(Evy	13 y) 5,464	- (Evy	13 y) 15,501	(Evy	13 y) 23,747	(Evy	13 y) 34,267	(Evy	13 y) 13,554
• Others		1,665		1,688	-	2,495	-	3,759	-	2,992
(6) Others	-	540	-	493	-	839	-	1,027	-	943
3.** Architectural Facilities	-	-	-	-	-	-	-	-	-	-
Total-A (excluding asphalt/periodic)	59,039	15,115	56,534	12,216	67,565	17,645	97,839	23,338	90,284	23,279
Total-B (only including asphalt/periodic)	-	10,757	-	15,501	-	23,747	-	34,267	-	21,955

Note ** : Architectural facilities cost is not accumulated to the total since the cost was counted for road construction works as the motorway facilities cost, or for BOT.

2) Basic Assumptions

The following assumptions are made for the basic case of this study:

(1) KGM will receive 10 percent of total toll revenue, and use all the facilities for OMM system built or installed under the motorway construction contracts by KOI fund without any extra financial burden to KGM.

(2) KGM will procure and install additional equipment for traffic management and maintenance operations necessary to complete the proposed OMM system on KGM account.

(3) The proposed OMM system will start to be developed in 1993 and completed within 1995. The complete system is assumed to start operations in 1996.

(4) The toll revenue allocation corresponding to the above OMM system is assumed to enter KGM account from the beginning of 1996.

(5) The toll rate is assumed fixed at the present rate converted in US currency for the duration of the project life.

(6) The traffic volume in 2000 and 2010 used for calculation of toll revenue is due to JICA study team's forecast. The revenue values for other years are inter- or extra-polated using the equal ratio compatible to both values.

(7) The project life after the start of operations of OMM system is assumed 15 years from 1996 to 2010 for the calculation of internal rate of returns.

(8) Corresponding to the revenue forecast which is based on the assumption of net growth rate of about 6 % per year in GDP, annual increase of personnel cost for OMM operations is taken into account in the calculation accordingly.

3) Revenue Forecast

The result of toll revenue forecast as mentioned above is shown on Table 6.6.

Table 6.6 Toll Revenue Forecast and Allocation to KGM (unit: US.$1,000)

	2000	2010
Division - 1	208,229	335,803
Division - 2	66,283	178,702
Division - 4	82,634	110,161
Division - 5	225,831	402,139
Division-17	228,945	368,947
Total	811,922	1,395,752
KGM's share		
10 % of total	81,192	139,575
20 % of total	162,384	279,150

4) Cash Flow on KGM Project Account (Base Case)

Cash flow based on the above basic assumptions is shown in Table 6.7. As seen from this cash flow, OMM account of KGM will continue to show red balance for the project period of 15 years and this trend will not improve thereafter, too.

5) Cash Flow on KGM Project Account (Case-2: toll revenue share 20 %)

In order to examine financial status of the OMM project by means of toll revenue share, Case-2 is considered, where 20 % of total toll revenue is allocated to KGM for OMM operation. Other conditions remain unchanged from those given in the basic assumptions. The cash flow calculated is as shown in Tables 6.8. The cash flow shows that the OMM operation is considered manageable if 20 % of the total toll revenue is allocated to KGM. The internal rate of return is calculated at 9.26 %. Generally speaking, the internal rate of return of about 10 % is a moderate value especially when the governmental project is financially evaluated. However, a project with such I.R.R value is judged to require a soft loan with an interest rate lower than 10 %.

In order to further examine the sensitivity of the toll share to the internal rate of return, the relationship between the two variables is calculated and shown on the graph given in Figure 6.7. As seen in the graph, IRR falls negative when the toll share drops to 16 % and IRR approaches 30 % when the share exceeds 30 %.

approaches 30 % when the share exceeds 30 %.

Table 6.7 Cash Flow in Base Case

(Unit : million U.S.$)

	Initial Cost	Annual Cost	Total Cost	Revenue	Net Revenue
1993	18.56		18.56		-18.56
1994	185.63		185.63		-185.63
1995	167.07		167.07		-167.07
1996		101.96	101.96	65.37	-36.32
1997		105.48	105.48	69.01	-36.47
1998		117.72	117.72	72.85	-44.87
1999		113.22	113.22	76.91	-36.31
2000		117.18	117.18	81.19	-35.99
2001		126.50	126.50	85.71	-40.79
2002		125.29	125.29	90.48	-34.81
2003		129.45	129.45	95.52	-33.93
2004		142.07	142.07	100.84	-41.23
2005		230.49	230.49	106.45	-124.04
2006		142.33	142.33	112.38	-29.95
2007		146.77	146.77	118.64	-28.13
2008		151.28	151.28	125.24	-26.04
2009		155.87	155.87	132.22	-23.65
2010		174.24	174.24	139.58	-34.66

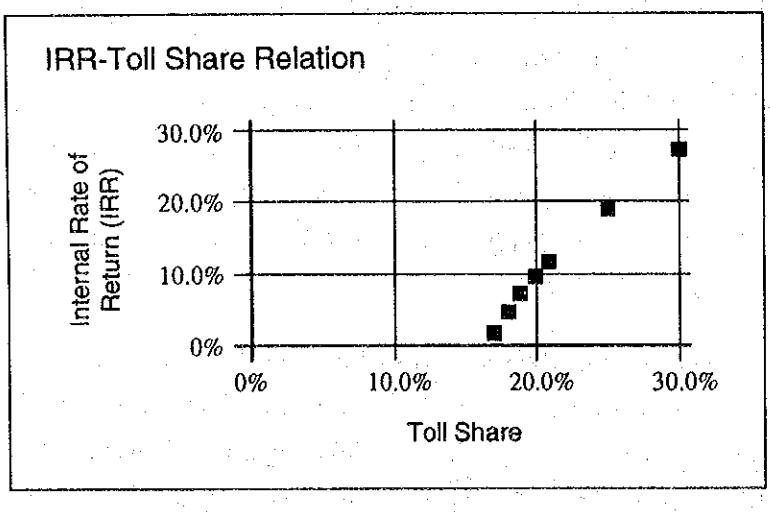


Fig. 6.5.1 IRR-Toll Share Relationship

Table 6.8 Cash Flow in Case-2

(Unit : million U.S.$)

	Initial Cost	Annual Cost	Total Cost	Revenue	Net Revenue
1993	18.56		18.56		-18.56
1994	185.63		185.63		-185.63
1995	167.07		167.07		-167.07
1996		101.96	101.96	130.74	29.05
1997		105.48	105.48	138.02	32.54
1998		117.72	117.72	145.70	27.98
1999		113.22	113.22	153.82	40.60
2000		117.18	117.18	162.38	45.20
2001		126.50	126.50	171.42	44.92
2002		125.29	125.29	180.96	55.67
2003		129.45	129.45	191.04	61.59
2004		142.07	142.07	201.68	59.71
2005		230.49	230.49	212.90	-17.59
2006		142.33	142.33	224.76	82.43
2007		146.77	146.77	237.28	90.51
2008		151.28	151.28	250.48	99.20
2009		155.87	155.87	264.44	108.57
2010		174.24	174.24	279.16	104.92

Internal Rate of Return = 9.26 %

6) Toll Revenue Forecast and Sensitivity to its Error

As logically understood from the discussion in the preceding section, a similar relationship must exist between IRR and the error in toll forecast. To examine this relationship, the toll share to KGM is fixed at 20 % and the error in the toll forecast is measured by the percentage of deviation from the JICA Forecast.

The result of calculation is shown in Figure 6.8. From the graph, it is understood that the actual IRR will be improved to 14 % if the actual toll revenue is found 10 % larger than the forecasted values.

It is also understood from the graph that even if KGM's 20 % share of toll revenue is approved by the authorities, the IRR will be minus if the actual toll revenue is 20 % less than that of the JICA forecast.

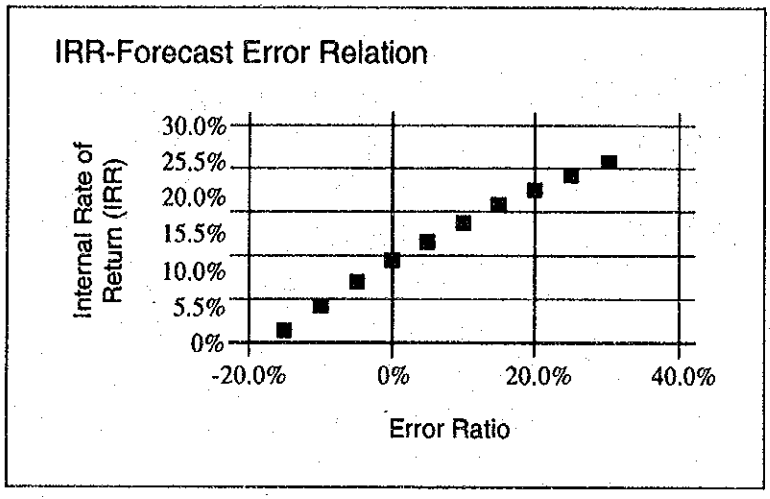


Fig. 6.5.2 IRR-Forecast Error Relationship

7) Cash Flow in Case-3 (Initial investment cost to KOI account)

In the previous Case-2, if the initial investment necessary for completing the OMM system is done on KOI's financial responsibility, KGM's share of the total toll revenue must be reduced considerably. Case-3 is considered as follows:

(1) The initial investment cost to complete the OMM system is to be borne by KOI as an extra construction cost of the motorway.

(2) The 15 % of the total toll revenue is allocated to KGM for the OMM operation. Other conditions remain unchanged from those assumed for the base case.

The cash flow for this case is as shown in Table 6.9. From the result, it seems that this case is sufficiently manageable for KGM's OMM operation. However, if KGM's share of the total toll revenue is reduced to 14.5 % without changing other conditions, the IRR is reduced to 9.43 %. As seen in these two cases, only 0.5 % change in share of the toll revenue resulted in 20 % change in I.R.R value.

It should also be noted herein that the I.R.R. turns into negative when the share ratio is reduced to 14 %.

Table 6.9 Cash Flow in Case-3 : Initial Investment KOI account

(Unit : million U.S.$)

	Initial Cost	Annual Cost	Total Cost	Revenue	Net Revenue
1993					
1994					
1995					
1996		101.69	101.96	98.06	-3.63
1997		105.48	105.48	103.52	-1.96
1998		117.72	117.72	109.28	-8.45
1999		113.22	113.22	115.37	2.15
2000		117.18	117.18	122.87	5.68
2001		126.50	126.50	128.57	2.07
2002		125.29	125.29	135.72	10.43
2003		129.45	129.45	143.28	13.83
2004		142.07	142.07	151.26	9.19
2005		230.49	230.49	159.68	-70.82
2006		142.33	142.33	168.57	26.24
2007		146.77	146.77	177.96	31.19
2008		151.28	151.28	187.86	36.58
2009		155.87	155.87	198.33	42.46
2010		174.24	174.24	209.37	35.13

I.R.R. = 29.44 %

8) Cash Flow on KGM Project Account (Case-5: employee's conversion)

The KGM is a large governmental organization with 33,000 employees. For the OMM operation KGM is required to assign 4,400 personnel to the new job. If KGM succeed in assigning a half the number of these personnel, for example, by conversion of the present employees without any supplement, the KGM's toll share ratio must considerably decreased. In this case, if the initial investment is borne by KGM, the KGM's toll share is reduced to 18 % and the IRR is calculated at 9.45 %. (Please refer to the cash flow for Case-5 in the Main Report.)

9) Review and Conclusion

Through the above analyses of cash flows in several cases, the following should be remarked.

(1) The present financial framework with KGM's toll share of 10 % is considered not adequate for the OMM operation on an internationally acceptable level.

(2) If the Government wish to adopt a financial framework for development and operation of Turkish motorway similar to the present one in the future too, the toll share ratio for OMM operation should be revised as follows:

   i. 20 % in case KGM shall bear the initial investment cost for completing OMM system.

   ii. 15 % in case KOI shall bear the initial investment cost for completing OMM system.

(3) In the above cases, the Government should arrange a soft loan to KGM if KGM experience deficits in their account in initial stages of operation.

(4) It should be understood that the forecast value adopted herein involves considerable errors with a range of 20 % or more. Therefore, it is advisable to periodically review the financial framework among the authorities concerned and adjust it to a suitable one for the actual conditions.

(5) Any large organization tends to grow with ages to an organization comfortable for the people belonging to the organization deviating from the original purpose on its foundation. As the KGM is also a large and old organization, there might be an opinion to point out that the organization must have some potential to absorb some extra duties with existing facilities and human resources. KGM should sincerely examine the present organization and function thereof toward a more efficient organization and try to minimize new employment for OMM operation. At least, KGM should be prepared for such discussion, when the toll share issue is negotiated with other authorities concerned.

(6) How much percent of toll revenue should be allocated to motorway operation and maintenance? As there are differences in statistical definitions among organizations, it is dangerous to simply compare our case with those in other countries. However, the following information is given for a reference. In the case of Japanese motorway system, about 30 % of toll revenue is allocated to the OMM operations. In the case of Indonesian motorway system, the percentage is heard more than that.

7. Recommendation

As described in the preceding chapter, the motorway system in Turkey will be developed to 3,000 km network in the long term plan. Therefore, the OMM system recommended herein is only an initial step for the complete system in the future. In the course of further development, KGM are recommended to continuously study the following subjects and develop the motorway maintenance, operations and traffic management (OMM) system in a good balance with further development of motorway system in Turkey.

(1) A sound development of the motorway system must be backed up by a sound financial system for motorway development and operation system. As recommended at the end of preceding chapter, we hereby recommend the Government of Turkey to review more carefully the present financial framework for the motorway development and operations and reach a more practical and balanced framework coordinating all the authorities concerned.

(2) In the OMM system hereby recommended, maintenance offices under the main maintenance centers have limited authority for any decision requiring judgment. However, we strongly recommend the KGM to try their best to transfer the authorities given now to the main maintenance centers to maintenance offices as promptly and widely as possible through the accumulation of actual operation and systematically programmed training of employees.

(3) In connection with the above subject, we recommend the KGM to further develop the existing employee training facilities for the above purpose. The development will also help smooth conversion of the existing employees into the OMM operations. The Operation Manual submitted herewith as a part of this study will be a good software material for this purpose. We hereby recommend the KGM to improve this material themselves in the course of accumulation of their own experience and innovation of related technology in the world.

(4) Next to the effective utilization of existing personnel, privatization of the system operations should be positively studied by KGM. Toll collection services, the privatization of which is now considered extremely difficult by the KGM, may also be carried out by private companies if a workable inspection system by KGM is properly introduced and a proper insurance or guarantee system is arranged.

(5) Maintenance and management cost for urban motorway sections will gradually increase along with the increase in the traffic volume and aging of road structures.

The KGM are recommended to start a study if the present system not to charge toll from intraurban motorway users should be maintained even when the urban motorway system has been further developed.

(6) Education of motorway users will be more effective than the introduction of any sophisticated equipment for traffic and safety management although it is a time consuming project. Licensing system for drivers should be reviewed in this line and introduction of related curriculum in the compulsory school education should be considered.

(7) In this study, planning for traffic management and operations on the second peripheral road in Istanbul was of a primary focus. However, for relieving the actual traffic congestion, a further intensive study is required to establish an areawide traffic control system which covers all related roads and is capable of collecting and analyzing detail traffic data in a wider area. KGM are recommended to continue this study for better solution.

(8) As to the axle scale problem discussed on the latest technical committee meeting between KGM and JICA, the Study Team's position is now as follows: It is actually impossible to completely shut out any overloaded vehicle from the motorways without causing interruption on motorway entrance and its connecting roads. Therefore, a practical solution would be to provide at least one axle scale on one motorway entrance and timely control overloaded vehicles in order to minimize the intrusion of such vehicles into motorways without causing traffic congestion. The KGM are requested to study rearrangement of the scheme before the actual implementation in accordance with this guideline.