Analysis of Nine European Public Transit Databases: Insights for the Urban Mass Transportation Administration Section 15 Program

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A study of nine European public transit databases is presented and insights into the debate over what to report under the UMTA Section 15 program are provided. The content and usefulness of the databases are compared to identify cases either where Section 15 could be improved or where it provides a valuable standard. These comparisons are used to evaluate the merits of proposals to modify Section 15. This report provides a critical guide to data sources for analysis of international transit performance. Access to these resources has been limited because of language barriers, lack of information on availability, and different definitions of key concepts. The analysis also provides insights into the difficulties of compiling and using comparative transit data. Section 15 includes financial and operating statistics from 438 U.S. urban public transit operators. In its seventh year, Section 15 provides standardized data for policy and management analysis, and for the UMTA Section 9 apportionment formula. In response to recommendations from the UMTA and American Public Transit Association advisory committees, UMTA has begun to overhaul Section 15. In the current debate, collection costs are balanced against the value of data to analysts. Although some recommendations add information, most require deletions. Relative to Section 15, the European databases (a) use similar output and ridership measures, including capacity and passenger miles (both proposed for elimination); (b) use similar expense and revenue structures but with fewer details; (c) distinguish public from private sector involvement less successfully; (d) do not clearly estimate capital costs; and (e) fail to estimate service area population accurately.

This report presents a critical analysis of nine European transit databases and provides insights into the debate in the U.S. transit community over what data should be reported under the Section 15 program of UMTA. This report also is a comprehensive guide to European and U.S. data sources for comparison and analysis of international transit performance. Access to these resources has been restricted by language barriers, lack of information on availability, and different definitions of key concepts.

Criteria to use in comparing the databases and in evaluating their value to international analysts are proposed. By focusing on definitions and selection of statistics to measure supply, demand, revenues, expenses, and other key data items, this report encourages informed use of these resources for international analysis. This review of strengths, weaknesses, and compatibilities is of particular value to analysts familiar with Section 15, which is the frame of reference for evaluation of the nine less complex databases. This review also identifies issues in development of transit databases that should be resolved if these resources are to be of maximum value.

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On the basis of comparative analysis, this study provides insights into the debate in the United States over what to report under the Section 15 program. Numerous recommendations have been made over the last 3 years by a Section 15 advisory committee appointed by the Secretary of Transportation *(1)*; a committee of the American Public Transit Association (APTA), representing operators; TRB, representing the research community; and industry sources. The APTA proposal discussed in this paper was submitted to the UMTA Section 15 Advisory Committee meeting on March 13, 1986, but APTA continues to develop its recommendations. In response to these recommendations, UMTA has begun a program to simplify and improve the data quality of Section 15. Although some recommendations require additional information, most require deletions. In the current debate over what to report, collection costs to reporters are contrasted with the benefits gained from use of the data for analysis *(2)*.

Proposals to modify Section 15 are evaluated on the basis of how other countries resolve common issues, including measurement of supply, demand, fleets, and workforces; distinction of capital from operating expenses; allocation of costs and fares by mode; level of expense detail; and identification of private contractors. The objectives are to identify ways in which Section 15 could be improved, often through simplification, and its comparative strengths as a valuable standard.

CRITERIA FOR EVALUATION OF COMPARATIVE DATABASES

A clear statement of intended objectives for the databases should precede development of evaluation criteria. Criteria should assist in answering the question "Do these databases successfully provide required information?" For this paper, the objectives are not those of the individual databases, which often are not explicit and differ among themselves.

It would be arbitrary to apply the objectives of one database in evaluation of other databases because of apparent differences in what each was designed to accomplish. Intended uses of Section 15, the most detailed of the databases, include provision of information for national and state analysis, local decision making, and academic research. The European databases are more modest undertakings, with fewer categories of information, and less detail in categories shared with Section 15. The databases from Belgium, the Federal Republic of Germany (FRG), and the International Union of Public Transport (UITP) contain ridership and output measures required for analysis of national and local historical trends but lack the financial data required for economic analysis using unit costs.

The 10 databases are evaluated for their ability to provide information for international performance evaluation and policy analysis. This is consistent with the intent of this report—to provide a guide to data sources for international analysis and insights into what to report under Section 15. Although performance evaluation and policy analysis are inclusive, they exclude local management and other applications that require additional details on routes, costs, and characteristics of riders. None of the databases are intended for this type of use. The evaluation criteria follow.

Usefulness in Performance Evaluation

Performance evaluation uses financial and operational data to analyze trends in and relationships among costs and services supplied and demanded, and to explain differences in transit system performance. Evaluation answers the questions, "How are the databases doing?" and "Where can they improve, and how?" Comparisons can determine whether performance is improving or deteriorating and can identify candidate items for cost reduction or service improvement.

Performance evaluation requires benchmarks of exemplary, acceptable, and unacceptable performance. Evaluation can be based on historical performance of a single operator or on comparisons with individual or group peer standards. International databases extend the range of transit experience and provide a broader universe of peers.

Fundamental data required for performance evaluation are operating expenses, revenues, service outputs, and ridership. Modal disaggregations by multimodal systems are required to analyze modal performance.

Usefulness in Productivity Analysis

Productivity analysis attempts to maximize transit benefits relative to resource input costs (labor, capital, and materials). Analysts disagree over whether to measure benefits in supply units (vehicle-miles) or demand units (trips), possibly with fares as a surrogate, or to include social benefits, including environmental effects, as used in the social cost benefit model or similar techniques mandated by the British Department of Transport for planning and investment decisions *(3)*.

Productivity is often viewed as having efficiency and effectiveness components. In economic theory, efficiency contrasts marginal costs and benefits to determine optimal resource use. In transit analysis, efficiency is often simplified to focus on ratios of costs to services supplied (in units of vehicle-miles or vehicle-hours), often within different managerial divisions. Effectiveness focuses on the extent to which outputs are consumed *(4)*.

Usefulness in Policy Analysis

The databases are evaluated for ability to provide information required to answer key policy questions, including whether public agencies should subsidize transit, how subsidies might best be provided, whether public investments should encourage particular modes or technologies, and whether public transit services should be deregulated or privatized. International data sources extend the information available to answer national policy questions.

Complete System-Wide Costs

Analysts are particularly interested in cost comparisons between operators, often expressed in costs per service output unit, rider, or passenger-mile, and in historical cost trends of operators individually or in modal, national, or other categories.

The appropriate level of operating expense detail is controversial and is the subject of the APTA proposals. Basic disaggregations include costs of operators, maintenance, administration, labor, and possibly contracts. Many policy questions and comparisons of interest involve modal costs or comparisons, which require cost allocations by mode. Comparisons between modes or operators with different degrees of labor and capital intensity require both operating and capital costs.

Complete Revenues

Revenues can be used to contrast earnings with operating and capital expenses by using farebox returns (fares divided by operating expenses) or other measures. Basic revenue categories include modal or system fares, amounts of public funds, identification of funding agency, tax or other source, and all other revenues.

Service Outputs

Products of a transit system are typically measured in units of service produced or supplied, including vehicle-miles or vehicle-hours, in modal disaggregations. Capacity-miles (seating and standing capacity multiplied by vehicle-miles) and distinctions between deadhead and revenue vehicle-miles and vehicle-hours are also useful.

Ridership

Ridership or service consumed data provide measures of the benefits derived from transit service and are required for analysis of productivity. Typical measures are number of unlinked trips (boardings), number of linked trips (completed origins to

destinations), and passenger-miles (sums of distances traveled by all passengers).

Integrated Structure

The different elements of a database should fit together. Modal expense categories can parallel those used for revenues, outputs, ridership, and labor. For example, parallel distinctions between modes or publicly operated and contracted service can be made throughout the database.

Consistent Definitions

Without clear definitions, particularly for international data, consistency should not be assumed among different modes and operators. For example, it should be specified whether trips are origins to destinations or boardings, whether operating expenses include depreciation, interest, or lease costs, and whether vehicle-miles include deadhead (return trip without load).

COMPARATIVE ANALYSIS OF SECTION 15 AND NINE EUROPEAN DATABASES

In this report, Section 15 and nine European databases are analyzed to determine differences and similarities in data and definitions. Of the 10 databases, 8 are national, published by government ministries or associations of operators, and the 2 produced by UITP are international (Table 1). All the databases contain operating statistics for urban operators, and most contain financial information.

Section 15 is the most detailed and complex database surveyed, and the only one except for the Swiss with statistics on vehicle failures, pensions, and accidents. However, basic categories for financial and operating statistics are similar to those used by the other databases. Of the 10 databases, 7 contain operating expenses and revenues, all 10 report service outputs and ridership, and 9 (all but Belgium) publish performance ratios.

Section 15 consolidates statistics in fleet-sized peer groups and presents graphics on national and historical trends. The other data sets do not sort by peer groups, although the British and UITP rail sets could be considered peer groupings. The FRG and UITP rail databases also provide graphics.

The Section 15 database, compiled by UMTA, contains data on commuter rail, light rail, rapid rail, motor bus, and other modes. In its seventh year, Section 15 includes financial and operating statistics on over 430 primarily urban U.S. public transit operators *(5–7)*. Although most operators are publicly owned and operated, information from private operators, mostly under public contract, has increased significantly.

The UITP handbook *(8)* includes urban rail and motor bus data for over 1,000 worldwide reporters. UITP contains detailed engineering descriptions of equipment and networks, but no operating expenses.

The UITP Rail Committee produced two sets of financial and operating statistics for its study of rapid rail performance (UITP–RR) *(9)*. The first version contains rapid rail information on 26 operators, including 20 from Europe, 3 from the

TABLE 1 BASIC INFORMATION AND DEMOGRAPHICS[1]

	Published By	Modes	Reporters	Data From	Information on Ownership	Population/ Density
USA	US Dept of Transport	CR,MB, RR,TB	438	1978-	Yes	Yes/Yes
UITP	Operators' association	LR,MB, RR,TB	1000 +	1964-	Yes	Yes/Yes
UITP Rail	Operators' association	RR	26	1981 & 1985	Yes	No/No
Great Britain	Operators' association	CR,MB RR	8	1977	All public	Yes/Yes
FRG	Operators' association	LR,MB, RR,TB	166	NAV	No	Yes/No
France	Transport Ministry	LR,MB, RR,TB	101	1975- 1984	Yes	Yes/Yes
Holland	Operators' association	LR,MB, RR,TB	9	NAV	All public	No/No
Belgium	Communicat Ministry	CR,LR, MB,RR	7	1949-	All public	No/No
Italy	Transport Ministry	LR,MB, RR	1272	1981- 1983	All public	Yes/Yes
Switzerland	Federal Statistics Office	LR,MB, TB	19	1948 -	All public	No/No

[1] Abbreviations follow Table 5.

United States, and 3 others. The more extensive second version is limited to data on 10 European rapid rail systems.

The Passenger Transport Executive Group (PTE), an association of British urban transit operators, publishes *Inter P.T.E. Comparisons (10)*, financial and operational statistics for motor bus, commuter rail, and rapid rail for London and seven major urban centers. Recommended accounting and record-keeping structures are described in a Department of Transport publication *(11)*.

The Association of Public Transit Operators, FRG, publishes *Statistik '85 (12)*. In its 15th edition, the database includes operating statistics for motor bus, rapid rail, light rail, and other modes for 166 operators. Financial information is collected but not published.

The French National Research Institute of the Transport Ministry (INRETS) publishes *101 Réseaux de transport urbain (13)*, with historical data (1975–1984) for motor bus, rapid rail, light rail, and other modes for 101 operators, excluding Paris. INRETS reports revenues and operating expenses in system and not modal totals and also describes involvement of different public agencies and private contractors in management and other functions.

In the Netherlands, the Committee of Economic Affairs of the association of nine major urban public transport companies (including Amsterdam) publishes *Bedrijfsvergelijking (14)*, an annual report with extensive motor bus, trolley bus, rapid rail, and light rail data. The report is used by the Dutch Transport Ministry for policy and financial analysis, but it is not publicly distributed.

Les Transports en Belgique (15) is a biannual statistical report on urban transit in Belgium, published in French and Flemish by the Belgian Ministry of Communications. In its 18th edition, the report includes operating statistics but no expense or revenue data on light rail, rapid rail, and motor bus operations for seven public operators in major urban centers.

In its third edition, *Il trasporto pubblico locale: analisi per regione (16)*, is published annually by the Italian Transport Ministry. The report contains revenues, operating expenses, and service statistics for 1,272 local public operators, including those in Rome, consolidated into 21 regional categories. Data are presented on motor bus, light rail, and rapid rail service, including a limited amount of contract service.

Statistique suisse des transports, 1983 (17), published by the Swiss federal Office of Statistics, contains motor bus, light rail, and trolley bus statistics from 4 regional and 14 urban public operators. Fares, other revenues, and capital and operating expenses are reported for all modes combined; accidents, service outputs, and ridership are reported by mode.

Demographic Data

Demographic information provided by the 10 databases is summarized in Table 1. Section 15, PTE, UITP, INRETS, and the Italian databases provide both population and density of service area; FRG provides only population. Population served, reported by Section 15, UITP, FRG, INRETS, and the Italian databases, is subject to common limitations. For Section 15 and the Italian databases, service areas are defined by political or socioeconomic boundaries and do not necessarily correspond to service access areas. Service areas for FRG and INRETS are not defined. Service area population is valuable for comparisons of access, for example, population within 0.25 mi of fixed-route service, and service outputs or ridership per capita.

Section 15 reports population and density only for the single major socioeconomic urban area served by operators. This consolidation can distort estimates of actual population served and service per capita because service could actually be provided to multiple urban or nonurban areas.

In the Italian database, population is provided only for the 21 regions into which data for 1,272 operators are consolidated. This consolidation could be valuable for national analysis but not for comparisons of operators.

Organizational Structure—Public or Private Ownership

Analysts are interested in the different levels of government funding transit, the mix of public and private operation, and the use of contractors. Important policy questions require information on how local systems are funded and managed; identification of public and private participation (joint development, contracting of functions or entire operations, and nonsubsidized service); and estimates of the growth of the private sector.

Standardized categories allow identification of the public or private character of purchasers and providers of contract services. More detailed descriptions would require narratives or follow-up calls to operators.

Costs, revenues, service, and ridership should be allocated between publicly operated and contracted service to prevent distortion in performance measures yet permit analysis of the effects of contracting and other privatization. Section 15 separates contracted from publicly operated outputs and ridership but provides incomplete costs for contract service. Although it is useful to distinguish the costs of management or maintenance contracts, at a minimum the value of all contracts should be consolidated.

None of the European databases clearly identifies ownership and use of contractors (Table 1). This lack is not an issue when operators are all publicly owned and operated, as in the Netherlands. Section 15 publishes contract service costs, outputs, and ridership and also identifies but does not publish information on public-private arrangements.

All PTE, UITP–RR, and Dutch operators are public, although that will change in the United Kingdom after deregulation, when PTE operators compete with private firms. PTE provides contract expenses for unspecified functions, and the Dutch provide costs of contract drivers. INRETS summarizes management and other roles of contractors but does not provide costs or other details. The value of UITP descriptions of organizational structures would improve with development of standardized categories.

Labor Data

All 10 databases measure total employees, and all but FRG count operators and maintenance staff (Table 2). With important cautions, these data can be used in labor productivity

TABLE 2 LABOR, FLEETS, CAPITAL EXPENSES, AND REVENUES[1]

	Labor Counts	Route Miles	Fleet Inventory	Capital Expenses	Revenues Total/Fares	Public Contributions
USA	Oper,Main, Admin	Yes	Peak,spares, base	Yes	Yes/System only	Yes
UITP	Oper,Main, Admin	Yes	Total	No	No/No	No
UITP Rail	Oper,Main, Admin	Yes	Peak, off-peak	Yes	Yes/Yes	Yes
Great Britain	Oper,Main, Admin	No	Total,peak	No	Yes/Modal	Yes
FRD	Totals only	Yes	Total	No	No/System only	No
France	Oper,Main	Yes	Peak,spares	No	Yes/System only	Yes
Holland	Oper,Main, Admin	Yes	Peak,spares	Yes	Yes/System only	Yes
Belgium	Oper,Main, Admin	Yes	Total	No	No/No	No
Italy	Oper,Main, Admin	Yes	Total	No	Yes/System only	Yes
Switzer-land	Oper,Main, Admin	Yes	Total	Yes	Yes/System only	No

[1] Abbreviations follow Table 5.

measures, for example, contrasting the cost per employee, or vehicle- or passenger-miles per employee or operator.

Imprecise definitions restrict the value of labor data for comparisons but can be overcome through use of standardized labor equivalents, measured in paid labor-hours. This method eliminates confusion about whether counts are annual averages or maximums or whether part-time staff are distinguished from full-time staff. For example, the Section 15 definition of a labor-year equivalent is 2,080 paid hours. A second approach is a head count of staff, with specification of whether the count is an annual average, maximum, or fiscal year end total, and whether part-time staff are weighted or counted as equal to full-time staff.

The European databases appear not to define whether counts are in standardized labor-years or are head counts. With over 1,000 reporters, UITP accepts whatever data are collected locally. It may be reasonable to assume consistency in databases collected by national transport ministries, although development of definitions would assist international analysts.

On the basis of an APTA recommendation, UMTA has redefined labor categories to match labor expenses and is evaluating methods to define part-time staff, which will be difficult because of inconsistent approaches in the industry.

Section 15 employee counts exclude contractors, whose roles are increasing in operations, management, maintenance, and security areas. This increase is distorting comparisons of labor productivity (vehicle-miles per employee) between operators with and without contractors.

On the basis of the limited statistics of the other databases, Section 15 may collect excessive labor data. Consolidation of separate labor equivalent and time-of-day head counts, as recommended by APTA, may be advisable. As a trade-off for reduced detail, clear annual measures of part-time labor, as collected by INRETS, and contract labor, as collected by the Dutch, could be added to allow analysis of these management options.

Physical Network

All databases except PTE measure rail and motor bus route lengths, as presented in Table 2. Only UITP and Section 15 describe system networks. UITP's network size for rapid transit, priority right-of-way, and exclusive right-of-way for nonrapid transit modes appear to correspond to directional route miles, exclusive right-of-way, and controlled access right-of-way, respectively, in Section 15.

It is essential to specify whether rail and nonrail networks are measured in one-way miles (1 mi of two parallel tracks or routes traveled in opposite directions counts as 2 mi), or round-trip miles (the previous example would count as 1 mi). INRETS uses round-trip miles; Section 15 and FRG use one-way miles.

Fleet Inventory

Basic fleet inventory measures include vehicles required to meet peak- and base-time-period schedule requirements and

spare vehicles required to maintain peak service. Analysts use peak-to-base vehicle ratios to understand daily service variation and peak-to-spare ratios to understand maintenance performance and fleet size requirements. All 10 measure fleet sizes, whereas only 5 measure the seating or standing capacity of their vehicles (Table 2).

UITP, FRG, Belgian, Italian, and Swiss databases provide undefined single fleet numbers, perhaps assuming that users are familiar with national definitions. These data sources do not provide the information required for the basic fleet ratios. Section 15, Dutch, PTE, and INRETS provide peak and spare counts; Section 15 and UITP–RR provide peak and base counts. Section 15 also provides scheduled fleet by time period (peak and base counts).

Section 15 and UITP describe vehicle types in detail. Section 15 includes vehicle type and manufacturer for all vehicles owned, as well as vehicles available for national emergency. APTA proposes to add air conditioning, registering fareboxes, radios, and lifts to inventories. Although inventory details are important to national policy makers and the transit industry, expansion of Section 15 inventories may not be justified.

Revenues

Fares and the sources and amounts of subsidies are used nationally and internationally to analyze farebox recovery rates, public and private support levels, and innovative mechanisms for distributing subsidies.

Fundamental information on subsidies includes institutional sources (government agencies, transit authority, or private sources); tax sources (income, sales, or employer); amounts; and distribution methods (percent of deficit, political discretion, incentive formulas, matching funds, tax credits, or direct subsidies to riders in special categories). These data can be combined with expenses, population, service outputs, and ridership to analyze subsidies in operator, modal, national, international, and other categories.

Except for the UITP and Belgian databases, all databases report fare revenues, but only PTE provides modal fares for multimodal systems (Table 2). Although Section 15 reporters are allowed to voluntarily distinguish fare revenue by mode, few have done so. All databases except UITP, FRG, Belgium, and Switzerland report the source and amount of governmental subsidies.

Details on subsidy distribution methods in the 10 databases are limited, perhaps because publishers assume analyst familiarity. Section 15 identifies federal, state, and local sources but does not describe distribution methods. The amount of assistance distributed on the basis of riders in specific categories is identified by PTE and INRETS and is collected but not published by Section 15. At a minimum, text summaries of distribution methods would be valuable to international analysts.

Section 15 identifies sources of revenues, including fares, advertising, dedicated taxes, and private contributions. It also distinguishes capital from operating subsidies.

UITP has the most thorough information on fare structures, including coordination among modes, transfers, discount passes, and collection technology. INRETS also summarizes fare systems. Because local fare policy, particularly low fares or recent increases, could be crucial to analysts, Section 15 allows optional unpublished narratives, which could be made available to analysts.

Capital Expenses

Without capital expenses, analysts focus on operating expenses, limiting and distorting comparisons among operators or modes with different labor and capital intensities. This is apparent in comparisons among automated guideways and other rail systems, with heavy capital and light labor costs, and bus systems with old fleets and high labor costs. Although it is difficult to compare systems operating under different conditions, such comparisons are vital for a variety of analyses. For example, an analysis of alternative modes and technologies for a service extension could use capital and operating expenses from national or international operators to derive unit costs for projections.

All 10 databases lack clearly defined capital expenses. Only Section 15, UITP–RR, Dutch, and Swiss databases identify capital expenses (Table 2). UITP–RR identifies annual capital costs for rolling stock and new works, but there may be comparability problems among 26 reporters in almost as many countries. In addition to amortization and depreciation, the Swiss database provides annual capital costs for construction and renovation of equipment.

APTA proposed eliminating the Section 15 balance sheet because of questions about its value to analysts and correspondence to operators' internal accounts. UMTA could investigate Swiss and UITP–RR reports of annual capital expenditures, along with other alternatives to modify the balance sheet.

Section 15, PTE, INRETS, Swiss, and Dutch databases identify depreciation or amortization as separate expenses, enabling analysts to define their own approaches to these costs and to avoid ambiguity over whether these costs are included in operating expenses. In the four European databases, depreciation is a system total and cannot be used for modal analyses of multimodal systems.

Operating Expenses

Operating expenses are vital to policy and management analysis. In transit accounts, operating costs are typically divided into operations, maintenance, labor, and administration. Performance measures determine costs per service unit; for example, maintenance expense per vehicle-mile. Some account structures permit cross-classification of expenses into combined function-object classes, for example, maintenance labor cost. Standardized total operating expenses are crucial for comparisons, with explicit approaches to depreciation, interest, and taxes. Also, modal allocations are required to respond to modal questions.

Differences in accounting conventions between modes within a country, such as commuter rail and urban bus in the United States, and internationally make it difficult to standardize. Also, operators resist divulging competitively damaging information. For example, the seven PTEs in the United Kingdom might cease public reporting of data after deregulation, when they will form separate companies and compete with private operators for market positions *(18)*. Expenses could be

underestimated and comparisons biased if multiple public agencies are involved. For example, if New York City uses city police to patrol subways, as planned, these costs may not appear in the operator's financial report.

Operating expenses published in the 10 data sets are summarized in Table 3. All but UITP, FRG, and Belgium provide total operating expenses. FRG collects but does not publish costs. Of the seven databases with operating expenses, all provide a maintenance total, six separate costs of operations, and all but INRETS and the Swiss database provide modal costs for multimodal systems. Contract costs, which are important for analysis of privatization, are identified in Section 15, PTE, Dutch, and Swiss databases.

Section 15 provides a complex matrix of 44 expense functions and 47 object classes for the 22 operators that voluntarily report the most detailed expenses. Some 85 percent of reporters, however, use only the four minimum or required functions. The matrix cross-classifies functions and object classes. For example, labor or materials costs can be identified for operating or maintenance functions.

Although use of more than four functions is voluntary, APTA recommended four functions for all reporters. The cost of reporting up to 44 functions is not the issue—operators report details voluntarily and may have information systems based on these accounts. APTA argued that the current structure is too complex and that because voluntary details produce choice-based rather than random samples, these data have no valid applications. Contrary to the APTA view that some data are worse than no data, voluntary data have legitimate applications if sources are identified and if universal conclusions are avoided without statistically valid methods. For example, voluntary data have been used in time series analyses, in deriving unit maintenance costs in national rail cost projections, and in an industry marketing trend study *(19)*.

From a review of the other databases, 44 functions appear excessive. As recommended by the UMTA committee, the optimal number may be more than the four proposed by APTA and the three or four common to the European systems. Examples of potentially useful costs lost under the APTA proposal include uninsured liability payouts, marketing, and fare collection. Compromises could consolidate the current 10 insurance objects into 2 (premiums and payouts) and preserve one marketing function in place of the current four, instead of consolidating all marketing into administration, as proposed. It is likely that UMTA and APTA will collaborate to simplify accounts while maintaining the most valuable details.

Service Outputs

A transit system's products are typically measured in units of service supplied, including vehicle-miles or vehicle-hours, with important distinctions between vehicle-miles, or total distance traveled, and revenue vehicle-miles, which are limited to revenue service. All 10 databases provide outputs, including vehicle-miles (Table 4). UITP–RR provides train instead of the car vehicle-miles reported in the other databases for rail modes. All except INRETS and the Dutch database provide the modal outputs of interest to many analysts. Only three databases report vehicle-hours—considered the single most valuable output measure by many analysts because of strong correlations to labor, the major component of cost. Only Section 15 reports revenue vehicle-hours and revenue vehicle-miles, which can be subtracted from vehicle-miles to determine deadheading, an important cost factor.

Five databases report capacity-miles, which UMTA has proposed eliminating *(20)*. Capacity-miles (seating and standing capacity multiplied by vehicle-miles) are difficult to define because of variations in seat configurations and local policies on standees. Nonetheless, capacity-miles are the only supply measure that reflects vehicle size variations within and between modes; for example, it allows distinctions between outputs of motor bus and rail, which are not permitted by vehicle-miles.

In five databases, capacity-miles can be combined with passenger-miles to derive load factors (passenger-miles divided by

TABLE 3 OPERATING EXPENSES[1]

	Operating Expenses	Operations	Maintenance	Administration	Labor	Contracts	Interest or Depreciation
USA	Modal	Yes	Yes	Yes	Yes	Yes	Yes
UITP	No	No	No	No	No	No	No
UITP Rail	Modal	Yes	Yes	Yes	Yes	No	No
UK	Modal	Yes	Yes	Yes	Yes	Yes	MB only
FRG	No	No	No	No	No	No	No
France	Total	No	Yes	No	Yes	No	Yes
Holland	Modal	Yes	Yes	Yes	Yes	Yes	Yes
Belgium	No	No	No	No	No	No	No
Italy	Modal	Yes	No	No	Yes	No	No
Switzer	Total	Yes	Yes	Yes	Yes	Yes	Yes

[1] Abbreviations follow Table 5.

TABLE 4 SERVICE OUTPUTS AND RIDERSHIP[1]

	Modal	VHr	VM	Capacity Miles	Passenger Trips	Passenger Miles
USA	Yes	Yes	Yes	Yes	Unlinked	Yes
UITP	Yes	No	Yes	D	Undefined	RR only
UITP Rail	NAP	No	Yes	No	Undefined	Yes
UK	Yes	Yes	Yes	No	Unlinked	Yes
FRG	Yes	No	Yes	Yes	Linked	Yes
France	No	No	Yes	Yes	Undefined	No
Holland	Yes	Yes	Yes	Yes	Unlinked	Yes
Belgium	Yes	D	Yes	Yes	Undefined	Yes
Italy	Yes	No	Yes	No	Undefined	Yes
Switzer	Yes	No	Yes	No	Undefined	No

[1] Abbreviations follow Table 5.

capacity-miles), a vital indicator of utilization. Capacity-miles are also valuable for comparisons between transportation industries, for example, to reflect differences in unit costs among air, intercity bus and rail, and transit.

Section 15 collects actual and scheduled revenue vehicle-miles, which provide estimates of missed trips and reliability. PTE is the only other database to indicate schedule adherence, with a measure of lost mileage.

Time-of-day data are used by analysts to explain cost trends, in models to predict costs of service changes, and by managers to develop deficit reduction strategies, including use of part-time drivers and peak-hour fares. Because costs correlate closely to peaking *(21)*, time periods with excess supply relative to demand could indicate cost savings opportunities, and excess demand could suggest service expansion.

Section 15 reports eight service measures by time of day, including vehicle-miles and vehicle-hours by peak and other time periods. If absence of time-of-day distinctions in the European databases is considered, Section 15 details appear excessive. For example, both actual and scheduled revenue vehicle-miles are not required to indicate peaking. However, APTA's proposal to report only vehicles by time of day appears extreme. Time-of-day data could be reduced to vehicle-hours and vehicle-miles, which better reflect congestion and speed than do vehicles. Vehicle-hours are of particular value because of strong correlations to costs.

Ridership

The basic measures of ridership are passenger-miles, unlinked trips (boardings), and linked trips (completed origins to destinations). Although unlinked trips are inexpensive to collect and could suffice for time series analysis of one operator, they are limited for comparisons among modes or operators with different transfer rates. Linked trips are costly to collect but are a superior measure of benefits because they are not inflated by transfers, which are required by route design and other conditions but do not produce additional benefits. Both linked and unlinked trips are limited for comparisons between modes, operators, or other transportation industries with different average trip lengths. For example, trip lengths can vary from 3.6 mi for light rail to 21.3 mi for commuter rail in the United States.

Passenger-miles, or the total distance travel by all passengers, allow comparisons between operators and modes with different transfer rates and average trip lengths. Although passenger-miles are a theoretically complete and comparable demand measure, collection can involve costly sampling or technology, and can produce inaccurate data.

Ridership information is presented in Table 4. With the exception of INRETS, all 10 databases provide modal data. All collect passenger trips: Section 15, PTE, and Dutch databases specify unlinked, FRG specifies linked, UITP reports linked and unlinked without identification, and five do not define trips, perhaps assuming national consistency. Without explicit definitions, operators report what they collect internally, and analysts do not know whether trips are linked or unlinked. Ambiguity could bias comparisons because unlinked trips could be as frequent as 60 percent more than linked trips. If trips are labeled as linked or unlinked, adjustments can be made in analysis.

Passenger-miles are controversial in Section 15 because UMTA requires annual totals to satisfy statistical standards of 95 percent confidence and 10 percent accuracy, and uses passenger-miles in the Section 9 apportionment formula. Although there is debate in the United States over the value of passenger-miles relative to collection costs, they are included in 8 of the 10 databases, and they have important planning and evaluation uses in the European countries surveyed. For example, passenger-miles are used in Great Britain as a proxy for benefits in the methodology mandated by the Ministry of Transport *(22)* to plan and make investment decisions. The Dutch Ministry of Transport uses passenger-miles to evaluate the performance of operators and plans to use the measure to allocate proceeds from the national fare program.

The accuracy, costs, and benefits of passenger-mile collection in Europe would be an interesting topic for future research and would provide insights for the Section 15 debate. For example, it would be interesting to know how the benefits of passenger-mile information compare to the costs of automated counters provided to operators by the Dutch Transport Ministry.

Section 15 requires estimates of passenger-miles and unlinked trips by peak and other periods. If the questionable accuracy of passenger-miles by time period (standards apply only to annual totals) and the absence of peak distinctions in the other databases are considered, it may be justifiable to limit time-of-day demand measures to unlinked trips but not to eliminate all measures, as proposed by APTA. Important uses for combined supply and demand data by time period were discussed in the previous section.

Performance Measures

Performance measures are typically ratios of expenses, revenues, outputs, and ridership. Efficiency measures typically indicate unit costs of outputs (cost per mile or per hour), and effectiveness measures indicate the extent to which outputs are consumed (passenger-miles per capacity-mile) or the unit costs of ridership (operating expense per unlinked trip) *(23)*. Other commonly derived ratios include peak to spare vehicles, load factors (passenger-miles per capacity-mile), speed, and average trip length (passenger-miles per trip).

Seven of the databases publish performance measures to assist analysts, who otherwise derive their own ratios (Table 5). Four produce and three allow derivation of average trip lengths. Two produce and four allow derivation of load factors. Section 15 does not publish load factor and average trip length but uses both in data validation. The importance others assign to these measures may interest UMTA as it considers reducing passenger-mile reporting. Four databases publish operating costs per passenger and vehicle-mile.

The most commonly published ratios are for labor and vehicle productivity, comparing outputs to employees and vehicles. Although cost recovery (the ratio of fares to operating expenses) is important for analysis, only UITP–RR publishes it; this factor can be derived from five other databases. Modal performance measures are limited by the availability of modal costs, ridership, and outputs, as discussed. Although the performance measures published out of the great number derivable could imply applications, analysis of how performance measures from each database are used would provide additional insights for the debate over what to report under Section 15.

CONCLUSIONS

The 10 databases were evaluated for their ability to provide information for performance evaluation and policy analysis. In

TABLE 5 PERFORMANCE MEASURES[1]

	Cost per Pass/Output	Peak/ Spare	Load Factor	Labor/Vehicle Productivity	Speed	Average Trip Length
USA	Yes/Yes	D	D	Yes/Yes	D	D
UITP	No/No	No	D	D/D	No	Yes
UITP Rail	D/Yes	No	Yes	Yes/Yes	No	D
UK	D/Yes	Yes	Yes	Yes/Yes	Yes	Yes
FRG	D/D	No	D	D/D	No	Yes
France	Yes/Yes	D	No	Yes/Yes	Yes	Yes
Holland	D/D	Yes	D	D/Yes	Yes	D
Belgium	No/No	No	No	No/No	Yes	No
Italy	No/No	No	No	Yes/No	No	No
Switzerland	No/No	No	No	No/No	No	No

[1] Abbreviations Used in Tables 1 to 5

Admin - Administration
CapMi - Capacity or place miles (kilometers); (seating + standing) X VM
CE - Capital Expenses
CR - Commuter Rail
D - Derivable
Emp - Employee
LR - Light Rail or Streetcar
Main - Maintenance
MB - Motorbus
NAP - Not Applicable
NAV - Not Available
OE - Operating Expenses
Ops - Operators
PM - Passenger Miles (Kilometers)
Pass - Passenger Trips (linked or unlinked)
RR - Rapid Rail or Metro
TB - Trolley Bus
Tr - Train
TrKm - Train Kilometers
Veh - Vehicles
VHr - Vehicle Hours
VMi - Vehicle Miles (Kilometers)
VM - Vehicle Miles (Kilometers)
VRH - Vehicle Revenue Hours
VRM - Vehicle Revenue Miles (Kilometers)

comparison to Section 15, the European databases are of modest scale, with fewer categories and less detail within each category. The comparisons between operators allowed by the European databases are less detailed than those allowed by Section 15. The 10 databases combine to provide valuable resources for international analysis because of similar measures of outputs, ridership, costs, and revenues. All 10 report passenger trips, vehicle-miles, labor counts, and fleet size; 8 report fares; 7 provide operating expenses; and 8 record passenger-miles.

The value of these databases is limited by inconsistent definitions. Database producers, particularly transport ministries, may assume that users are familiar with definitions. Analysts can adjust for inconsistent definitions, but missing definitions create formidable problems, particularly when it is unclear whether trips are linked or unlinked, whether operating expenses include depreciation, and whether vehicle-miles include deadhead. Thorough definitions and a structure that ties cost, revenue, labor, and other data categories together are major strengths of Section 15.

Comparative analysis of the other databases provides insights for the debate over Section 15 reporting. UMTA is considering reducing reports of passenger-miles, a key demand measure in seven other databases, and eliminating capacity-miles, a supply measure in five others. All 10 databases generally neglect capital costs, although Swiss and UITP–RR reports of annual capital expenditure could provide useful alternatives for UMTA. Detailed labor counts in Section 15 could be improved through incorporation of approaches to part-time labor by INRETS and contract labor by the Dutch. Identification of the costs, revenues, outputs, and ridership of contract service is a strength of Section 15 that the other databases could incorporate to improve analysis of privatization policies.

In other important areas, Section 15 appears excessively detailed. Time-of-day data for eight output and two ridership measures could certainly be reduced. Operating expense categories could also be reduced, although the optimal number may be more than the four proposed by APTA and common to the European systems.

Several promising areas for related future research were identified. The U.S. industry might be interested in the collection methods, accuracy, and applications made of passenger-miles in the other databases, including how the benefits compare to the costs of automated passenger counters in the Netherlands and elsewhere. Also, a framework to identify data required for specific types of applications would require theoretical efforts and a review of representative analyses, but it would focus the Section 15 debate and provide a basis for future development of comparative databases.

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