DEMAND FORECASTING AND DEVELOPMENT OF A FRAMEWORK FOR ANALYSIS OF URBAN COMMODITY FLOW: STATEMENT OF THE PROBLEM

Charles A. Hedges

The genesis of the Conference on Urban Commodity Flow was the interest of the U.S. Department of Transportation in the development of techniques and data to analyze and forecast the demand for the movement of goods within urban areas. Although sophistication in the treatment of passenger travel demand has been taken for granted for some time (or at least since the 1962 Federal-Aid Highway Act), explicit treatment of the demand for urban goods movement was not considered before 1968. In April 1968, the Bureau of the Budget (now the Office of Management and Budget) requested the Department of Transportation to inaugurate a continuing study of transportation demand forecasting. The department was instructed to "review current forecasting methods for the various modes to create a methodology for projecting a range of transportation demand," and to

> . . .improve the methodologies by. . .taking into account:
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> A. Technological changes, including shifts between modes or substitutes for transportation (e.g., communication developments, industrial location)
> B. Feedback among variables
> C. Internal analytical consistency
> D. Sensitivity tests of the models and their use.

After we began to investigate urban goods movements, concepts such as feedbacks and interdependencies took on new meanings. Rightly or wrongly, we concluded that even more than for urban passenger travel urban goods movements cannot be understood apart from land uses, industry location, and interfaces with intercity freight (i.e., terminals), particularly over the long run. Interactions with people movement are obvious but at the same time more subtle than most realize. Urban commodity flow also is intimately related to larger questions such as those relating to urban form and environment.

It was the hope of the conference Steering Committee (and particularly the Canadian Ministry of Transport and the U.S. Department of Transportation) that the conference would produce ideas and suggestions for developing frameworks (models) to analyze and forecast the demand for the movement of goods within urban areas. It is anticipated that these notes will serve as a point of departure and provide some guidance to this end.

NATURE AND USES OF INFORMATION CONCERNING THE DEMAND FOR URBAN GOODS MOVEMENTS

The Nature of Demand

There has been a discernible trend in recent years for transportation analysts to treat the demand for transportation services as a functional relation between the number of units of a given transportation service consumed per time period and the major determinants of the number of units consumed. For urban passenger travel, for example,

the number of automobile commuting trips is related to the following characteristics of both automobile and transit trips: (a) different levels of price, e.g., vehicle operating costs, user charges, and fares; (b) door-to-door travel times; (c) socioeconomic characteristics of travelers, particularly income levels and automobile ownership; (d) service characteristics, e.g., privacy and transit schedules; and (e) land uses, particularly at the place of employment. A similar list of the logical determinants of the demand for the movement of freight can be developed. The characteristics of the commodities would constitute one obvious set. Fashion items, perishables, and waste materials all require different types of handling. Institutional considerations are probably more important in some instances, for example, the normal working hours of those engaged in transporting, unloading, and receiving freight.

The Uses of Demand Information

The data sets that describe the functional demand for transportation services contain a wealth of information. Among the potential uses of this information are the following: to explain existing relations between the volumes of a particular commodity carried between 2 areas and the key determinants affecting these flows, such as freight rates, shipment time, and land uses at the points of origin and destination; to predict the effects of changes in the key determinants, e.g., increased shipment time as a result of conflicts between freight vehicles and passenger vehicles; to forecast future demands for commodity flows in response to changes in city size and structure, transportation network, and income and population over time; and to evaluate the benefits and the costs of decisions that will affect commodity flows.

The Users of Demand Information

The potential market for better information concerning the demand for the transport of freight within urban areas is quite large. It includes the following:

1. Urban and regional planners who are concerned with urban form and structure and who must make estimates of the facilities required to transport both passengers and freight corresponding to different rates of urban growth, different types and intensities of land uses, and alternative industry locations;
2. Suppliers of transportation and terminal services who must make decisions concerning the types and the amounts of services to offer and the rates to charge;
3. Manufacturers of transportation equipment who must consider what types of equipment to market, including innovations such as secure containers for night delivery;
4. Labor unions that assess the market for labor services and the effects of demands for higher wage rates;
5. Regulatory agencies, e.g., state public utility commissions and the Interstate Commerce Commission, that assess the impacts of changes in rate structures and change the boundaries of terminal zones in urban areas or abolish them altogether;
6. Federal and state legislatures that determine the types and the amounts of user charges and financial assistance for carriers and terminal operators;
7. Federal Highway Administration that treats explicitly relations between urban goods movements and congestion, land uses and zoning ordinances, and industry location in the FHWA-approved urban transportation planning process;
8. Federal Aviation Administration and the Federal Railroad Administration that plan for the location of terminal complexes, anticipate the types of facilities necessary for these terminals, and provide links between these terminals and the urban shippers and receivers;
9. Urban Mass Transportation Administration that assesses the feasibility of urban transportation systems capable of serving both passengers and freight;
10. Office of the Assistant Secretary for Transportation and Urban Environment that evaluates urban transportation planning and considers the environmental effects, particularly air pollution and noise, of alternative technologies for moving commodities;
11. Office of the Assistant Secretary for Policy and International Affairs that develops policy and evaluates alternative federal-aid programs; and

12. U.S. Department of Housing and Urban Development that relates urban transportation requirements to urban growth and development.

MODELING THE DEMAND FOR URBAN GOODS MOVEMENTS

What Kind of Model Do We Want?

Just as a package of models is needed to forecast urban passenger travel demand, separate models probably will be needed to deal with different facets of the demand for urban goods movements. At some stage in estimating the demand for goods movements within an urban area, however, it appears that urban transportation planning requires a comprehensive framework to relate the demand for urban goods movements to the major economic activities. Such a framework, ideally, will have the following characteristics:

1. It will be behavorial or structural, i.e., it will describe the relationships between the specific transportation service demanded and the key determinants of the demand (as discussed earlier in the section on the uses of demand information);
2. It will be multimodal or at least be capable of handling more than the truck mode (even trucks might not all be treated as a single mode for some purposes);
3. It will include passenger as well as goods movements and show how and where the two conflict;
4. It will show the feedback effects of changes in policy variables (transportation investments such as increasing street or highway capacity affect land uses, and changes in land uses may produce significant changes in the types and quantities of goods used and in the demand for goods movement);
5. It will be dynamic, i.e., it will show the movement from one equilibrium to another in response to changes in policy variables; and
6. It will have general applicability, i.e., it can be applied to cities with similar topographical, demographic, economic, and transport characteristics.

The model should assist in answering the following types of questions: What are the effects of congestion on the demand for freight movements (both total demand and by mode), on land uses, and on industry location? What are the effects of changes in "institutional boundaries", such as zoning laws and commercial zones, on land uses, particularly as they relate to freight terminals? How efficient are existing and proposed networks under varying assumptions concerning the hourly distribution of freight and passenger traffic? How can interrelations among modes be determined in order to identify potentials for intramodal and intermodal consolidation and coordination? Is there a market for innovations in goods movements, and what are the savings that might be achieved from innovations? What are the alternatives for reducing the interface costs between intercity and intraurban freight movements? What will be the effects of changes in government programs and policies, e.g., truck size and weight restrictions, and in user taxes?

The Dimensions of Urban Goods Movements

So far, there have been few attempts to define the dimensions of urban commodity movements. Although it does not exhaust the number of items that might logically be collected, the following stratification scheme is suggested; more detailed stratifications are given elsewhere (1, 2):

1. Definition of urban goods movement: package goods, dry bulk, liquid bulk, and dry flowable;
2. Characteristics of freight: physical state (liquid, gaseous, or solid), density, bulk or package, nature (durable versus fragible, perishable versus nonperishable, hazardous versus inert, odorous versus odorless), and value;
3. Characteristics of freight handling: mode, packaging (including use of containers), size of shipment, break-bulk, and institutional constraints (labor unions, terminal zones, restrictions on loading and unloading);

4. Freight service characteristics: frequency of service, hours and days of service, average delays, average loss or damage, average speed, and rate per ton-mile based on Standard Transportation Commodity Code (STCC);
5. Characteristics of orgin and destination: geographic location and type of establishment (land use);
6. Mode (vehicle) characteristics: type of vehicle, size, weight, and load-carrying capacity; and
7. Direction of freight movements: internal (intraurban), through, inbound (imports), and outbound (exports).

Demand for Urban Movements Versus Demand for Urban Passenger Travel

The similarities are as follows: Both are sensitive to the level of economic activity within a metropolitan area; both have pronounced peaks during weekdays; except in the most densely populated cities, both are carried predominantly by motor vehicles and frequently over the same rights-of-way; and for both the bulk of the travel occurs during the daylight hours on weekdays.

The differences include the following: Demand for goods movement appears to be more sensitive to seasonal and cyclical influences; passenger peak volumes typically precede and are more pronounced than observed freight (truck) volumes; passenger movements usually are 2-way (round-trip) movements, while goods movements usually are a series of 1-way flows; trip ends for commodities are not as dispersed as those for passengers; trucks, particularly delivery trucks and those with 2 or more axles, make more trips per day than automobiles; demand for freight transportation services is much more heterogeneous than the demand for passenger transport (goods vary widely with respect to perishability, value, density, and the like); goods movements require more modal interchanges and transfers; documentation is essential in goods movements; a greater proportion of the drivers of freight vehicles belong to labor unions; and freight data are more difficult to obtain than passenger data. A more complete list of differences is given by Pixton (3).

Present Practice

How are goods movements treated in present urban (or regional) transportation (or transportation-land use) models?

1. Are the weights attached to goods movements representative of the market demand, and are goods movements treated explicitly; or is it implicitly assumed that the pattern of freight movements is adequately represented by passenger travel (i.e., goods and passengers have the same origins and destinations), that goods movements can be expressed in terms of numbers of truck trips, and that the latter may be reduced to equivalent numbers of passenger car units?
2. Are the interactions or feedbacks between transportation and land use recognized and treated explicitly?
3. Are the frameworks city-specific or general in their applicability?
4. Are the models intended to deal with specific points in time, or are they designed to include time as one of the variables; or are future demands estimated by multiplying past trends by a (constant) growth factor?
5. In addition to land uses, what other variables are treated explicitly, especially type and characteristics of commodity, amount (weight) of shipment, mode and type of vehicle, trip length, elapsed time from origin to destination, cost of movement (tariff structure), and terminal characteristics?

REFERENCES

1. Mitchell, R. B., and Rapkin, C. Urban Traffic: A Function of Land Use. Columbia Univ., New York, 1954.
2. Urban Goods-Movement Demand. Battelle Memorial Institute, Oct. 1967.
3. Pixton, C. E. Issues Affecting the Transportation of Goods in the Baltimore Region. Regional Planning Council, Baltimore, Aug. 1968.