Design of A Road Traffic Data Recording System on a Continuous Basis[1]

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1. BACKGROUND

The road sector is a dominant mode of transport in India. The vast road networks exceed 3.3 million kilometers, including about 65,569 km of National Highways, 1,31,899 km of State Highways and 4,70,000 km Major District Roads and other roads, indicative of the diversity and sizes. The country is experiencing rapid growth in motorized vehicles that is impacting transportation infrastructure. The total vehicle fleet has grown from 0.3 to 67 million between 1951 and 2003[5]. Goods vehicle fleet registrations have increased 42 folds, from 82,000 in 1951 to 3.5 million in 2003[6]. The road sector's share of freight traffic has increased from 11 percent in 1950 to over 70 percent in 2003[7].

The national and state highways of India are major corridors of movement. Traffic on these major arteries of India is growing at a rate of 5 to 10% per annum. Most of the national highways are two-lane, single or intermediate lane. About 10 percent of national highways are four-lane. Of the total primary network (NH and SH) 2-3% are 4 laned and 15% are single laned[8]. Approximately 80-90 percent of the national and state highways are suitable for a standard axle load of 8.16 tonnes and are not structurally adequate for permissible axle loads of 10.2 tonnes[9].

However over 50 percent of the national and state highways, and a higher percentage of other roads, are in a bad condition[10]. About 25 percent of national and state highways are congested. Average truck and bus speeds are in the range of 30-40 km/h on national and state highways[11]. An estimated Rs 200-300 billion is lost to the economy annually due to constraints of road network capacity and quality[12]. Annual road safety toll is high. At least 85,000 deaths are attributable to road accidents[13].

These trends together with constraints on the resources highlight the need for better transport decision process, both in terms of Transportation Systems Planning and Operations. A key component to any transport decision is availability of current and reliable data *characterizing transportation supply, demand, impact, and performance.*

There is a woeful lack of traffic data so much so that even the reliable data on number of vehicles on road is not available entirely in the state/country. Importantly, traffic data on continuous basis is not available. This has hampered meaningful research in this sector and consequently the development of sustainable and rational policies considering ground realities. In the light of these considerations the a comprehensive research paper on “Design of a Road Traffic Data Recording System on a Continuous Basis” has been selected as one of the submissions to be included in the initiative of the

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[1] This report was prepared by consultants for the Asian Development Bank. The views expressed in this report are the views of the authors and do not necessarily reflect the views or policies of the Asian Development Bank (ADB), or its Board of Governors, or the governments they represent. ADB does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequence of their use.

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[5] MOST, *Motor Transport Statistics*, 1997

[6] ibid.

[7] S. Malik, "Phenomenal Growth: Skewed Structure", *The Asian Journal*, Volume 7, No 2, June 2000.

[8] Indian Roads Congress, *Road Development Plan Vision: 2021*, November 2000.

[9] Op. cit., Malik 2000.

[10] Based on data collected on roughness on state roads for various projects prepared under the World Bank State Road Infrastructure Development TA Loan - 4114-IN.

[11] Inferred from limited survey quoted in A. Bhattacharya, "The Indian Trucker and His Travails", *The Asian Journal*, Volume 7, No 2, June 2000.

[12] Expert Group on the Commercialization of Infrastructure Projects, *The India Infrastructure Report*, 1996.

[13] G. Tiwari, "Transportation Safety Issues - Institutional Restructuring Proposed for India", IIT Delhi, 2001.

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The scope of the paper as defined by the Advisory Group is to suggest a system for continuous recording of broad details of traffic movements at select points on main highways using modern IT methodology covering technical and institutional aspects. Given the above, this paper:

- reviews existing traffic data systems,
- identifies gaps, and
- defines a conceptual framework for collection, organisation and dissemination of relevant traffic information.

An analysis of existing practices and issues in collecting relevant information is presented along with a 12-point action plan for strengthening interventions.

2. AGENCIES AND FUNCTIONS

In India, most road infrastructure building, operation and maintenance operations are largely in the public realm. Accordingly agencies at the center and state level have established traffic monitoring programmes. These are in accordance with the guidelines of the Ministry of Road Transport and Highways (MoRTH) and Indian Roads Congress (IRC). The section below reviews agencies in terms of their functions, data needs, present methods of data collection, organization, use and dissemination.

The Planning Commission is entrusted with the responsibility of preparing plans at the macro level. The agency deals with policy issues related to sectors and sub-sectors. The Deputy Chairman and the full time Members of the Commission, as a composite body, provide advice and guidance to the subject Divisions for the formulation of Five Year Plans, Annual Plans, State Plans, Monitoring Plan Programmes, Projects and Schemes.

The Planning Commission functions through 28 Divisions and several units, each headed by a Senior Officer. Of the several functions, the Planning Commission's Perspective Planning Division (PPD) on the basis of a multi-sectoral, consistency model does the demand forecasts for the transport sector, including inter-modal allocation of traffic between rail and road. The inputs are obtained from respective ministries.

The Ministry of Shipping, Road Transport and Highways (MoSRTH), an apex agency of the Central Government, is entrusted with the task of formulating and administering, policies for Shipping, Road Transport, National Highways and Transport Research with a view to increasing the mobility and efficiency of the road transport system in the country. This is done in consultation with other Central Ministries/Departments, State Governments/UT Administrations, organizations and experts in these areas. The Roads Wing of the Ministry deals with issues relating to National Highways in the country. The Transport Wing deals with issues pertaining to transport.

In the National Highways Sector, the Ministry is primarily responsible for planning, development and maintenance of National Highways in the country. It also extends technical and financial support to State Governments for the development of state roads and roads of inter-state connectivity of economic importance. The Department evolves specifications for roads and bridges in the country. Above all, it serves as a repository of technical knowledge on roads and bridges.

In the Road Transport Sector, the Ministry is responsible for Motor Vehicle legislation, administration of the Motor Vehicles Act, 1988, taxation of motor vehicles, compulsory insurance of motor vehicles, administration of the Road Transport Corporations Act, 1950, and promotion of Transport Co-operatives in the field of motor transport. The Department also evolves road safety standards in the form of a National Policy on Road Safety and by preparing and implementing the Annual Road Safety Plan. It collects, compiles and analyses road accident statistics and takes steps for developing a Road Safety Culture in the country by involving the members of public and organizing various awareness campaigns. To this end, it provides grants-in-aid to Non-Governmental Organizations in accordance with prescribed guidelines.

The National Highways Authority of India (NHAI) was constituted by an Act of Parliament. The National Highways Authority of India Act, 1988, is responsible for the development, maintenance and management of National Highways entrusted to it and for matters connected or incidental thereto. The Authority became functional in February 1995.

The Indian Roads Congress (IRC) is the premier technical body of Highway Engineers in the country. The IRC was set up in December, 1934 on the recommendations of the Indian Road Development

Committee best known as Jayakar Committee set up by the Govt. of India with the objective of Road Development in India. As the activities of the IRC expanded, it was formally registered as a Society in 1937 under the Societies Registration Act of 1860. Over the years the Congress has grown into a multi-dimensional organisation, devoted to the cause of better roads and bridges in the country. The Congress provides a National forum for sharing of knowledge and pooling of experience on the entire range of subjects dealing with the construction and maintenance of roads and bridges, including technology, equipment, research, planning, finance, taxation, organisation and all connected policy issues.

The Central Road Research Institute (CRRI), New Delhi, is a premier institute engaged in R&D in the field of roads and road transportation. CRRI was established in 1952 as a laboratory of the Council of Scientific & Industrial Research (CSIR). As an apex organization in road sector, CRRI has always provided guidance to user departments and agencies in solving complex highway and transportation engineering problems. The major R&D programmes of CRRI relate to the entire spectrum of pavement design and performance, rural roads, traffic and transportation engineering, management and improved technologies for pavement rehabilitation, etc.

The states have Roads and Buildings Department (R& B) or Public Works Department (PWD) to mange road networks. They look after road development and maintenance. A few states such as Madhya Pradesh and Orissa also have specialized rural development agencies. Tamil-Nadu, Gujarat, Karnataka, and Maharashtra have road development corporations, which help raise private finance. In addition to the primary responsibilities such as project preparation, implementation, operation and management, these agencies are also responsible for collecting and managing databases on traffic as per the MoRTH / IRC guidelines.

Innovative Road Financing using Private Sector has gained popularity in the recent past. The BOT operator, as part of their toll collection operations, generates certain amount of data. The data items include volumes by class of vehicle and entry and exit time of the corridor (in case of closed system). However, with the expansion of private sector participation on several stretches, performance based contracts will gain popularity. With this, switching over from traditional concept of toll to shadow toll would become a necessity. In these partnerships multiple parties would be involved. This implies different set of data needs to meet with the contractual requirements.

3. TRAFFIC DATA NEEDS AND PRESENT PRACTICES

3.1. Traffic Data Needs

Different sets of traffic data are required and used to address specific planning requirements viz. perspective planning, strategic planning, road development plan preparation, performance monitoring, research and development etc. The following table presents the broad types of traffic data required to meet various planning requirements.

Sl. No.	Traffic Data	Outputs	Potential Uses
1.	Traffic Volume Traffic Classification	• Annual Average Daily Traffic • Design Hourly Volume • Peak Hour Traffic Characteristics • Peak Hour Traffic percentage • Peak Hour Traffic Volume • Commercial Traffic Volume • Non-motorized traffic volume	• Perspective Planning • Strategic Planning • Road Development Plans • Performance monitoring of road network/section • Research and Development • Shadow Tolling
2.	Commodity Flow (O-D Pattern)	• Inter-regional commodity flows by principal modes of transport viz. railways, roads, coastal shipping etc.	• Perspective Planning
3.	Axle Load	• Vehicle Damage Factor, MESA etc.	• Planning, Policy and Pavement Design
4.	Ridership/Occupancy	• Intercity passenger flow	• Perspective Planning • Performance Monitoring of a system
5.	Resource Cost of transport services	• Cost advantage between different modes such as rail, road, water etc.	• Perspective Planning • Economic justification of individual transport projects
6.	Vehicle Characteristics	• Utilsation (passenger-km,	• Perspective Planning

		tonne-km, vehicle-km etc.), Ownership and nature of operation	
7.	Travel Time	• Journey Speed	• Project evaluation • Performance monitoring
8.	Accidents	• Reasons of accidents, black spots etc.	• Perspective Planning • Performance Monitoring of a system • Localized improvement measures
9.	Registered Vehicle fleet	• Relationship between vehicular growth rate and the GNP	• Demand projection

In addition, environment data, roadway details and pavement conditions are relevant for making shadow tolling operational. Real-time data systems along with intelligent toll systems would be necessary if a performance based variable toll system has to be implemented. Traffic data needed for multi-modal transportation planning processes in urban areas, for efficient, safe and environmentally compliant operation of transportation systems are not covered in this paper.

3.2. Traffic Data – Present Practices

As part of annual traffic census programme, traffic data in terms of classified volume counts is gathered from permanent traffic census locations by State agencies using manual count method. These are done twice a year (generally April and October) on NHs and SHs for one week. The guidelines issued by Ministry are followed to collect data on National Highways (Attachment – 1). It is our estimate that traffic data gets collected in a year at about 2,000 locations on National Highways and about 5000 - 6000 locations on State Highways (map shows distribution of locations on all NH and SH in Gujarat and Ahmedabad district of Gujarat). Limited coverage on MDR is also done. In addition, as part of Highway Project Preparation, traffic surveys are undertaken in about 1000 locations.

The programme as operational now is beset with series of problems. The system of data collection, analysis, storage, retrieving and sharing is in its very basic form. Locations, duration and frequency of traffic volume data collection have to be reviewed. Traffic Census Data along with geo-referenced map is yet to be developed. Reliability of data collected is always under question, as the exercise has become an annual routine.

Further, to our understanding no technology is deployed or contemplated to be deployed except by research and academic institutes as part of activities. With secondary and tertiary activities becoming lead sectors of the economy, carrying out traffic counts just in April and October need reconsideration. Continuous counts are necessary to capture variations in traffic.

Police Department records information on road accidents and data compiled are supplied to the MoRTH for analysis and publication. The provisions of the Police Act drive data collection process. Information on the road accidents does not provide full coverage of the number and type of accidents and the nature of accidents. The type of data available is not useful for carrying out black spot analysis;

Commodity flow (O-D) data and Axle load data are not collected on a continuous basis. Some feasibility studies, detailed engineering aspects of various sections of NHs under NHDP, and strategic option studies on selected state roads do provide some information. Given the emerging nature of multimodal transportation system, freight flow data would be a very useful addition to transportation planning process.

The statistics of vehicle fleet in the country is more readily available and more updated. The transport research division of the MoRTH publishes these statistics. The Society of Indian Automobile Manufacturers also has data on the production and sale of various categories of vehicles. However, despite statutory registration of vehicles and regulatory control in operations, very little information is compiled and published on vehicle characteristics, particularly of goods carriers, their ownership and nature of operation. Data regarding output of goods vehicles in terms of tonnes carried and tonne-kilometers performed are not available at all.

The need for collection and publication of information on transport costs was highlighted by the Committee on Transport Policy and Co-ordination (CTPC) 1959. But to date very little has been done in this direction.

State transport undertaking also publishes information on the overall Ridership along with other operational characteristics. However, no such information is available in case of private bus operators in India.

In addition to the annual traffic census, a number of studies are being undertaken in the road sector, which gives valuable traffic data. The number of locations where such data could be available is estimated to be about over 1000. The data coverage tends to be comprehensive and generally includes the following:

- Classified Volume Counts by 15 min interval
- Occupancy rates
- Origin-Destination details
- Axle load data
- Road condition
- General Environment Data

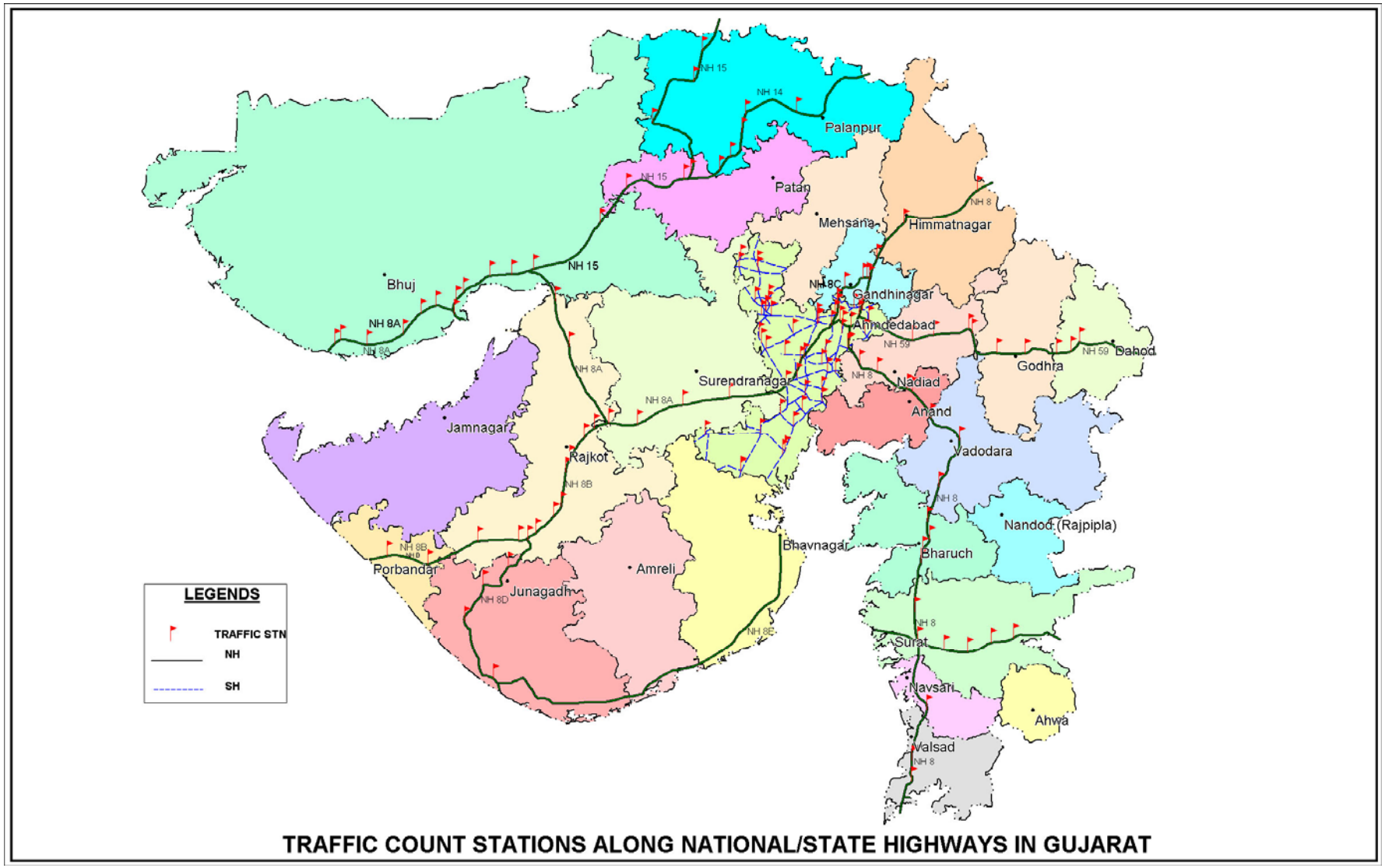
Often these studies use technology extensively. However need for compiling these within a national framework in a format along with data dissemination framework is required.

An insight of the existing practice in Gujarat

Following the directives of Ministry of Road Transport and Highways and Indian Roads Congress guidelines on "Traffic Census on Non-Urban Roads", the Roads and Buildings Department, the Govt. of Gujarat conducts traffic census at 94 locations on NH (over 2,300 km) and at 816 locations (over 19,000 km) on State Highways. The department conducts traffic volume surveys at pre-identified locations for 7 continuous days in case of NH and for 3 continuous days in the latter case. Generally the departmental staff does it. Most of the traffic survey/census stations considered for conducting periodic traffic census were identified and located some decades ago. Due to urban development and other factors, many of the stations are now well within urbanized areas. Traffic at these sites tends to include much more non-motorized vehicles, scooters and small motorcycles compared to traffic in between developed areas.

Many sites are also located right at junctions/intersections, notwithstanding the fact that traffic patterns are not typical of either section represented. Survey formats used for the purpose are outdated (as recommended in IRC:9-1972) and include only seven vehicle types. Data management and sharing are not up-to-date. However, the Directorate of Economics and Statistics produces results in a report called "Traffic Census Results" however, with a lag of 3 to 4 years.

The importance of quality data needs to be understood by the field engineers, as they are the persons actually collecting the data. Of late, this task of collecting traffic data twice every year is considered to be the most non-productive work and hence quality of data is always doubtful.



TRAFFIC COUNT STATIONS ALONG NATIONAL/STATE HIGHWAYS IN GUJARAT

4. SUGGESTED FRAMEWORK

Given the above, the mandate of the present paper shall be to define conceptual framework for traffic data collection and management. Here, the traffic data would mean the "classified traffic volume data", "Origin-Destination Data", and Axle "Load Data". (Please refer to Attachment – 3 on user expectations). For better planning and management, it is suggested that the highway agencies should essentially report on at least the following:

- Classified ADT and AADT;
- Peak hour volumes and share including the peak periods; and
- Commercial vehicular volumes and/or percentages
- Vehicle Damage Factor and/or ESA at select representative locations

The traffic data and the associated road system aspects should be addressed, and not in isolation, as traffic data in itself will not provide any comprehensive ideas/ solutions to the issue. The domain will also need to include data collection and processing efforts. The proposed data collection program consists of:

- Portable short duration (up to 7 days) traffic volume counts,
- Permanent continuous (365 days) traffic volume counts,
- Commodity Flow and Loading Pattern, and
- Accident Information

4.1. Portable Short Duration Traffic Counts

Traffic volumes tend to vary dramatically from one location to another and therefore highway agencies need to have information on all the roads. Continuous counts on all the roadways are not economically justifiable. Hence to provide the geographic coverage needed to understand traffic characteristics on individual roadways, as well as on specific sections of those roadways short duration counts are carried out. It is recommended to conduct traffic volume count once in a year (any month excluding rainy seasons) at short duration - yearly count station.

Recommendations on the spacing between mid block survey stations is primarily based on the existing practice, understanding of network density (NH and SH) at the national level, average spacing between junctions/intersections (NH/NH and NH/SH), some specific experience dealing with larger network viz. Strategic Options Studies carried out in different states and some cost considerations. A general framework for mid-block traffic counts locations on NH and SH is recommended as follows:

Road Category	No. of location	Duration and Procedure
National Highways	Yearly Count Station: One location at every 25 km (on an average) hence approximately 2,500 locations in India.	7 days traffic volume once in a year (any month excluding rainy season) To start with, manual count method may be adopted. Subsequently around 125 nos. of ATC can be used in rotation.
	Monthly Count Station: One Location at every 500 km (on an average) hence approximately additional 130 locations in India.	7 days traffic volume count using vision based ATC, once in each month of a year. These locations are to be covered under Commodity flow and Axle Load Surveys.

Road Category	No. of location	Duration and Procedure
State Highways	Yearly Count Station: One location at every 50 km (on an average) hence approximately 2,500 locations in India.	3 days traffic volume by manual count method, once in a year (any month excluding rainy season) to start with. Subsequently around 75 nos. of ATC can be used in rotation.
	Monthly Count Station: One Location at every 1000 km (on an average) hence approximately additional 130 locations in India.	3 days traffic volume count using vision based ATC, once in each month of a year. Potential locations to have Commodity flow and Axle Load Survey done.

It is also possible that a two-year cycle may be adopted to rotate survey locations so that the coverage can be increased to twice the recommended number.

Site Selection framework For Short Duration Counts (Traffic Census Locations):

Identification of a homogeneous road section in terms of traffic and road conditions is crucial to the success of a census programme. Criteria stated in the following may be adopted in locating traffic survey stations.

- Identify the end points along the homogeneous section of any such developed areas, which could include volumes of local traffic. Identify junctions and intersections that could have high volumes of local traffic.
- Identify tentative locations for survey/census stations, which can avoid local commuter traffic. The locations should be well away from all urbanized developments, major villages, and major junctions/intersection on the road section.
- Ensure that the necessary logistics for conducting traffic volume survey such as permanent shelter, light, table/chairs etc. are provided at the identified location.
- Finalize the location and name the traffic survey station.
- Locate and mark all the traffic survey stations on an index map at the district level. It should then be compiled and marked at the state level.

Since division of the roads into road sections and fixation of traffic census points are decisions of long lasting significance it is important to these should be taken care of by experienced field engineers. Short duration volume counts usually require a number of adjustments (factors obtained from continuous data base) in order to convert a daily traffic volume "raw" count into an estimate of Annual Average Daily Traffic (AADT).

4.2. Permanent Continuous Traffic Counts

Continuous traffic monitoring efforts are carried out in several countries to understand seasonal, day-of-week, and time-of-day traffic volume patterns. With improved data collection equipment, continuous data can also be used as input for traffic management systems and other operational purposes. On tolled highway, real time traffic data collected through vision based traffic counters can be used to define toll rates based on congestion levels (Level of Service), number of lanes open for the traffic etc. Thereafter, continuously collected data may be summarized and stored and the rest may be discarded.

The most common continuous traffic monitoring data collection programs use Automatic Traffic Counters and Classifiers (ATC/AVC) and continuously operating Weigh-in-Motion (WIM) scales placed to monitor statewide trends in vehicle weights.

As part of the NHDP about 15000 kms are proposed to be toll roads. In addition SH also has toll roads. As part of these project packages, near all toll plazas, continuous traffic count operations should be implemented. Developing ITS facility at these places is recommended.

4.3. Technologies for Traffic Data Collection

In the developed world, a variety of equipment is used to collect data by classifying the traffic stream. Technology allowed the use of axle, vehicle length, and machine vision as classifiers. New technologies are rapidly evolving. In these countries, human observation is used, as a last resort. In India, technology is procured to match our conditions and systems as part of several efforts at state and central levels to develop comprehensive information systems. These are particularly developed as part of projects funded by multi lateral funding agencies.

Historically, classified volume counts have been done by visually counting the traffic stream considering vehicle's body style and axle. This system cannot help count accurately under high volume, multi-lane conditions.

Automated Counters including Axle Sensor Based Counters resolve the limitations of manual counting. The microchip equipment relies on two carefully spaced axle sensors (usually road tubes). These counters measure the number of axles associated with each passing vehicle and the spacing between axles. This axle spacing is computed from the speed of the vehicle and the time between axle pulses on each sensor. Vehicle speed is commonly computed by measuring the time it takes for the front axle to travel from the first axle sensor to the second (a known distance). The number and spacing of axles is then fed into an algorithm that associates a given number and spacing of axles with a particular class of vehicles.

The accuracy of axle sensor based counters is a function of the type of axle sensor used, the geometry at the site where the sensors are placed and the quality of the equipment installation and/or the pavement on which the sensors are placed. Most classifiers report not only the number of vehicles in each class but also the number of vehicles that crossed the sensors but could not be classified.

Portable sensors have the advantage of being usable at many locations. However, they are usually difficult to place on lanes that are not next to the shoulder of a road, thus making it difficult to use these classifiers on multi-lane, undivided arterials

Permanent sensors are often used for both long-term data collection sessions and for collecting data on multi-lane highways, where portable axle-sensors cannot be placed. They are however costlier and the lanes have to be closed for installation.

In general, axle based classifiers work very well on smaller (two-lane) rural roads and divided four-lane rural roads where congestion is not a problem. This type of counter has difficulty counting accurately on roads where traffic speeds are highly variable.

Vehicle Length Based Counters, which are dual loop classifiers the vehicle length is computed by dividing the total time a vehicle, is over the loop by the speed of that vehicle. Vehicle speed is determined by the difference in time taken for the vehicle to be detected by the first loop and the second loop. The length of this "detection field" is a function of a number of factors related to loop sensitivity and vehicle characteristics.

Machine vision systems, are based on video image processing. Camera systems allow the detector to be placed above or beside the roadway, in a location that is more accessible to maintenance crews. In some cases, cameras are also able to transmit traditional video images to system operators, allowing for dual use of the data collection equipment.

New approaches to image processing (e.g., edge detection algorithms) are being developed to improve on the performance of the existing image processing algorithms. Systems currently on the market still tend to classify vehicles on the basis of their overall size and are thus likely to use classification schemes similar to those supplied by current loop based systems.

For each of the technology solutions (axle, length, or vision) there are generally a number of different sensor technologies. Each sensor has its own advantages and disadvantages regarding cost, reliability, accuracy, life span, ease of set up, and type of information provided. No technology has proven to be the best under all conditions.

The different sensor technologies also require a variety of different vehicle classification schemes because the vehicle characteristic information provided by each sensor differs. The ideal vehicle classifier would be able to measure a wide variety of vehicle characteristics to differentiate trucks on the basis of several different factors and to meet the needs of different users. Unfortunately, such a sensor does not currently exist at an affordable price. Consequently, agencies must select the technologies that provide the data they most need to provide the classification information they require, at the locations where those data are needed, at prices they can afford.

For most engineering tasks the primary issue is separating "heavy" vehicles from "light" vehicles, because heavy vehicles cause more pavement damage and tend to have poorer acceleration and braking characteristics. However, weight is not the only issue, since overall dimension (length, width, height) has a major impact on the geometric design needed for safe roadway operation. Other desired vehicle classification attributes include the type of connection used on multi-unit vehicles (the connection has major safety implications) and the type of engine that provides the power (since the type of engine affects the amount and type of pollutants emitted). Unfortunately, these last two vehicle

A summary of the features of the techniques referred is presented in the following.

Technology	Advantages	Disadvantages
Manual Count	• Can classify vehicles on the basis of body, style, axle • Less classification error • Easy to mobilize • Cheap, if short period	• Can not classify vehicle by weight • Huge human resource at a time • Training and logistics • Expensive, if longer duration
Axle Sensor Based Counters	• Based on no. of axles associated with each passing vehicles • Can provide continuous results	• Difficult to classify different type of vehicles with same similar axle spacing. • Not accurate, if lane driving is not properly enforced • Costly and difficult to install and calibrate
Vehicle Length Based Counters	• Dual loop system • Can provide continuous results	• Difficult to classify different type of vehicles with same similar axle spacing. • Not accurate, if lane driving is not properly enforced • Costly and difficult to install and calibrate
Machine Vision Based Counters	• Based on image processing • Do not require installation of in the roadway. • Can classify vehicle by size and type	• Costly • Better in accuracy

characteristics are extremely difficult to obtain from conventional classification equipment, and as a result, these vehicle characteristics are normally collected as part of special studies, not as part of the traffic monitoring effort.

4.4. Commodity Flow and Loading Pattern

Comprehensive data on interregional commodity flows by different modes viz. Rail, Coastal Shipping, Air and Road are essential for planning purpose. While such data is available to some extent in case of air, rail, and coastal shipping, information on commodity flows is not easily available for road transport because of multiplicity of transport agencies, preponderance of single vehicle operators and absence of traffic recording procedures.

In the past some efforts have been made to estimate interregional commodity flows by road from Ministry of Transport, GoI. Technical Group had identified major trunk routes and commodity types for Transport Planning (JTG) in the Planning Commission 1963. Surveys were conducted and results have been used as one-off exercise. Subsequently a similar attempt was made once again by RITES on behalf of Planning Commission. This time information was collected for 37 major commodities and the level of disaggregating selected for generating interregional flows being a revenue district. Thereafter no attempt was made to collect information on commodities flow.

We all realize the need for information on a continuous basis to frame appropriate policy on inter-modal mix from time to time. It is suggested that “Monthly Count Locations” suggested for the purpose of conducting traffic volume count survey on monthly basis would also be appropriate to have commodity flow survey done. These surveys could be once (24 hrs) in two years.

Standard traffic zoning systems with the level of dis-aggregation at district level should be evolved at national level to analyze commodity flow data consistently and have commodity flow pattern on core network (NH and SH). As monthly count stations will represent 500 km of NH and 1000 km of SH, there would be 260 such survey stations (130 on NH and SH each) on which once (24 hrs.) in two years a survey may be conducted.

We recommend axle load survey once (24 hrs.) in two years for information on loading pattern on various goods vehicle types. The results of this survey in terms of VDF and ESA are very important for highway engineers in pavement design.

There are alternative ways to obtain origin-destination data of goods traffic and commodity flows. As an exploratory exercise, the authors have examined the possibility of utilizing other existing sources to generate interregional commodity flow. There are two mechanisms, which have some scope to expand the information base and help develop origin-destination details of freight movement.

Interstate Border Check-post of the Transport Department: The inter-state border check-posts verify commercial vehicle permits in terms of validity and load. In case the vehicle is not carrying valid permit, temporary permits are issued on payment. In case of overloading/over sizing, penalties for overload are collected. The data collected include ‘Registration Number’, ‘Vehicle type and class’,

'Permit Number', 'Type of offence (in case of DA case)', 'Load', and 'Fees / Fine / Tax amount'. It is to be noted that the data is registered only for those vehicles which have to pay some charge/penalty. Information on weight can be made useful with some further effort for arriving at Vehicle Damage Factor by different vehicle type on a sample basis. The department would however see any additional effort as irrelevant to their core function. But, this can be negotiated for a good cause.

Freight Origin – Destination Pattern Through Sales Tax Check-Posts: The sales tax department also has an elaborate network of check posts to monitor sales tax payment. At every state border, the department has check posts to collect information on sales tax aspects. In Gujarat, there are six major check posts of which four have been computerized. The check posts are connected to the head office of Sales Tax Dept., Ahmedabad through 'v-sat'. Other states, which have computerized their operations, are Karnataka, A.P, M.P, Punjab and Haryana. The states of Maharastra and Rajasthan are in the process of computerization.
The department monitors incoming, outgoing and bypassing vehicles. The data registered include among other things the vehicle registration number, commodity type, value and from and to (place). The data on commodity type (taxable, may vary from state to state), vehicle type along with origin and destination can be very well utilized for analyzing interregional (inter state) commodity flow by vehicle type. However, modalities of data sharing and handling are major issues and need to be deliberated at the national level by involving states.

4.5. Accident Information

Information on accidents should be made an integral part of traffic data collection. We are all aware that there is no standardized accident record form used by the data collecting agencies i.e. police department across nation. Indian Roads Congress through its code "IRC:53-1982" have recommended "Road Accident Form-4" for the use. So far, none of the agencies have implemented primarily because of complexity and exhaustiveness of the data. Revisions in the "Accident Record Form", which is acceptable and implementable by the police department and also have useful information required by the road engineers, are necessary. A major effort is required in this direction at national level with participation of all states.

4.6. Data Storage and Dissemination

The database in respect of traffic needs to be strengthened. It should be dynamic with arrangements for regular updating and creating a time series to assist in proper planning and management of various categories of roads. It would be desirable for the Ministry of Road Transport and Highways to take the lead in getting an integrated system developed for collection and storage of traffic (related) data with proper referencing with other highway[14] components. This would provide a meaningful appreciation of flows on network. This may call for the use of Geographic Information System (GIS). The system should be designed in such a way that it should be simple to user and should give the output in desired format. The most common theme of the data collection and management would be to have a Integrated Traffic Records System (ITRS) which shall also facilitate data dissemination across user groups.
The conceptual system framework for maintaining traffic data on continuous basis should therefore encompass at minimum the following:

Road Information System (RIS)	• Link referencing (latitude, longitude and ID) • Road inventory (jurisdiction & no, ROW, C/W width, land use, lane configuration, etc.) • Central database, accessible to all for viewing and necessary use
Traffic Information System (TIS)	• Field Data Sheet • Appropriate location of permanent and temporary traffic survey stations. • Data entry forms (Count Location (km, latitude, longitude), Year, Day and time

[14] National Highway Authority of India, is already in progress on an effort towards forming a Road information system (RIS) i.e. to develop a comprehensive integrated database of National Highways and to interface with the existing planning or engineering analysis packages

	of data collection, data entry (traffic volume, origin-destination, axle load, accident etc.) • Data Validation and Truth-in Data check • Analysis schedules (Peak hour traffic, ADT, AADT, monthly, weekly, daily traffic, Correction factors) • Central database, accessible to all for viewing and necessary use • Reports and Pictorial presentation of data and outputs

A 12-point plan outlining important actions has been evolved and presented in the table below.

Table-1: Action Agenda: Design of Comprehensive Traffic Data

S. No.	Aspect/ Description	Present Initiatives/ Practices	Reform Initiative/ Action Proposed
1.	Defining Road Network	About 65,000 km of NH and about 132,000 km of SH as defined now could be part of this initiative.	Mapping of NHs and SHs should be undertaken. Scope to extend the network should exist. GIS as platform to define network is considered appropriate for this purpose. Mapping NHs and SHs for India is major effort. It requires effort from central and state agencies.
2.	Link Referencing	Having accurate length of roads is important. Present practice has been to adopt approximation of lengths.	Need to define correct length between nodes. This could be by location reference points. One time major effort.
3.	Road Network Details	Preliminary details could be available with national and state agencies.	A detailed review of available data is recommended. Gaps need to be filled.
4.	Defining Homogeneous Sections	No such practice, exists now.	There is a need to define sections based on road and traffic characteristics.
5.	Identification of Mid Block Traffic Survey Locations	Permanent (short duration) survey locations as defined decides/ years back are being followed now.	It is recommended to have one location (Yearly Count Station) per 25 km (on an average) of NH and per 50 km (on an average) of SH as short duration (3-7 days, once in a year any month excluding rainy seasons). In addition, few permanent (continuous) traffic count station (Monthly Count Station) are also needed at every 500 km of NH and at every 1000 km in case of state highways. Locations need to be identified by scientific process. These can be decided by conducting flow survey on network. A major effort.
6.	Design Standard Survey Formats	IRC suggested formats.	Given present project appraisal methods/ techniques and changes in technologies and modes in use by states, a standard format need to be designed.
7.	Defining Data Collection Methods/ Technology	Manual counts is the practice. Methods followed internationally also vary significantly.	Adoption of technology is a major issue. Have wider implications. Larger debate and detailed research is needed to adopt or have indigenous technology developed. Given the number of locations and its duration (1 to 7 days per year), manual count method is the most logical. For monthly count and continuous count (365 days), use of latest technology, preferably image based technology is recommended.
8.	Data Processing and Checks	No standard practice. Checks seem to have been made on data collected.	Standards checks on data are very important. Processing need to be at state level before committing data to central level.
9.	Presentation of Data	No such practice exists.	On a regular basis, on pre-designed format, the basic data should be presented on web based system.
10.	Data Management/ Control	MoRTH at Central and PWDs & R&BDs at State Level are custodians of the data	Need to define the detailed data management and control mechanism. The agency (ies) and the power to be vested with them needs to be decided.
11.	Development of RIS	Some efforts in this direction are reportedly underway at central and state levels.	Road Information System Recommended for development. Should be a web based system. Should comprise all the NHs and State Highway details.
12.	Development of TIS	Some efforts in this direction are reportedly underway at central and state levels.	Traffic Information System (TIS) recommended for development. Should be a web based system. Should have all the NHs and SHs data base. Should be able to accommodate special traffic volume courts, commodity flow data and axle-load data.

4.7. Institutional Framework

Two important bodies of the Government; the Planning Commission and the Road agencies both at Central and State levels are relevant in this context. It is suggested that at Central level the Adviser (Transport), Planning Commission, GoI should act as Custodian of this entire set up. The Chief Engineer (Planning), MORTH,GoI should act as Nodal officer. Similarly at states' level, the State Planning Body should act as nodal office supported by Chief Engineer (Planning) of the PWD or R&BD. Data to be collected by PWDs and R&BDs.

Data collection and processing should be outsourced to private agencies. The data collected systematically and continuously can be disseminated commercially in many ways such as CDs, through web access charge. National Sample Survey Organisation (NSSO), with technical support from Indian Road Congress (IRC) and Indian Statistical Institute (ISI) can become a lead agency to compile, store, analyze and disseminate traffic data. The data control and cost sharing details need to be separately dwelt upon on taking these larger decisions.

5. SUMMARY

It is recommended that a web based Integrated Traffic Record System (ITRS) should be developed for India. This system, should include the Nhs and SHs in the intial stage and extend it to include other roads. A major national level effort is needed for this purpose. Adoption or development of technology to collect data needs to be studied further. It is important to undertake pilot projects by short listing 3-4 alternate technologies on a pilot basis.

Further, efforts should also be made to explore the need and/or potential to develop indigenous technology in India, given the scale of requirements. With this it is anticipated that there shall be improvement in the existing traffic volume data collection and management procedure across India. To carry out this task, we suggest a Working Group under the initiative of the MoRTH should be formed. The Planning Commission, State R&B department Secretaries, representatives from Indian Statistical Institute, National Sample Survey organization and research and academic institutions can also be involved in this effort.

The traffic volume count on the National highways are being conducted by the respective State Governments and follows the Ministry's technical circulars. The following are Ministry guidelines and our observations:

Guidelines	Observations/ Comments
• Traffic census should be done twice in a year. Once during the peak season of harvesting and marketing and again during the off season. Each time, the counts should be made for seven consecutive days.	• It is done twice a year (April and October). Each time for seven continuous days.
• Standard Performa to be adopted for compiling the data	• Performa as suggested in IRC:9-1972 that includes only six vehicle types. Needs to be revised.
• Traffic census should not generally encompass abnormal conditions of traffic like a fair or exhibition. In such cases the count to the area should be postponed by a few days till normalcy returns.	• Adequate care is not never taken. If postponed, never done.
• A road should be divided into convenient sections, each carrying approximately similar traffic between points of substantial traffic change. Count stations should be set up for each such section. The limits of the sections could generally be the important towns along the road or major roads intersecting or taking off from the highway in question.	• Most of the road sections are not homogeneous in terms of traffic. Once decided never relocated considering development in the network.
• For trunk routes serving inter-city traffic the census sites should be fixed well away from all urbanized developments and village. In particular, sites within zone of influence of towns where there may be regular flow of commuter traffic must be avoided. If need be additional stations could be fixed for these zones.	• Many of the sites are well within urbanized developments/village and hence include local commuter traffic.
• Every subsequent census should be taken at the same locations. New stations could, of course, be added as and who needed.	• Done.
• For the purpose of traffic counts a day may be divided into 3 shifts of 8 hours each and separate enumerators with a supervisor assigned for each shift.	• Varies.
• Recording should be done for each direction of travel separately. For this the staff should be divided in two parties for every shift.	• Done.
• In each hourly column the traffic should be recorded by making tally marks in five dash system (vertical strokes for the first four vehicles, followed by an oblique stroke for the fifth vehicle so as to depict a total of five). Hourly totals should be made at the end of the shift.	• Done.
• An index map indicating the location of the census site should be attached to the traffic summary sheets.	• Missing. Location references are also not consistent.
• If considered necessary, the volume of pneumatic tyred and iron tyred vehicles may be recorded in separate columns.	• Never done separately.
• The highest peak hour traffic in a day for fast as well as slow vehicles may be highlighted in summary sheets by drawing firm line in red around the figurers in appropriate column.	• Missing. In most of the cases, availability of such summary sheets is a question.

ATTACHMENT 2

Traffic Volume Data – Importance

The traffic volume counts are used in a number of disciplines in highway planning, engineering and management. Following table highlights in brief the different activities where traffic characteristics can be used.

Component of Road development	Application of traffic Characteristics		
	Traffic Counting	Vehicle Classification	Truck Weighing
Engineering	Highway Geometry	Pavement Design	Structural Design
Engineering Economy	Benefit of Highway Improvements	Cost of Vehicle Operation	Benefit of Truck Climbing Lane
Finance	Estimates of Road Revenue	Highway Cost Allocation	Weight Distance Taxes
Legislation	Selection of Highway Routes	Speed Limits and Oversize Vehicle Policy	Permit Policy for Overweight Vehicles
Maintenance	Selecting the Timing of Maintenance	Selection of Maintenance Activities	Design of Maintenance Actions
Operations	Signal Timing	Development of Control Strategies	Designation of Truck Routes
Planning	Location and Design of Highway Systems	Forecasts of Travel by Vehicle Type	Resurfacing Forecasts
Environmental Analysis	Air Quality Analysis	Forecasts of Emissions By Type of Vehicle	Noise Studies, NOX Emissions
Safety	Design of Traffic Control Systems and Accident Rates	Safety Conflicts Due to Vehicle Mix and Accident Rates	Posting of Bridges for Load Limits
Statistics	Average Daily Traffic	Travel by Vehicle Type	Weight Distance Traveled
Private Sector	Location of Service Areas	Marketing Keyed to Particular Vehicle Types	Trends in Freight Movement
Application of Traffic Characteristics			
Component of Road development	Traffic Counting	Vehicle Classification	Truck Weighing
		Vehicle Types	Movement

Collection of data is only useful if those data are processed and the resulting summary statistics are made readily available to users. Users require access to these traffic data in a variety of forms, including summary statistics and raw data collected from the field. Meeting user needs is further complicated by the fact that, many data users may not be familiar with the available data resources.

Developing a mechanism that users can access to learn about data available, and how those data can be obtained, are key components for getting users to take advantage of data already collected by the highway agency. It is also equally important to revise and recommend "field data collection sheet" applicable for all road categories and to be used by all state agencies for consistency in data. The new "Field Data Collection Sheet" should include more vehicle type as follows:

Ongoing Practice on Vehicle Type	Proposed Vehicle Type	Vehicle Category	Brief Description
Motor Cycles and Scooters	Sc/Mc	Passenger Motorised	All motorized two wheelers eg. Scooters/motor cycles/mopeds with or without sidecar.
Cars, Jeeps, Vans, Three Wheelers	Auto Rickshaw/Chakada	Passenger Motorised	All motorized three-wheelers (3-seaters or 6-seaters) including country made Chakada carrying primarily passengers or sometimes goods.
	Car/Jeep (Old Tech.)	Passenger Motorised	Passenger carrying four-wheelers (up to 8/10 seaters) equipped with old technology ignition and fuel injection system. Examples: Ambassador, Fiat, Mahindra Jeeps etc.
	Car/Jeep (New Tech.)	Passenger Motorised	Passenger carrying four-wheelers (up to 8/10 seaters) with new technology ignition and fuel injection system. Examples: All Maruti/Hyundai/ Ford/Toyota/TATA/Daewoo products, Palio, Scorpio etc.
Buses	Mini Bus	Passenger Motorised	Passenger carrying four/six-wheelers (up to 25 seaters) mini buses built on TATA-407/607 chassis or other products such as Swaraj Majda, Eicher etc.
	Std. Bus	Passenger Motorised	Passenger carrying six-wheelers (from 26 to 60 seaters or more) big buses built on TATA or Ashok Leyland chassis or other products such as Volvo etc.
Trucks	Light Commercial Vehicle (LCV)	Goods Motorised	Goods carrying four/six-wheelers (up to 5 tonne capacity) small/mini trucks built on TATA-407/607 chassis or other products such as Swaraj Majda, Eicher etc including pick-up vans (light delivery vehicles).
	2-Axle Truck	Goods Motorised	Goods carrying six-wheelers (up to 9 tonne capacity) big trucks built on TATA or Ashok Leyland chassis. Rear axle normally has four wheels, two on each side.
	3-Axle Truck	Goods Motorised	Goods carrying ten-wheelers (up to 13 tonne capacity) big trucks with tandem axle or semi articulated typically built on TATA make chassis or other products such as Volvo. These trucks shall have three axles in total. The rear two axles normally have four wheels on each axle, two on each side.
	M-Axle Truck	Goods Motorised	Goods carrying truck trailers with more than three axles or more than ten-wheels (up to 60 tonne capacity) articulated typically built on TATA make chasis or other products such as Volvo.
Not defined	Tractor With Trailer	Goods Motorised	Tractors used for agricultural purposes from any manufacturing companies such as Mahindra, Ford, Eicher, Massy etc with trailer(s) for transportation of agricultural products or any other goods.
	Tractor without Trailer	Goods Motorised	Tractors used for agricultural purposes without trailer from any manufacturing companies such as Mahindra, Ford, Eicher, Massy etc.
Cycles	Cycle	Passenger Non Motorised	Non-motorised two wheelers operated with pedals used for self-transport.
Not defined	Cycle Rickshaw	Passenger Non Motorised	Non-motorised three-wheeler operated with pedals used for passenger transport. With a bit change in body are also used for goods transport.
Animal Drawn	Animal Drawn	Non Motorised	Non-motorised vehicles driven by animal(s) such as bullock(s), Horse(s), Camel, and Buffalow(s) etc.
Others	Others (pl. specify)	Motorised/Non-Motorised	Any other vehicle type not covered above. Typically construction vehicles or country-made customized vehicle for specific purpose. Mention local name of these vehicle type.

These "data discovery" mechanisms are becoming more "user friendly" based on computer systems. Each highway agency should use a fully computerized system to maintain its traffic monitoring data. This system should download data from the field (Collected either manually or through Automatic traffic counters (ATC'S), perform the necessary quality assurance checks to ensure that the data are valid, allow the data to be edited as necessary to remove invalid data, summarize data as appropriate, store data, report summary statistics, and allow easy retrieval.
Many highway agencies link their traffic databases to other agency databases through geographic information systems (GIS) and other relational tools. GIS systems are particularly effective means for helping users identify and obtain available traffic information. New Internet technologies that allow remote access to GIS based traffic databases offer even wider distribution of collected traffic data, and can significantly increase the use and utility of traffic data collected by the highway agency. These tools allow users to determine the availability of traffic statistics and then access those data via simple interfaces. In addition, CD-ROM based data distribution systems allows users to obtain traffic statistics without having to have web access.

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