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Transportation Information Assets and Impacts

An Assessment of Needs

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Data and the information produced from data are key assets of transportation systems because of the roles they play in support of decision-making: problem identification, design of options, and priority setting. This paper presents an assessment of transportation information needs as viewed by professionals active in the work of the Transportation Research Board (TRB) and by selected policy makers.

The effort began in support of the congressional mandate in the current surface transportation authorization act, the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), directing the U.S. Department of Transportation (USDOT) to sponsor a comprehensive transportation information needs assessment (TINA). Our intent was to contribute to the identification of information needs, but as the TINA study remained unfunded, our perspective broadened to develop an understanding of the role of data and information in transportation planning and management. The work is based on a survey of TRB committee members to identify data needs and examples of productive applications of data and information in transportation decision making. This was followed by interviews with a small number of decision makers to develop a better understanding of the attributes of information that are most useful in the policy process.

The paper begins with a description of the relationship between data, as the raw material, and information as the processed, useful product supporting decisions. It summarizes data needs as identified by members of TRB technical committees. The value of information in specific decisions is illustrated with a series of real examples and further elucidated through the results of decision maker interviews. Finally, an ongoing process is outlined to help ensure that transportation information needs are met.

The results of this effort emphasize the importance of understanding decision-maker needs in the development of data and analysis programs; underscore the value of national transportation databases; remind us that, like any asset, data require investment of resources to produce a return of value; illustrate the efficiencies of sharing data across regions and agencies; and stress the importance of the timely availability of data to support decisions.

INFORMATION AS AN ASSET FOR TRANSPORTATION DECISION MAKING

The U.S. transportation system is a large, complex, multicomponent, multiplayer collection of interacting elements and subsystems. This system plays a critical role in our society and economy, providing accessibility (and thus value) to places and mobility to people and goods. Decisions about development and operation of the transportation system are of central importance to our leadership at all levels, in both government and the private sector. Among the key values of national concern directly linked to the condition and performance of the transportation system are

- Accessibility to opportunities,
- Efficient movement of people and goods,
- Environment and health,
- Strength and competitiveness of the economy,
- Availability and cost of energy,
- Safety and security, and
- Public and private finance.

Ensuring these values is complicated by the fact that no single individual or entity manages the entire transportation system in the traditional sense; instead, many people manage interacting components. For example, a truck driver manages the progress of her vehicle along the road, at the direction of the trucking company, but her trip will be affected by the operational management of the road network, which is the responsibility of a regional traffic management center. The driver or trucking company may also have the option of paying a toll to save travel time on a free-flowing route. Investments in the road that determine its capacity and condition may be in the hands of the city, county, or state DOT, and in some cases private sector infrastructure operators. The USDOT, through FHWA, sets investment policies and design standards and allocates money to achieve certain national objectives through that roadway. The manager of a parallel railroad may give or take business from the trucking company based on his own operating and marketing decisions, as well as those of any and all of the other managers.

Valid, comprehensive, and timely information is an important resource for planning, implementing, managing, and maintaining an increasingly multimodal transportation system, its operation, and its interrelationships with the economy, our society, and the environment. Transportation managers across this system use a variety of types of information to guide their decisions, some formally and comprehensively, and others casually and selectively. Information types and applications include

- Information about challenges and problems warranting action: descriptions of condition, performance—now or in the future—important for defining or clarifying problems and setting the agenda for action.
- Information about alternative courses of actions or options: what can be done in response to the challenges? What options are infeasible or unacceptable?
- Information about available resources and restrictions on their use.
- Information about outcomes: what will happen—and to whom—if a particular option is selected?

Information can guide priority setting and resource allocation. It can sharpen the discussion, contribute to conflict resolution, and facilitate stakeholder involvement; and it can help establish accountability for actions. Information derives from data describing system characteristics, condition, operations, and capabilities, as well as characteristics of the economy, environment and society. Data are the raw material which, when appropriately processed—analyzed, organized, modeled, and depicted—is converted to information that is directly useful in system management and decision making.

From this perspective, transportation data are assets of the transportation system, as are bridges, pavements, railroad cars, and runways. An asset is an element of value, and clearly data have value in guiding planning, design, construction, operation, and maintenance of transportation systems.

As Figure 1 suggests, data and information contribute to transportation decisions, but they may not determine the decision; data inform us about problems, options, and outcomes, but transportation decisions are also influenced by values, opinions, and biases, which may or may not be informed by data.

Of course, decisions can and are made with poor information, or even with no information at all, but logic and experience suggest that responsive, accurate, and timely information is important for sustained, effective, and efficient decision making. Providing such information is what transportation planning is about, and its contributions to decision processes are substantially driven by data. Arguably, more useful information (from the perspective of the decision makers), founded on better data, will contribute to informed choice—decisions made with awareness of real problems, relevant options, and the outcomes expected from those options.

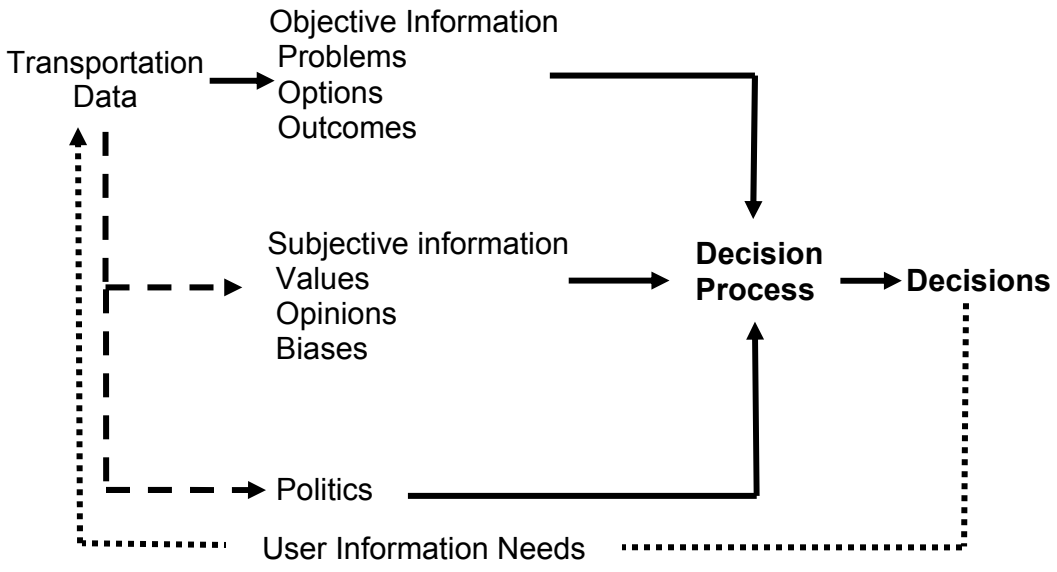

FIGURE 1 Data and decision making.

OBJECTIVES AND APPROACH

Ensuring the availability of the data necessary to support transportation decisions, like every other asset of the system, requires resources—money and time, as well as planning. That planning requires an understanding of information needs and current data resources. The gaps between needs and resources define targets for improving the quality and availability of transportation data.

The U.S. Congress recognized the importance of information for transportation decision making in the current surface transportation authorization act, SAFETEA-LU, which directs USDOT to contract with the National Research Council to conduct a comprehensive transportation information needs assessment. The effort behind this paper was initiated to help define these information needs, but our perspective has expanded to develop an understanding of the role of data and information in transportation planning and management, and to establish and implement an ongoing process to monitor and assess data needs in this field.

Toward that broader end, we designed a process to tap the considerable knowledge and experience of TRB's standing committees. This began at the 85th Annual Meeting of TRB in 2006, where the committees were invited to discuss unmet or poorly met transportation information needs. In the spring of 2006, 144 TRB committees and their members, representing all modes and all 11 Technical Activity Groups, were invited to use a dedicated web site through which they offered over 650 transportation information needs. The information needs cited ranged from very specific data elements or classes of elements to ideas for analyzing, archiving, and communicating information and findings from data analyses.

The set of needs was reviewed separately by the authors and each developed a classification scheme to encompass the responses and convey them in an understandable structure. The taxonomies developed by individual authors were then merged to form a unified framework into which all expressed needs could fit.

An overview of these results, and the data needs framework described below, were presented to a workshop with more than 40 TRB committee chairs at the TRB Summer Conference in July 2006. The discussion at this workshop led to some revisions of the framework, and stronger insights into the value of, and deficiencies in, data assets for transportation decision making. The workshop also motivated the investigation of the perceptions of policy makers of the value and limitations of transportation data.

The TRB source groups (*1*) for the responses, and the number of data needs cited for each group, are shown in Table 1. All TRB groups are represented, with responses coming from 61% of the committees. Responses were more concentrated in some of the nonmodal, cross-cutting groups focused on policy, planning, and operations. These groups may be more oriented toward decision making, in general, and the use of information for decision support.

Data needs as identified by TRB committee members offer an assessment of the current quality and availability of transportation data as defined by key transportation professionals. The framework and the suggested transportation data needs presented in the next section are intended to foster further discussion about these needs and the priorities and means for addressing them. These results may also provide a basis for periodic reviews of transportation data needs to assess progress and to keep data priorities salient.

TABLE 1 TRB Group Sources and Numbers of Cited Data Needs

Technical Activities Division	Number of Committees Responding	Number of Committees in Group	Number of Needs Cited
Policy and Organization Group	24	34	137
Planning and Environment Group	25	31	116
Design and Construction Group	31	70	118
Operations and Maintenance Group	26	27	144
Legal Resources Group	1	7	0
System Users Group	12	19	33
Public Transportation Group	9	17	27
Rail Group	3	7	16
Freight Systems Group	9	12	43
Aviation Group	3	8	13
Marine Group	1	3	3
Total	144	235	650

Framework for Transportation Data Needs

The transportation data needs framework includes data and non-data categories, and further divides the data needs by subject and geographic level, separating needs into local–regional or national data elements about physical or operational aspects of transportation. The structure differs from traditional information groupings in at least one important way—it does not separate the information needs by mode. This approach allows common data elements to be identified regardless of the current transportation patterns.

While this framework is not the only way to organize these needs, it is logical from the perspective of data types and levels, and, because of its source, it connects the information needs with the TRB committee and program structures, and thus it reflects the concerns of key technical data providers and consumers.

The framework for transportation data needs is shown as Table 2. TRB committee respondents emphasized the need to fill in missing data, to ensure availability of timely data, and to have data and analytical techniques that produce information in sufficient detail to understand key patterns and support planning and decision making.

This classification organizes data needs according to these dimensions:

- *National and local or regional:* Although the initial focus of the effort was on national information needs, responses included needs at all levels of analysis. Of course there were clear distinctions between national and local information needs, both in terms of the level of detail and the locus of responsibility for data collection and dissemination. For example, origin–destination (O-D) flows and link volume data needs exist at both levels, but the level of detail, and sometimes the methods for data collection, are different. However, data collected at one level are often useful useful in analysis and decision support at other geographic levels.

TABLE 2 Transportation Data Needs Framework

Type	Information Need Subject	National		Regional or Local	
		Physical	**Operational**	**Physical**	**Operational**
Data Items	System inventory, land use, travel and flows: quantity, type and location	Miles of road, rail, routes	Persons, freight, O-D flows, volumes	Miles of road, rail, routes	Persons, freight, O-D flows, volumes
	Infrastructure and facility condition (status and trends)	Pavement or facility condition		Pavement or facility condition	
	Performance, service quality, cost and safety: how well are systems operating and serving travelers and shippers		Performance of systems; user service quality		Performance of systems; user service quality
	Externalities due to transportation investments and operations			Pollution emissions, land use, social impacts	
Procedures and tools	Data collection tools; analysis, synthesis, estimating, and forecasting techniques, metadata				
Data access	Formatting, archiving, access, and dissemination procedures for data and methods				
Programs and practices	Funding programs, agency activities, and best practices				

Note: Examples of data and information needs are shown in italics; these are not all of the data elements in any category. (O-D = origin–destination.)

Projects that are deployed in relatively few locations, such as managed lanes or high-occupancy toll (HOT) lanes, and archives of real-time travel time data, present the need for regional or local information, but as other cities consider similar programs and projects, data may be borrowed and used for guidance. Data from numerous locations may, in turn, guide the evolution of national policy, and thus even local data may have national value. Traditional large-scale surveys such as the American Community Survey (ACS), the National Household Travel Survey (NHTS) or the Commodity Flow Survey (CFS) were identified by respondents as common elements of the national data resource.

- *Physical or operational:* Data needs can also be characterized as measuring either physical condition or operational characteristics. The needs for pavement and bridge condition information called for more detailed construction and inspection data. Operations elements included more information about the operating strategies, signal timing plans, and resulting performance measures. There are also significant needs for linking the data on physical and operational measures to identify the causes and outcomes of transportation and land use actions.

- *Inventory:* Inventory components include physical assets and measures of operations—miles or ton-miles of travel. Inventory data answers questions about quantity, type, and location of assets and activities.
- *Condition and performance:* The condition information label was tied to physical aspects and the performance label was applied to operational aspects. Most of the suggestions fell in one of these categories, which are more likely to represent results of data analyses rather than primary data items. An important trend, however, is that some advanced programs are collecting condition or performance information directly and automatically.
- *Externalities:* Data on externalities describe the consequential impacts of the construction and operations of transportation systems. These largely occur at the local or regional level, but they are relevant to national programs and policies.
- *Procedures:* Processing primary data to make it useful in planning and management requires a range of analytical tools, collecting, forecasting, and estimating techniques and a variety of data and data quality descriptions. Procedure suggestions went beyond data analysis items to include methods for improving planning and management of transportation systems and services. While these are not primary data needs with a specific audience or use, these techniques can be essential for turning data into useful transportation management information. Identified needs also included more efficient and effective data collection methods that ensure the required data are available at an acceptable cost.
- *Data access:* Several respondents from all areas of TRB mentioned that a significant amount of useful data exists, but it is either not readily available or not properly referenced or documented. Data partnerships, as well as improvements in the access to libraries, databases and geographically referenced information, were suggested as solutions. Respondents also cited the importance of ready access to data—archiving in usable and standard formats, providing easy, web-based data access, sharing of data across jurisdictions and agencies, and maintaining long-term trend data sets. Some of the most creative ideas offered by the respondents for enhancing the usefulness of existing data were included in this need area.

Interpretation of Reported Data Needs

Most of the framework cells shown in Table 2 included between 35 and 80 data needs. The suggested needs were quite rich, for example, encompassing the decision-making needs for inter-regional commodity flows, personal travel by different socioeconomic groups and genders, and characteristics of tribal travel and infrastructure. At the local and regional levels, gaps in timely data about location and land use were noted. Some of the general ideas offered in the survey are summarized below.

- Local and regional data needs were similar in nature but different in scope from national data needs. Local freight movement patterns and volumes, for example, differ from interstate traffic, sometimes in commodity types, modes, quantities, and perhaps in data collection methods. Generally more detail is required to support local and regional decision making. Some respondents concerned with local planning felt that there were many gaps in data availability and/or quality at the local and regional levels.
- Respondents emphasized the importance of data quality to provide valid answers to *if–then* support for decisions about operations management and investments. Important data attributes include

  - Timeliness (recent data),
  - Availability (data that are reliably available; routinely collected as a part of ongoing data programs, not only data from special studies), and
  - Coverage and detail (e.g., broader coverage of commodity types, condition, and performance of lower level roadways).

- Repeated calls were made to continue to collect and improve data on travel patterns and demographics in the NHTS and the ACS, which are important inputs to regional planning in many regions. These surveys provide default values for forecasting model parameters in some regions and baseline trends against which to benchmark current system performance and predictions; they are irreplaceable sources of general relationships between demographic characteristics, individual attributes, and travel patterns.
- Similarly, there is strong interest in expanding coverage and increasing the detail on the CFS, which is a primary data source for much of the freight planning in regions and Interstate corridors.
- The implied demand for programmatic data—regularly collected and disseminated data products that can be accessed off the shelf when a problem arises—is a consistent message conveyed in the data needs cited and some of the examples presented in the next section of this paper. NHTS, CFS, and other national and regional data programs support a variety of decisions and actions, not all of which are foreseen when the data are collected.
- Spatially defined network inventory data were suggested for a variety of applications, ranging from collision patterns to wildlife migration, regional airport access, and network level of service. The uses of these data assets could be at the national, regional, or local levels.
- There was much demand for real-time performance data for many applications, including incident management, traveler information, truck parking availability for freight operations management, network capacity assessment, and roadway and hotel capacity for evacuation management.
- Because transportation system demand and performance are driven by the spatial patterns of activities, some respondents noted the need for timely and comprehensive data on land use, population, and employment, including current characteristics, plans, and forecasts. These data are primarily needed at the local and regional level, but relating demographics, and eventually land use, to national data sources such as the NHTS and CFS may provide a more informed basis for national policy making.
- Data on the physical infrastructure describing material composition, construction conditions, and costs of construction, would be useful not only for system management but also for identifying typical and best practices.
- Better, more detailed data on crash rates and characteristics are important for safety management. This includes more specific information on crashes, and coverage of small crashes on minor roadways, which may foretell larger problems in the future.
- Data describing the outcomes of both infrastructure investment and policy changes (e.g., pricing, demand management) on travel and shipment patterns, location, and the associated social and environmental consequences were desired to support the search for and choice of future transportation actions.
- Data on traveler perceptions of system performance and options, including stated preference survey results, are desired both for responding to citizen (customer) concerns and predicting future behaviors.

- Many respondents called for actions to enhance data access, i.e., where useful data exist but are not made available, or access is difficult, the quality of decisions may be unnecessarily constrained. Access issues involve compatible formats and archiving valuable data, as well as reasonable access to private and first responder data.
- Respondents identified procedures and analysis tools as an important need. These include improved models of personal and freight travel and emissions; and methods for setting pavement and bridge investment priorities, transportation facility design, environmental justice analyses, and allocation of both human and physical resources.
- Respondents were also interested in descriptions of best practices—what the practice leaders are doing, how problems have been solved by others, and availability and requirements of government programs.
- Many needs statements were focused on data relationships, not raw data items, e.g., safety effects of control devices, true costs of HOT lanes. It is both necessary and common to link data items to support decisions and answer policy questions. For example, locations, flows, and people or commodity characteristics are often linked to provide information for defining problems and evaluating options. While professionals within TRB can talk about raw data needs in a narrow sense, most users are engaged in supporting decision processes with information—processed data—where the processing normally involves merging and analyzing several different types of data. Integrating data sets in this way requires not only data availability, but also compatibility in terms of aggregation, spatial identification, as well as documentation to support merging and analysis tasks.

EXAMPLES OF DATA AS A TRANSPORTATION ASSET: PROFESSIONAL VIEWS

Ensuring the future of our transportation systems requires that we secure the data assets needed to make good decisions about investments and operations. That data, and access to it, requires resources. While it is tempting for decision makers to direct all available resources into facility investments and operations, without a strong basis in data, doing so may put the quality of transportation decisions at risk. Thus, it is important to convey the value of data for transportation decisions and to show how that data enhances the knowledge base of decision makers—those who allocate resources.

To gain a better understanding of data as an asset for transportation decision making, we asked the TRB committee chairs attending the July 2006 meeting, and others, to provide actual, illustrative cases where data made a difference in a decision by facilitating a better, easier, or more informed choice. A few of the responses are described briefly below.

Local Transit Subsidy Decision

- *Decision or action:* Decision by local jurisdiction to continue and enhance support for a part of the regional bus service.
- *Context:* In the Burlington, Vermont, region, the local transit provider, Chittenden County Transportation Authority (CCTA), had obtained temporary funding from the municipality of Williston, a fast-growing suburban town with significant employment growth and a major retail center, to expand fixed-route bus service to the center of town and provide connections to key activity centers in the region. The town was reluctant to continue this support

because it placed another demand on property tax revenues, and the conventional wisdom was that "no one will ride a bus" in such an auto-oriented environment. Therefore, the funding agreement had a sunset date and continuing support required deliberate action by the town Selectboard. Tracking and informing decision makers and the public about the actual level of transit ridership would be essential for the Selectboard to decide whether to continue support for the service.

- *Data sources:* The data source was CCTA's own ridership data, collected daily onboard its vehicles and compiled into monthly reports.
- *Analysis and presentation tools:* Ridership trend data was presented in both tabular and graphic forms to elected officials on a regular basis, as well as to the public as part of comprehensive transportation studies. CCTA used the data to demonstrate steady increases in bus usage over approximately 2 years.
- *How data made a difference:* When continued funding for bus service support was requested, the town Selectboard voted to maintain the service based largely on the evidence of steady and growing demand as documented in the data collected by CCTA.

Local Traffic Planning Decision

- *Decision or action:* Rerouting evening peak period traffic entering the Lincoln Tunnel in midtown Manhattan.
- *Context:* Merging conflicts along the short expressway accessing the Lincoln Tunnel created significant congestion and delays. In response, the Port Authority of New York and New Jersey, in cooperation with New York City DOT and New York City Police Department, identified a number of strategies to increase the efficiency of the traffic flow, including closing selected entrances to reduce merging conflicts, organizing flows into specific travel lanes, and re-routing buses to the north tube to reserve the center tube for autos. The plan was controversial, it was implemented on an experimental basis, and considerable effort was required to build and maintain support from decision makers and the public.
- *Data sources:* Traffic counts and travel time studies were conducted on both the tunnel access and adjacent streets. Bus access times from the Port Authority Bus Terminal were measured. Data were collected using existing traffic monitoring systems as well as special, manual measurements. Data were collected before the changes to guide planning, and during the first few weeks of implementation to support assessment of, and build support for, the changes in traffic patterns.
- *Analysis and presentation tools:* Despite a comprehensive communication program to announce the new traffic patterns, delays increased at the outset as drivers learned the new routes, and because of rain and downstream traffic incidents. This eroded public and official support for the plan. By providing daily reports of traffic throughput by hour to illustrate how the plan was working and where it broke down, support for the plan was restored. Reports included before and after comparisons of travel times, delays and throughput, as well as photos to illustrate changes in traffic conditions.
- *How data made a difference:* Current data was critical for sustaining the heavily questioned program during its difficult first few days. Without a strong, data-based argument at the outset, the program might have been terminated. Over time, the data provided an objective basis for enforcement changes and minor access refinements. Presentations to elected officials,

community groups, transportation operators and decision makers helped make the program permanent.

Pedestrian Safety Action Program

- *Decision or action:* Reducing pedestrian fatalities and injuries in the Miami–Dade County, Florida, area.
- *Context:* Pedestrian crashes are a serious problem in U.S. cities. The risks in the Miami–Dade area were particularly challenging, not only because of the number of crashes—over 1,700 per year—but also because the racial, ethnic, and age diversity in the region made intervention more problematic. The problem was recognized by local officials, and the NHTSA selected this setting to apply and test an aggressive, data-intensive approach to pedestrian crash reduction based on extensive NHTSA and FHWA research projects. The effort was led by the Highway Safety Research Center at the University of North Carolina at Chapel Hill, and was supported by the Florida DOT (FDOT) and Miami–Dade County, as well as NHTSA.
- *Data sources:* Pedestrian crash records for the area were already available, and the research team geocoded individual records to build a 9-year spatial database to provide support for locally targeted interventions. Crash types were recoded at a highly detailed level (using over 100 categories) and racial and ethnic classifications of pedestrians were extracted from original police crash reports. The existence and availability of the original crash records were essential to the success of this effort, and substantial value was added by enhancing this database by geocoding and refinement of crash and demographic information.
- *Analysis and presentation tools:* Data were used to identify problems and their variations across the study area, particularly the differences in patterns across ethnic and age groups. On the basis of these more detailed problem definitions, a repertoire of interventions was defined and matched to crash types, locations and pedestrian–driver demographics. The interventions included educational programs (e.g., brochures, public service announcements, classroom training); enforcement (especially targeted at night time driving under the influence crashes); and infrastructure enhancements (safety medians, signals, cross walks). Data collection was continued for 2 years after program implementation to support before-and-after assessment of the cost effectiveness of the overall program.
- *How data made a difference:* The development of detailed, spatial data on crashes, crash types, and demographic characteristics of victims, supported a sharply focused pedestrian safety program:
  - Location and demographic-specific crash patterns were identified;
  - The most appropriate interventions were matched to each class of crash problem; and
  - Target markets were defined to permit programs to be tailored by language, content, medium, and distribution channel.

The before-and-after evaluation results are not yet available, but the effort attracted support from participating agencies, the interventions were implemented, and FDOT has extended the approach to other locations in the state. The program illustrates the value of specific, detailed data for targeting problems and finely tuning interventions. It was based on a substantial effort to enhance existing data. Future applications would benefit from the collection of more detailed and precise data at the outset to reduce or eliminate the need for extensive,

after-the-fact database preparation. In particular, detailed crash type and accurate location and demographic coding would add value to existing crash data. Routine collection and archiving of crash data on roads not included in the state road network would provide a more complete picture of crash risks.

Freight Rerouting Decision in Response to Bridge Collapse

- *Decision or action:* Planned rerouting of trucks around collapsed Interstate highway bridge.
- *Context:* In May 2002 the bridge carrying Interstate 40 across the Arkansas River near Webbers Falls, Oklahoma, collapsed when struck by a barge. I-40 is a major east–west route across the central United States, carrying substantial truck volumes.
- *Data sources:* Data from the CFS was analyzed to determine freight O-D patterns in the I-40 corridor. Results indicated that more than two-thirds of the affected truck tonnage had neither origin nor destination within Oklahoma. This suggested the viability of a larger scale diversion scheme.
- *How data made a difference:* Available, objective data on truck freight flows supported rapid development of plans to divert trucks to alternate corridors during the 2-month period while the bridge was being rebuilt.

State Asset Management Budgeting Decision

- *Decision or action:* Budgeting for bridge rehabilitation in Massachusetts. The objectives of the highway department are to reduce the number of structurally deficient bridges in the state and to determine the appropriate allocation of funds between reducing the inventory of deficient bridges and preventing other bridges from becoming deficient.
- *Context:* As a result of the governor's "fix it first" initiative, the highway department needed to develop a bridge rehabilitation budget as part of its programming and budgeting process.
- *Data sources:* The primary data source was the bridge inventory and inspection database supporting the department's bridge condition assessment and FHWA's National Bridge Inventory reporting requirements.
- *Analysis and presentation tool:* The primary analysis tool was the Pontis bridge management system (*2*), supported by comparisons to other approaches used by the department to identify and prioritize bridge rehabilitation or replacement projects.
- *How data made a difference:* The result of the analysis and bridge inventory and condition data was to increase the budget substantially and to balance the replacement or rehabilitation of existing structurally deficient bridges with other preservation projects aimed at preventing additional bridges from deteriorating to a deficient condition.

Statewide Project Programming Process

- *Decision or action:* Identification and prioritization of unscheduled transportation projects.
- *Context:* Ongoing joint effort of state and local agencies (metropolitan planning organizations) across Kentucky.

- *Data sources:* Roadway adequacy ratings, based on the critical crash rate, pavement roughness index, traffic volume (mobility); present and projected average daily traffic; existing conditions, including access control, right-of-way width, roadway geometrics and structures; transportation need statement, project description, regional transportation goals addressed; human and natural environmental impacts (water, air, endangered species, historic or archeological sites); economic impacts, multimodal opportunities, cost estimate, project prioritization history (local, regional, and highway district).
- *Analysis and presentation tools:* Data are assembled in project identification forms, which are integral to the biannual project prioritization process conducted across the state at the local, regional, and district highway office levels. Each project is assigned a low, medium, or high priority and the top 10 unscheduled projects are selected for each region and highway district.
- *How data made a difference:* This process provides local and state transportation decision makers a data-driven foundation for transportation planning which feeds into the process for selecting projects to be scheduled and funded in the state 6-year plan.

Statewide Grade-Crossing Protection Programming

- *Decision or action:* Prioritize and allocate resources for improving highway–rail grade crossings.
- *Context:* Statewide in Illinois.
- *Data sources:* FRA inventory of highway–rail crossings, including characteristics of the crossing and the rail and motor vehicle traffic.
- *Analysis and presentation tools:* The primary tool is a resource allocation method based on a regression model that predicts the number of collisions expected to occur annually.
- *How data made a difference:* The model output is a significant factor in guiding annual grade crossing investments. The output is balanced by the need to have a geographically and politically distributed investment program, so the collision prediction value is only one of several factors considered. Availability of the federal crossing inventory, the only national database of crossings and structures, is important to objectivity of the information, although the data quality is inconsistent.

National Policy Decision on Congestion Pricing

- *Decision or action:* Acceptance of HOT lanes by political leaders, specifically, incorporation of congestion pricing as a major component of the USDOT National Strategy to Reduce Congestion.
- *Context:* Decision makers included Congress, during development of SAFETEA-LU, and the Secretary of Transportation, in early 2006. Resistance to promoting a road pricing strategy was based on concerns about equity and the impacts on low-income travelers, and on doubts that pricing would actually reduce congestion.
- *Data sources:* Outcome data from California State Route 91 Value Priced Express Lanes and I-15 HOT lane described use and acceptance of HOT lanes by low-income individuals, and quantified vehicle throughput and speed on express lanes versus adjacent (free) general purpose lanes. This was supplemented with national data on consumption of gasoline and

purchase of motor vehicles by income class, and household travel data from the NHTS, which tabulated commuting behavior by income group.

- *How data made a difference:* Political leaders were convinced that HOT lanes can reduce congestion, unlike other strategies, which only reduce the rate of growth of congestion, and that low-income individuals would not be adversely affected. In general, peak highway travelers are mainly from middle- and upper-income households, with less than 5% classified as poor. Road pricing, even without compensating transfers, does not appear to be regressive, absolutely or in comparison to alternative methods for funding peak capacity (e.g., fuel excise taxes).

Allocating Motor Carrier Safety Inspection Resources

- *Decision or action:* Identifying and prioritizing high-risk motor carriers for roadside inspections and on-site safety compliance reviews.
- *Context:* The Federal Motor Carrier Safety Administration (FMCSA) promotes truck safety through inspection and regulatory compliance monitoring. Limited inspection resources must be deployed efficiently.
- *Data sources:* SafeStat (Safety Status Measurement System) is an automated analysis system developed at the Volpe National Transportation Systems Center for the FMCSA. It combines current and historical safety performance data to measure the relative safety fitness of interstate commercial motor carriers.

SafeStat measures a motor carrier's safety performance and compliance with safety regulations and evaluates its relative safety with respect to the rest of the motor carrier population in four Safety Evaluation Areas (SEAs): accident, driver, vehicle, and safety management. It uses up to 30 months of motor carrier safety performance, compliance and normalizing data to develop measures in the four SEAs, which are combined into an overall safety status assessment score. SafeStat requires complete and accurate data from state crash reporting, roadside inspections, compliance reviews, and enforcement cases.

- *How data made a difference:* SafeStat has been implemented nationally to enable the FMCSA to quantify and monitor the safety status of motor carriers, guide deployment of resources toward carriers posing the greatest safety risk, select motor carriers for on-site safety compliance reviews, and recommend to roadside inspectors both drivers and vehicles for inspection based on the safety status of the responsible motor carrier.

What the Examples Indicate

These examples suggest the usefulness of data in transportation decision making at the local, state and national levels from the perspective of transportation professionals. Several types of data were judged to be of value in these cases:

- Locally collected data assessing specific policy actions is used to inform decisions by showing program effectiveness. In the case of Burlington, Vermont, local data informed a local decision. Near real-time local traffic data collected in support of the Lincoln Tunnel access improvement not only provided a basis for operations planning, but also demonstrated the effectiveness of the plan in the face of opposition due to startup problems. In the case of the national policy on road pricing, outcome data from California field experiments was used to

guide federal strategy. Data borrowing is both a common and relatively invisible indication of the broader value that local data assets may have. The use of borrowed or transferred data relies on

- Original collection of potentially valuable data;
- Archiving and documentation of data; and
- Making data known and available for others to use. It is a form of data partnering that leverages data collected at many levels for broad and economical use.

- Data on local project and program implementation (California road pricing, Vermont transit subsidies) can also be useful to other government entities by illustrating best, or at least feasible, practices.
- The FMCSA SafeStat inspection deployment program relies on locally collected data. Here a federal program depends on data collected at the state level. Such data partnering is efficient, but in this application and the example of the FRA grade crossing database, the usefulness of the national database was limited by the quality and coverage of the local data collection efforts. This implies a role for the federal government in facilitating standard setting and quality control for data collection.
- Local and statewide system condition and utilization data is used to guide budgeting and resource allocation at those levels. This is illustrated in the examples of the Massachusetts bridge management, Kentucky project scheduling, and Illinois grade crossing decisions. Clearly such decisions warrant local inventory and condition data, collected on an ongoing basis, since the decisions are made at regular intervals. Such data can also be useful in guiding national policy on transportation budgets and priorities.
- National data resources used to support decisions at all levels of analysis. In the case of rerouting I-40 truck traffic, the availability of commodity flow data by mode in the CFS provided a unique, objective basis for supporting a short-term, regional operations decision. In the Illinois grade crossing example, the ready availability of the (national) FRA database offered a rational foundation for local resource allocation. In the case of the U.S. road pricing policy, national travel (NHTS) and consumption data helped sort out the equity implications of congestion pricing. Existence of nationally maintained data fills gaps in local and statewide decision support, provides a national perspective on system characteristics, condition, and use, and allows lower-level governments to benchmark against each other.

Not surprisingly, these examples show that data assets are shared across levels of analysis and across the nation. This reflects both gaps in available and responsive data, as well as creative application of data and knowledge gained in one setting to other decision contexts. These shared uses of data suggest that the value of some data assets go beyond, sometimes far beyond, the usefulness to the agency that gathers them. While the taxonomy presented in Table 1 differentiates between local–regional and national data, these examples show that local data can have national value (in addition to the interest that federal policy makers have in ensuring effective local decisions), and national data clearly can bring value to local transportation decisions.

The value of programmatic (regularly collected) data is re-emphasized in these examples. Analysts and decision makers tend to use the most readily available data. New data are sometimes collected for special projects, those that are very large or very small, or projects where no other data source can substitute (e.g., the Vermont transit subsidies and the Lincoln Tunnel). Yet special, project-specific data collection efforts are less common, probably because

of the pressure to make timely decisions. Thus, available data—collected under a national program (NHTS, CFS, Vehicle Inventory and Use Survey, FRA, FMCSA) are commonly utilized. Creative analysts stretch data applications by using old data (e.g., 10-year old Census or NHTS data) or distant data (European applications of road pricing and advanced telematics for traffic flow management) to support decisions about current problems. The key programmatic data sources seem at once critically important and undervalued.

Finally, it is important to guide data collection programs with an understanding of the end use of the information produced, e.g., problem identification and decision making (represented by the dotted line in Figure 1). For example, the use of crash data to guide the pedestrian crash reduction program in Miami–Dade County would have been more efficient—and thus more jurisdictions might adopt this approach—if the content, detail, and coverage of the original crash reports supported this application.

THE VALUE OF DATA TO DECISION MAKERS

To understand the information needs of transportation decision makers, structured interviews were conducted with eight senior transportation managers and former managers. These interviews consistently suggested that knowing what decision makers need to support the choice process is of high value. "Know the customer" is a maxim that was consistently revealed. For data collectors and information producers, that means understanding the needs of elected or appointed decision makers and sometimes those of the system users, as well, for they are also important decision makers. Developing this understanding takes time, effort, observation, and interpretation.

Data do not drive out politics from decision making, but they can be a powerful tool that can level the playing field, sometimes overcoming political pressures, e.g., earmarking. Data make it harder for people to maintain myths. But better data do not guarantee better decisions. Some issues are just too tied up in politics.

Among the kinds of information requested by decision makers, both for defining problems and selecting solutions, were these:

- Infrastructure condition data, sometimes the dominant factor in asset management decision making;
- Demand data (e.g., volumes);
- Performance data (e.g., delay measures);
- Demographic trends; and
- Outcomes of past actions—performance, social and environmental impacts, actual costs. There is considerable interest in results of before-and-after studies (now infrequently done). Decision makers and program planners alike are interested in connecting spending to actual outcomes (e.g., performance or condition improvements), and in ensuring accountability.

Current (recent) data are often more important than forecasts, because they are credible and verifiable sources of information about system condition, performance and problems. Such hard data can have high value because of their certainty, e.g., fresh traffic counts, periodic aerial photographs.

Private sector players have a substantial interest in good data to reduce their risks when partnering with government. They not only scrutinize publicly collected data, but often collect their own data to support high-value decision making. "Owned" data and local data have high value in decision processes. The trend toward more public–private partnerships is creating increased demand for high quality investment grade, data.

Information attributes important to decision makers included these:

- *Timeliness.* Decisions are made at their own pace. If data are available, they may be used. If they are not available, the decision will generally be made anyway.
- *Responsiveness.* Data are processed into information to be provided to decision makers. That processing or analysis must produce information that is meaningful, responding to the problems and issues at hand, to be useful and used. Some decision makers are "data rich and information poor"; data that are not useful are not likely to be used.
- *Clarity (simplicity).* Many decision makers are not technically skilled, and information produced by analysts is commonly used by the general public, as well. Simple information is preferred and more likely to be considered in the decision process. Graphical presentations and "data dashboards" that bring several or many facts together in a single place and support tracking over time have been well-received by decision makers.
- *Perfection or imperfection.* Generally data do not have to be perfect to be useful. In some cases it is not cost effective to improve data quality and, when they are properly informed, decision makers can usually understand and accommodate uncertainty of information.
- *Conciseness.* Decision makers generally want the smallest information package that does the job—informs them about problems (current state of the system), options and likely outcomes. Too much data can confound decision making or cause all data to be ignored.

National databases can be useful for benchmarking and sometimes as a source of parameters for predictive models. However, it is not unusual for decision makers to be unaware that the information they are given has been derived from a national data base such as NHTS, CFS, or Highway Performance Monitoring System. They receive information collected and processed by others and may be unaware, and uninterested in, the link between the original data and the ultimate decision package. Analysts know the progeny of the information they supply, and thus they may be a better source of evidence for the value of data sets, both national and local.

Agencies do invest in data and data quality when it is clear that they have real value in planning and decision making. For example, the Metropolitan Washington Council of Governments Transportation Planning Board assembled its own database on the regional fleet mix to develop a better forecast of vehicle emissions. Similarly, data that are used tend to get better over time because the value of data investments becomes clearer.

Data can have particularly high asset value when it serves as a warehouse for institutional knowledge that would otherwise be lost when professionals do not spent a lifetime in a single position or agency. Data can be the repository of history and a substitute for experience.

Policy makers use technical data in decision processes—when it is available, responsive, and understandable. They can assess and articulate the quality and value of data and information, and thus their perspectives are both important and useful in the design of data programs.

INTEGRATION AND INTERPRETATION

Data and information are assets that have clear and recognized value in the planning and management of transportation systems. The resources required to maintain data programs at all levels and sectors may be more readily secured based on a recognition of the costs and benefits of data to the transportation system. The data needs identified in this effort, and the organizational structure suggested in Table 2, can be used to communicate unmet needs and their importance to managers and policy makers. The examples of data contributions to decisions, and decision maker perspectives on useful information, begin to clarify the value proposition underlying data programs. As this picture is sharpened through continuing, collaborative efforts within and beyond TRB, it should provide a basis for building the support necessary to ensure that data are available to facilitate informed transportation choices at all levels and sectors of decision making.

The data and information needs derived from all of the sources described in this paper suggest a few overarching principles:

- **Data are a transportation asset.** Like materials, energy, and human resources, data are an important asset for planning, building, and operating transportation systems, public and private. Data cost money and can provide commensurate returns on investment. System managers need to plan for and allocate resources to collecting and maintaining databases sufficient in coverage, quantity, and quality to support transportation decision making.
- **Decisions are the product.** The critical use of data and information is to support and improve transportation decision-making. Data have little value if they cannot be understood and acted upon by the ultimate users, decision makers, and their customers, the public. Understanding user needs should be a key element in any data program.
- **Sharing data extends their value.** It is both common and efficient to share data across users. Data collected in one locale can be useful for understanding problems and anticipating outcomes in other settings. National data support local decisions, and local data sometimes guide national policy. Data sharing can be facilitated by archiving, making it freely available, and documenting sources and formats. Data-sharing programs extend the benefits of data collection resources to a broader range of applications. The value of shared data programs is likely to become clearer when the original source of data is explicitly identified.
- **Sustained data programs ensure timely response to decisions.** Decisions proceed with or without information support. There is no substitute for having data "in the bank" when a decision is imminent. This emphasizes the need for carefully focused, ongoing data collection programs at both national and local levels.
- **Technology is changing the picture.** Advances in data collection technologies, including real-time tracking of vehicles and shipments and monitoring infrastructure components, Internet-based survey methods, remote surveillance, video imaging and interpretation, and cellular phone-based data collection, are making it easier to collect more, and more accurate, data about transportation and travel. These innovations can improve decision support, but care is needed to avoid swamping the decision process with data. Concerns about personal and business privacy will also need to be addressed.
- **There are needs beyond data.** Efficient and effective collection of data, and the analysis tasks necessary to convert data to useful information for decision support and

presentation, require appropriate tools and procedures. There is still considerable need for developing, improving, and implementing the most responsive methods and models.

The federal role in transportation has been evolving, with increased reliance on local and regional choices supported by broad federal policies and grant programs. Under these circumstances, it may be appropriate to re-evaluate the need for data and information collection at the national level. Many are making the case that the federal role should emphasize informed decision-making at all levels, investment in a set of national priorities, dissemination of best practices and lessons learned from past investments and policies, and use of flexible funding arrangements. At the same time, local, regional, as well as private transportation improvement decisions will continue to need consistent national datasets and information sources for benchmarking, calibrating travel models, understanding the person and freight flows to and through a region, and learning from experience by evaluating the effect of those improvements.

WHERE DO WE GO NEXT?

There will always be unmet transportation data needs. There will always be competing demands on resources that might be used for data collection and analyses, and as conditions and methods change, new data needs will arise, and new methods for acquiring and disseminating data assets will be developed. To track and support changing data needs and methods, it would be useful for TRB standing committees to devote some attention on an annual basis to the status of data assets within their scope, identifying new data sources, new and unmet data needs, the expected value and costs of meeting those needs, and recommended priorities for enhancing local and national transportation data assets. A similar initiative could be directed to TRB conference organizers. Public agencies, private investors, and professional organizations all have roles to play in reviewing data needs for transportation decision making and supporting appropriate and directed investments in shared transportation data. These actions will keep transportation data asset management in focus at the grass roots level, helping to ensure the availability of the data needed for effective planning and operation of our transportation systems.

NOTES

1. A TRB group consists of committees addressing various related transportation functional components.
2. http://aashtoware.camsys.com/docs/brochure.pdf.

THE NATIONAL ACADEMIES

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