Traffic Data Collection and Use in the Mexican Interurban Road Network

Jorge A. Acha-Daza
Jefe de la Unidad de Análisis
Coordinación de Integración del Transporte, Instituto Mexicano del Transporte
Km 12 Carretera Querétaro - Galindo, Sanfandila, Qro., México 76700
Telephone (52-4) 216-9777 ext. 318
Email: jacha@citlali.imt.mx

&

G. Gustavo Manzo-Garcia
Director de Vialidad y Proyectos
Dirección General de Servicios Técnicos, Secretaría de Comunicaciones y Transportes
Av. Coyoacán 1895, Col. Acacias, México, D. F., México 03240
Email: gmanzo@sct.gob.mx

August 2000

ABSTRACT

This paper describes how in the past, road construction in Mexico was linked more to sociopolitical concerns than to technical or economic studies to justify their construction. Now, new approaches are considered for the planning, construction, maintenance and operation of the roads, taking into account traffic data gathered from technical studies to serve adequately transport demand and trying to achieve the lowest cost and the highest safety levels. After a description of the early efforts in the subject, this paper reviews the work done in the area of traffic data collection and use for the last thirty years at the Mexican Ministry of Transport (Secretaría de Comunicaciones y Transportes, SCT). The article describes the approaches taken in the nineteen fifties and sixties to measure vehicular flow on the roads. It also reviews later implemented approaches that established strategies to know other information such as traffic composition, point speeds and origin and destination of trips. Finally, the paper elaborates on a proposal for the future of traffic data collection in Mexico.

INTRODUCTION

Historically, road construction in Mexico was linked more to social, political and country integration concerns than to transport needs to justify the building of new roads or the upgrade of the existing ones. It was with that approach that in 1842, then president, General Antonio López de Santa Anna, promulgated a decree and its bylaw for road construction, which would mark later road construction policy. This law recognized the need to have an improved communication network to keep the nation together. The decree set the road classification and specifications: the highest specifications were given to the roads that connected the capital of the country, the department capitals and the major

seaports of Veracruz and Acapulco. Slopes not higher than six percent and ten varas (8.35 m; 27 ft, 5 in) basic widths, which could be increased up to twelve to fifteen varas (10.02 to 12.52 m; 32 ft, 10 in to 41 ft, 1 in) at the entrance points of the towns, were set for these roads. Second class roads would connect the department capitals, the major seaports and the neighboring countries. For these roads widths were set from eight to ten varas (6.68 m to 8.35 m; 21 ft, 11 in to 27 ft, 5 in) with slopes not higher than six percent. Third class roads would be used to connect the department capitals and smaller towns. They would have slopes lower than eight percent with six varas (5.01 m; 16 ft, 5 in) of width (*1*). Later construction in the 1920´s, to upgrade roads for motor vehicle use, gave importance to the above specifications along with others regarding degrees of curvature, drainage and road surface. Road upgrades responded again mainly to the need to communicate the capital city of the country.

The current Mexican road network is formed basically by three subsystems: the federal road network comprises 48,103.6 kilometers (29,896.6 miles) of toll-free and toll roads; the state network with 63,405.1 kilometers (39,406.5 miles) and; rural roads and trials with 211,347.8 kilometers (131,353.5 miles) (*2*). The total road network is then 322,856.5 kilometers (200,656.6 miles) of which 95 per cent are two lane roads and the rest are four lanes or more roads. Only 30 per cent of the roads are fifteen years old or newer (*3*). The above road classification considers the origin of the funds for road construction, maintenance and supervision. The importance of road transport is shown by the fact that it moves about 55% of freight and 98% of passengers (*4*). In the federal road network about 178,000 trucks circulate (*4*), carrying 260 billion metric ton-kilometers per year (*5*). In 1998, total vehicular park for Mexico was 13,620,794 vehicles with a motorization rate of 0.14 vehicles per person.

In the federal road network about 49 per cent of kilometers record traffic volumes of less than 3 thousand vehicles per day; 20 per cent between 3 and 5 thousand vehicles; other 20 per cent between 5 an 10 thousand and 11 per cent of more than 10 thousand vehicles per day. In the same way, 8 per cent of the roads operate with a level of service between E and F, 11 per cent with operate with a level of service D and 81 % with a level of service A, B or C.

Recently, a new road classification that considers the importance of the role that roads have in the local, state, regional and national levels and takes into account the current government policy to decentralize road construction, maintenance and operation, has been done. Under this new classification, two types of road infrastructure networks were defined: the basic network and the state network. The basic network consists of the main federal toll-free roads, the toll highways operated by “Caminos y Puentes Federales de Ingreso y Servicios Conexos” (CAPUFE), a public agency, and the concessioned toll roads. The state network consists of the state roads, the federal roads of regional or state importance and the rural roads. The basic national network is presented in Figure 1.

Within the basic road network, ten main highway corridors have been identified. About sixty percent of freight and close to fifty percent of the traffic circulates on these highway corridors. They communicate the major agricultural and production zones, as well as the most important urban and tourist centers of the country. These ten main highway corridors, shown in Figure 2, have a total length of 15,831 kilometers (9,839 miles), which is about 56% of the basic national network.

It can be said that the current Mexican road network fulfills the purpose to communicate most of the towns in the country. In the last decades, the road system has evolved to support the transport system and, it covers, for the current needs, the objective of

Source. Secretaría de Comunicaciones y Transportes. "Modernización del Sistema Carretero Troncal/Modernization of the Main Highway System". México, D. F. October 1999.

Figure 1. National Primary Network

serving as a main instrument for the social, economic and cultural integration of the nation. The problem is now to modernize the existing road network, to keep the good physical road conditions and to offer high levels of safety. The challenge is more difficult due to the fact that the road network is growing with higher traffic volumes and with a vehicular park, in particular that used by freight, heavier and longer and that imposes higher stress to the roads.

To achieve the listed objectives, it is necessary to know the current infrastructure and existing road network conditions. Characteristics such as geometry, state of the

Source. Secretaría de Comunicaciones y Transportes. "Modernización del Sistema Carretero Troncal". México, D. F. October 1999.

Figure 2. Main Highway System

infrastructure, accident factors, service levels, traffic volumes, traffic composition and origin and destination of trips, among others, must be known with better accuracy.

This paper has as main objective to describe the works conducted in the last thirty years by the Mexican Ministry of Transportation (Secretaría de Comunicaciones y Transportes, SCT) to collect traffic data in the Mexican road network. The paper reviews

the different methodologies employed to get the information on traffic volumes and origin and destination of trips.

After a description in this section of the Mexican road network and of the general objective of the paper, the next section describes the early efforts for data collection. The current approach is then presented. Finally, the paper tries to foresee how traffic data collection will be conducted in Mexico.

EARLY STUDIES

The knowledge of the traffic volumes and its composition that uses the road network allows one to find the occupation level and service conditions on which every segment of the network is working; the analysis of its historical evolution serves as a basis to define its tendency of growth and to plan on time the actions to avoid that any of the segments work below the best service level.

The first efforts to collect traffic data in the national road network were conducted in the early nineteen fifties (*6*). Traffic counts were done manually and were aimed to capture information about the vehicular traffic without a defined strategy. Personnel was located at the previously selected sites and they were given a sheet of paper were they wrote the number and classification of the vehicles passing by. The low traffic volumes made that personnel remain resting for long periods. Weather conditions affected the quality of the collected information since personnel had to endure extreme conditions for a long time. This method of collecting information continued until the end of the nineteen fifties.

CURRENT APPROACH

Since 1960, a systematic approach to gather traffic data has been implemented in Mexico. The collected information has been mainly traffic volumes and composition, point speeds, and origin and destination of trips. This information is used for multiple purposes such as: planning and project of new roads, modernization and maintenance of the existing ones, estimation of levels of service, financial studies for toll highways, lighting projects, safety studies, traffic management and auxiliary roads.

Traffic Information

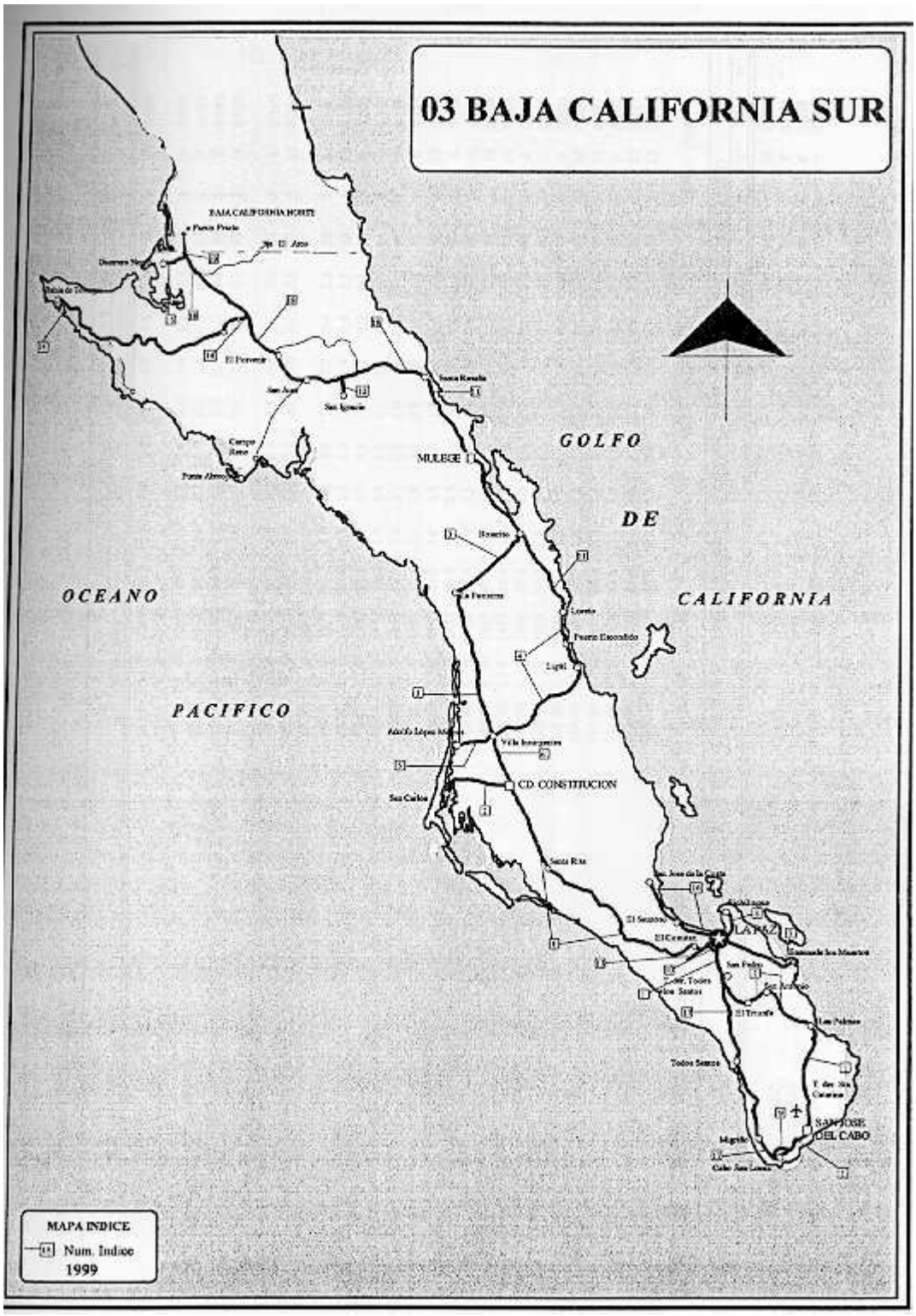
Currently, to know the traffic volumes, composition and seasonal variation on every segment of the road network, the next approach is taken:

There are 150 permanent traffic-counting stations installed at different sites of the road network. The stations are equipped with automatic vehicle counters. They record the hourly volume continuously trying to know the volume fluctuations along the year in the different regions of the country which roads have a similar seasonal variation. The information gathered at the 179 toll plazas installed at the toll bridges and roads is used for the same purpose. The toll plazas provide also detailed information about the vehicular composition.

With the information gathered at the permanent stations, it has been possible to estimate the average annual daily traffic for each segment from approximately 3,000 traffic counts of weekly sample done annually. The location of the sites for the traffic counts was defined from the volume variations along the roadways found from the 24 h traffic counts at the main traffic generating points which include cities, towns, junctions, industrial cities, etc.

Until 1990, every year from 1000 to 1500 manual traffic counts in a three-hour peak were conducted to know the traffic composition for each of the road segments. Currently the counting equipment used for the weekly traffic counts finds the vehicular composition too.

Since 1974, the information collected in the traffic studies for the Mexican road network has been published in the book “Datos Viales” (Traffic Data) edited from 1974 to 1975 for the “Comision de Ingenieria de Transito”(Traffic Engineering Commission) of the “Secretaria de Obras Publicas” (Ministry of Public Works), from 1976 to date for the “Direccion General de Servicios Tecnicos” (Technical Services General Directorate) first within the “Secretaria de Asentamientos Humanos y Obras Publicas” (Ministry of Human Settlements and Public Works) and from 1982 to date within the “Secretaria de Comunicaciones y Transportes” (Ministry of Communications and Transport). For the last editions, the book includes a floppy disk with the traffic data as a spreadsheet. Traffic data is also available ate the Instituto Mexicano del Transporte (IMT) web site (http://www.imt.mx). The information is divided into two parts. The first part presents information on traffic volumes for the paved National Road Network grouped by state. Every state has an index map, as the one presented on Figure 3, that shows the number assigned to each road so it can be found in the information lists. Every list has the name of the closest generating point, distance to the generating point, traffic direction, average annual daily traffic and vehicular composition. The second part of the report shows the traffic counts for the permanent stations located at the toll plazas. It shows the location of the plaza, the traffic volumes for each of the months of the year and its corresponding composition, average annual daily traffic and a histogram that shows the monthly variation.



Source: Secretaría de Comunicaciones y Transportes. "Datos Viales 1999". México, D. F., 1999.

Figure 3. Index Map for Baja California Sur

MOSAICO. Traffic Information System

Recently, the "Unidad de Autopistas de Cuota" (Toll Highways Unit) of the Mexican Ministry of Transportation has created a system that complements the traffic information gathered with the studies of the "Direccion General de Servicios Tecnicos" and the permanent stations. The system has information about traffic volumes and composition, income and accidents recorded on the concessioned toll highways (*7*).

The system was designed and started working in 1994 as a report of the information recorded daily by the toll highway operator. At the beginning, the information was transferred monthly to the central headquarters of the Toll Highway Unit using floppy disks. This process has been gradually changed to an electronic transfer of the information.

Looking for a faster information access, system administrators have developed tools that allow an easier review of the information, both of the concessioned highways as well as those operated by CAPUFE. The information system developed is known as "Modelo de Seguimiento de Aforos e Ingresos de Concesiones" (Model to Follow up Traffic Counts and Income of Concessions, MOSAICO) and, it has the following characteristics:

- It has functions that allow one to know operational data such as lengths, toll plaza locations, segments charged for each toll plaza and road segment sketches for the roads in the system.
- It can show traffic counts and income at different aggregation levels from a single toll plaza to the complete toll system.
- It can show the information by vehicle type or aggregated.
- It can show the information using different units (for traffic counts: vehicles, thousands of vehicles or daily traffic for the selected period; for income:

current pesos, thousands of current pesos, or discounted pesos for a user selected date).

- It can display the information using graphics each time the system is consulted and print hard or electronic copies.
- Up to six different periods (monthly or annually) can be selected to compare traffic counts or income information.
- It can show current rates for all the toll plazas as well as the historical rates using pesos or pesos per kilometer for each type of vehicle.
- It allows one to compare results for traffic counts or income from different toll highways

The MOSAICO system is currently installed and working in the Intranet of the Toll Highway Unit but it is expected to be available to the general public via Internet in the near future.

Origin Destination Studies

Another important information for the planning and maintenance of the road network is the knowledge of the users movement desires as well as the weight of the freight vehicles and the freight they transport. The OD studies done up to date have been focussed on solving two types of problems: first, for the evaluation of specific projects, especially for traffic assignment when a new road is planned, shortcuts, and bypasses or for the upgrade of existing road segments. These studies are conducted according to the specific needs of the project. Second, to gather information about the OD for the trips at the national level since such global information provides data for planning the road transport of the country.

In Mexico, The second class of OD studies began in 1962 on the Mexico-Palmilas segment of the Mexico-Queretaro highway. The information was collected using surveys via roadside interviews to the drivers passing by the study sites during the 24 h sample days. The Information collected included: the location of the site were the information was collected, the traffic count, its daily average and maximum, traffic composition, average number of passengers per car, average weight of freight for trucks, the weight of freight by type of product, traffic direction and the main OD routes (*8*).

Since 1990, the OD studies done by the Mexican Ministry of Transportation – known as Weight and Dimension Studies – have been focused on knowing the characteristics of the freight transport and the equipment used for it. These studies are covered in detail in another presentation at this conference and will no longer be covered here.

The information gathered from the OD studies done in Mexico has been enough to cover the objectives set, but it will be desirable to redefine the location of the sites for the global studies since changes in the developed zones and road infrastructure have occurred since the studies started.

THE FUTURE OF TRAFFIC DATA COLLECTION

In the future, the location of the permanent stations will have to be redefined according to the changes that have occurred in the information in the different periods. Permanent stations have been generally located on the main roads without having made a global or particular analysis about their location. It will be necessary to consider the information needed to evaluate their location. That will be the basis for the elimination, relocation or installation of the permanent stations. It will be necessary to try that the

location of the permanent stations be representative of the traffic annual fluctuations for each geographical zone formed by roads with similar characteristics.

On the other hand, it will be necessary that for the traffic counts, of the weekly samples, a strategy to cover the complete road network with a similar number of traffic counts currently done be developed. This as a part of the need to have accurate and up to date information for the roads close to their capacity.

It is desirable that the OD studies be conducted at different times within a year, since the kind and amount of goods, number passengers and movements desires change seasonally. It will be also desirable to know if the gathered information is enough for the users of this information.

Due to personnel cuts in the areas of the Ministry of Transport in charge of this type of work, private sector participation for traffic data collection and OD studies development is becoming more important. Private companies now do the fieldwork, and the Ministry of Transport role is more on the supervision of the work, looking at it closely to achieve better quality levels.

Acknowledgement. We wish to thank Mr. Roberto Aguerrebere from the Instituto Mexicano del Transporte and Mr. Oscar de Buen from the Unidad de Autopistas de Cuota of SCT for their comments to earlier versions of this paper.

REFERENCES

1. Manzo-García, G. G. “Aspectos de Ingeniería de Tránsito para el Desarrollo y Operación de Redes Viales”. *Las Vías Terrestres en Desarrollo de México*. Memorias de la IX Reunión Nacional de Ingeniería de Vías Terrestres. AMIVT. Veracruz, Ver. México. May 1990. pp. 41-45.

2. Secretaría de Comunicaciones y Transportes. “Modernización del Sistema Carretero Troncal/Modernization of the Main Highway System”. México, D. F., October 1999.

3. Manzo-García, G. G. “Programa Nacional de Mejoramiento de la Infraestructura en Puntos Conflictivos”. Memorias de la V Reunión Hispano-Mexicana de Técnicos en Vías Terrestres. April 1999.

4. Secretaría de Comunicaciones y Transportes. “Estadística Básica del Autotransporte Federal 1997”. México, D. F., June 1997.

5. Rico, A., A. Mendoza, and E. Mayoral. *Main Freight Land Transport Corridors in Mexico*. Transportation Research Record 1613, pp. 79-87, Transportation Research Board, Washington, D.C., USA, 1998.

6. Secretaría de Comunicaciones y Obras Públicas. “Memoria de la SCOP 1954-1955”. México, D. F. 1956.

7. Personal Communication. Ing. Santiago Rico Galindo from the Unidad de Autopistas de Cuota, SCT.

8. Secretaría de Comunicaciones y Transportes. “Estudios de Origen y Destino 1977-1982”. México, D. F.