

FINAL REPORT

EVALUATION OF PARKING MANAGEMENT STRATEGIES
FOR URBAN AREAS

by

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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TABLE OF CONTENTS

	<u>Page</u>
ABSTRACT-----	vii
FOREWORD-----	ix
ACKNOWLEDGEMENTS-----	xi
SUMMARY OF FINDINGS-----	xiii
CONCLUSIONS AND RECOMMENDATIONS-----	xv
INTRODUCTION-----	1
NEED FOR RESEARCH-----	2
PURPOSE AND SCOPE-----	2
METHODOLOGY-----	5
Literature Review-----	6
Questionnaire Survey-----	6
OVERVIEW OF PARKING MANAGEMENT-----	10
Parking as a Function of Trip Making-----	10
Groups Affected by Parking Policies-----	17
Impacts of Parking Management Strategies-----	19
Parking as an Element of the Planning Process-----	19
New Concepts in Urban Parking Management-----	24
List of Parking Management Strategies-----	30
Need for Parking Management-----	30
Environmental Protection Agency-----	34
Federal Highway Administration and Urban Mass Transportation Administration-----	36
Department of Energy-----	38
Local Area Needs for Parking Management-----	38
Problems With Implementing Parking Management Strategies-----	40
SURVEY OF PARKING MANAGEMENT STRATEGIES-----	46
General Results of Questionnaire Survey-----	48

TABLE OF CONTENTS (cont.)

	<u>Page</u>
Parking Management Supply Strategies-----	59
Short-Term On-Street Parking Only-----	59
No On-Street Parking-----	60
Strict Enforcement of Parking Regulations-----	61
Reserved Parking for Priority Vehicles-----	62
Restricted Parking Time at all Facilities-----	63
Residential Parking Permits-----	66
Freeze on Number of Parking Spaces-----	67
Limit on Parking Garage Construction-----	68
Zoning Law Limits-----	69
Parking Management Pricing Strategies-----	70
High Rates for Single-occupancy Vehicles-----	70
Discriminating Hourly Rates-----	71
Increase In All Parking Rates-----	72
Reduced Parking Costs for Priority Vehicles-----	75
Parking Taxes on Users-----	76
Tax on Parking Garage Owners-----	77
Parking Management Location Strategies-----	77
Park and Ride Lots-----	77
Peripheral Parking Areas-----	79
SURVEY OF COMPLEMENTARY STRATEGIES-----	79
GUIDELINES FOR SELECTING AND EVALUATING PARKING MANAGEMENT STRATEGIES-----	81
SUMMARY OF MOST PROMISING PARKING MANAGEMENT STRATEGIES---	93
CASE STUDIES-----	95
Palo Alto Case Study-----	95
Madison Case Study-----	96
REFERENCES-----	99

TABLE OF CONTENTS (cont.)

	<u>Page</u>
APPENDIX A. QUESTIONNAIRE SURVEY OF CITY TRANSPORTATION OFFICIALS-----	A-1
APPENDIX B. CITIES RESPONDING TO THE QUESTIONNAIRE-----	B-1
APPENDIX C. SELECTED GENERAL COMMENTS FROM CITY TRANS- PORTATION OFFICIALS-----	C-1

1030

ABSTRACT

The state of the art of parking management in urban areas in the United States was established using an extensive review of the literature and a nationwide questionnaire survey that was distributed to 458 city officials, 173 of whom responded. Based on the information thus obtained, key elements of parking management were identified including groups affected and impacts of parking, descriptions of various strategies, the need for management, and problems encountered with implementing parking controls. A detailed evaluation of 17 strategies and 9 support measures was performed, and a practical set of guidelines that can be used by planners and traffic engineers for selecting and evaluating parking management measures was developed. A list of reference materials was provided to aid transportation engineers locate additional information sources.

It was concluded that parking management strategies are not being used on an areawide basis; however, several measures, including residential parking permit programs, in-lieu parking regulations, and park and ride lots, provide potential benefits for most urban areas. Field evaluations of parking strategies are needed to determine the effectiveness of these measures and to promote their use in transportation plans.

1052

FOREWORD

The results of the research study entitled "Traffic Restraint: An Evaluation of Parking Controls" are reported in two documents. The primary findings and study method are described in this report, while a complete list of references is provided in the report "Selected Bibliography on Parking Management" by Martin R. Parker, Jr. and Michael J. Demetsky.

1034

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1005

SUMMARY OF FINDINGS

An examination of the application of parking management strategies in urban areas in the United States revealed the following general findings.

1. Parking management, through the regulation of parking supply, price, and location, can have widespread impacts on an urban area. Because of the broad range of interest groups affected, parking management is a complex and sensitive issue.
2. Parking management strategies are not widely coordinated on an areawide basis in most American cities.
3. No single parking control appears to have the potential to achieve local transportation goals in an area; however, when combined with other transportation control measures, parking strategies can be beneficial in reducing transportation related problems created by single-occupancy auto use.
4. No local problem that would require the extensive use of parking strategies to limit auto travel is perceived by officials in most cities; however, there is a national concern for the inefficient use of energy for transportation.
5. Some of the major barriers to the implementation of parking strategies are public, political, and business opposition to the controls, reluctance of auto drivers to switch to public transit or other modes, existing parking rates and programs favoring the long-term parker, and limited evidence of the effectiveness of various strategies.
6. Very few attempts have been made to evaluate the effectiveness of parking strategies and little is known about the interrelationships between parking controls and supporting transportation controls.
7. There appear to be few legal problems associated with implementing parking policies and most of the problems can be overcome by changing city ordinances.
8. The implementation of parking management strategies must be closely coordinated with improvements in other transportation modes to prevent the economic decline of the downtown area.

9. The most widely used parking strategies in American cities are short-term parking, eliminating on-street parking, and enforcement of parking regulations.
10. Most parking management strategies in use have been implemented gradually over a long period of time.
11. Local and regional planners need information concerning the possible alternative parking strategies available along with a procedure for evaluating the strategies.

CONCLUSIONS AND RECOMMENDATIONS

When carefully selected and implemented with other transportation service measures, parking management strategies offer the potential to conserve energy, reduce peak period congestion, contribute to downtown revitalization, and encourage improved efficiency in the utilization of land and existing transportation facilities. The success of implementing parking strategies is greatly enhanced if the measures are used to respond to perceived local problems. Because of the widespread impacts of many parking measures, the strategies should be implemented in stages over a period of time. Also, strategies which focus on improving transportation service should be selected, if possible, because they are easier to implement than strategies which discourage auto travel.

The extent to which parking management strategies can be used to alleviate transportation related problems in urban areas should be explored. Perhaps the greatest impediment to implementing parking strategies is the lack of sufficient data for judging the effectiveness of the measures. It is recommended that research in this area be directed to obtaining data through controlled experimentation with demonstration projects. These experiments will also aid in overcoming the barriers which currently obstruct the implementation of innovative parking strategies.

1040

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INTRODUCTION

Until recently, transportation plans developed for urban areas in the United States were designed to provide adequate highway and storage facilities so that motorists could conveniently travel by automobile to and from locations in the areas. During the past few years, attitudes toward urban growth, environmental protection, energy conservation, social responsibility, and taxes to support public transportation programs have noticeably changed. In response to the problems created by reliance on auto travel, federal, state, and local officials are now concentrating on a unified transportation management approach which addresses all elements of the transportation system including automobiles, public transit, railways, pedestrian facilities, taxis, and parking.⁽¹⁾ The purpose of this Transportation System Management (TSM) approach is to develop the most efficient and feasible transportation strategies that are compatible with the goals, needs, and planning objectives of the community.

One of the key areas of multimodal transportation management is parking management. In the past, parking management policies focused on providing adequate facilities to accommodate automobiles.⁽²⁾ Now, in view of environmental, energy, social, and economic problems related to single-occupancy-auto travel and the potential enhancements offered by parking management policies, increased emphasis has been placed on using parking controls to achieve urban development objectives.

Because the parked vehicle is easier to control than the moving vehicle, constraints on parking through pricing, availability, and location have been suggested.^(3,4,5) Plans to use parking controls to reduce auto travel in American cities have been strongly opposed by the private parking industry, merchants, building developers, city officials, automobile user groups, auto manufacturers, and

some transportation officials, politicians, and citizens. (6, 7, 8) Researchers have also expressed concern over the applicability and effectiveness of various controls and have outlined major impediments to implementing some parking policies. (9, 10, 11, 12, 13)

NEED FOR RESEARCH

In practice, a variety of strategies have been proposed and utilized to manage parking. Although some investigators have examined the effects of a number of control strategies, the extent to which parking management strategies have been implemented in urban areas in the U. S., along with the concomitant impacts and problems, is not known. In view of the growing demand to improve mobility within environmental, energy, social, and economic constraints, and considering the potential benefits of parking policies, there is a need to examine the role that various parking strategies can play in achieving community development goals. An increased understanding of the existing use of parking strategies and their effectiveness and problems would be beneficial to planners and other transportation engineers responsible for developing urban transportation policies.

Although the impacts of some parking control measures have been reported, there is relatively little information available describing the application and impacts of various strategies in American cities. Furthermore, neither a list identifying alternative strategies nor the successes, failures, or problems experienced in implementing these measures is available in a single document. A method for including parking strategies in urban transportation planning and guidelines with quantifiable and nonquantifiable measures for evaluating the impacts of various controls are also needed.

PURPOSE AND SCOPE

The purpose of this research was to examine the existing and planned use of parking strategies and to develop a state-of-the-art summary of parking management applications in urban areas in the U. S. The specific objectives of the study were to —

1. examine the role of parking management as an element of the urban transportation system;
2. identify a wide variety of techniques that can be used to control parking;

3. describe existing and planned use of various parking strategies in U. S. cities;
4. determine the impacts, including the advantages and disadvantages, of implementing parking strategies;
5. examine the political, institutional, administrative, and legal problems associated with implementing alternative parking strategies;
6. identify other transportation services and improvements that can be used to enhance the effectiveness of parking strategies; and
7. develop planning guidelines, including evaluation criteria, that can be used to incorporate parking strategies into transportation plans.

When the research working plan was published, the study was entitled, "Traffic Restraint: An Evaluation of Parking Controls".⁽¹⁴⁾ As the research progressed, it became obvious that the study title should be changed for two reasons. First, parking management strategies are found in all three categories of traffic limitation; i.e., traffic restriction, traffic restraint, and traffic avoidance (a detailed discussion of these terms is given in a later section of the report).⁽¹⁵⁾ An evaluation of parking controls that is limited to traffic restraint measures would severely restrict the scope of the study and reduce the potential uses of the final report.

Second, many public and transportation officials associate the term "traffic restraint" with methods that restrict or reduce all travel. A restriction on auto travel through the implementation of parking controls is only one aspect of parking management that, without the implementation of other travel alternatives, may not be appropriate for any urban area. A reduction of mobility is clearly not advocated in the report; however, improved efficiency in the management and utilization of the existing transportation system through the careful application of parking strategies is suggested. For example, in some cases improving the efficiency of management may entail a strategy to discourage single-occupancy-auto work trips by significantly increasing the cost of commuter parking in the central area and providing a cost and service competitive transit system to encourage a shift in the mode of travel. In other cases, a strategy that encourages auto trips for shopping by permitting two hours of free on-street parking at commercial areas may be a preferred management technique for revitalizing a business sector.

The choice of the appropriate strategy is dependent upon many considerations as discussed in a later section of the report. Consequently, to reflect the intended scope of the research, the study title was changed to "Evaluation of Parking Management Strategies for Urban Areas".

A broad research approach was required to address the project objectives. The scope of the study included a review of the literature and a questionnaire survey of transportation officials to determine current parking management practices in U. S. urban areas. No attempt was made to collect field data for evaluating the impacts of any strategy as the purpose of the study was to develop an overview of the state of the art of parking management. To accomplish this purpose, the literature and results of the questionnaire were synthesized and are presented in this report in a systematic order to produce a coherent approach to understanding the concepts and describing the applications of parking management strategies.

A review of the literature revealed that a number of parking controls have been implemented in foreign cities, especially in Europe. Although the results of parking studies conducted abroad are discussed in several sections of this report, the scope of the study was limited to an evaluation of parking strategies in U. S. urban areas. This limitation does not imply that foreign experience is not applicable in the U. S.; however, the state of the art there and here may be appreciably different because the development of the urban areas, the preference for auto travel, and the political and institutional structures found in American cities are considerably different from the policies used in foreign cities.

While it was recognized that loading and unloading facilities for the movement of goods are an integral part of the urban transportation system, the scope of the study was limited to an evaluation of parking management strategies for automobiles. Strategies for the management of truck movements and truck terminals have been addressed by other researchers. (16,17,18,19,20)

During the study practical methods of managing parking were emphasized. Theoretical techniques, including various pricing schemes, have been proposed in the literature, but they have not been implemented in the U. S. because of hardware requirements and difficulties associated with administering the collection systems. (21) While some of these techniques are discussed in the report, most of the strategies evaluated were considered to be feasible for widespread implementation in U. S. cities. Some of the strategies described have been implemented, while other measures have been planned but have not been applied to address specific problems. Also, other strategies are identified which have not been planned or implemented but appear to have potential application.

METHODOLOGY

The work plan designed to evaluate parking management strategies outlined four tasks that are expanded upon below.

Task A: Describe Existing and Planned Parking Control Strategies

To gain insight into the appropriate role of parking management, associated experiences and attitudes were examined through a review of the literature and a nationwide questionnaire survey of transportation officials.

Task B: Establish Quantifiable and Nonquantifiable Criteria for Measuring the Impacts of Parking Controls

Alternative criteria for evaluating parking management strategies were identified and compared based on the results of completed and ongoing studies and through specific questions addressed to transportation officials during the study.

Task C: Establish the Advantages and Disadvantages of Existing and Proposed Parking Controls

Utilizing the alternative measures of effectiveness identified in Task B and the comments submitted by transportation officials, the feasibility of implementing various parking management strategies was outlined.

Task D: Prepare a State-of-the-Art Report

The study data were integrated into the topics listed below to produce the state-of-the-art report.

1. Overview of the role of parking in urban transportation management
2. List of a variety of parking controls that have been proposed
3. List of specific strategies that have been planned or implemented in U. S. urban areas
4. Summary of the issues, impacts, and implementation problems associated with alternative parking strategies

5. List of complementary strategies to enhance the effectiveness of parking management policies
6. Guidelines for selecting and evaluating the impacts of parking strategies
7. Case studies illustrating the use of parking management strategies
8. Summary of needed research

Specific details of the literature review and the questionnaire survey, the two major sources of information for the study, are given below.

Literature Review

An extensive collection of publications including articles from journals, magazines, reports, and university and government documents was conducted. References identified in some of the articles, as well as several bibliographies on automobile parking, provided additional material.^(22,23) Respondents to the questionnaire survey offered other published and unpublished documents. Over 500 references were reviewed for the study, and over 200 publications were found to be particularly relevant to the research. Because of the large number of publications and the broad range of topics included within the scope of parking management, no attempt has been made to synthesize the material into a bibliography or to discuss the literature in a separate section of this report. However, the information contained in the publications was integrated into the discussion throughout the text and is identified by appropriate reference notations. Also, a separate report entitled "Selected Bibliography on Parking Management" has been published where the documents are categorized by specific subject areas to aid the reader in identifying additional sources of information.

Questionnaire Survey

Although various parking controls have been used in a number of cities to improve mobility, a comprehensive survey of the existing and planned application of parking management strategies in U.S. urban areas was not available. To examine the state of the art, a questionnaire was designed to solicit opinions from urban transportation officials. The specific purpose of the questionnaire was to determine the types of parking controls in use and those planned

for implementation, the reasons for their selection, the basis for evaluating their impact, and the problems encountered in implementing them.

The survey materials, shown in Appendix A, consisted of a transmittal letter, a description of parking management strategies, and a four-page questionnaire. The general concept of parking management presented in the survey was based on a composite of policies* promulgated by the Federal Highway Administration, the Urban Mass Transportation Administration, and the Environmental Protection Agency.^(1,3) With these basic federal policies as a focus, a literature review was conducted to define a set of practical parking control options. The list of parking controls developed is given in Table 1, which outlines 15 basic means for managing parking and 11 supporting actions which may be required to sustain mobility when controls are placed on automobile parking in urban areas.

After a draft questionnaire was pretested by transportation officials in four Virginia cities to ensure clarity of the concepts and terminology, the survey materials were revised and mailed on April 8, 1977. Survey forms were distributed to transportation officials in 458 U. S. cities, including all urban areas with a population greater than 100,000. Questionnaires were also sent to officials in randomly selected cities with populations between 10,000 and 100,000 persons. The questionnaires were specifically sent to city officials responsible for planning and administering parking policies.

By July 1, 1977, a total of 173 questionnaires had been returned by transportation officials in 47 states, the District of Columbia, and Puerto Rico. The distribution and return of the questionnaires by population of the area are given in Table 2. The distribution indicates that each population category was proportionally represented by the responses ($\chi^2 = 2.19$, $p > 0.01$, $df = 3$). The 38% return rate was lower than was expected.** The low percentage of responses may be attributed to the length of the survey, i.e., three instructional pages plus the four-page questionnaire, which may have been perceived by many busy officials as being too complex and time consuming to complete. Also, no follow-up letters were sent to encourage additional responses because of the

*A discussion of the federal policies is given in a later section of this report.

**In 1971 a four-page questionnaire on zoning and parking regulations was mailed to 398 city officials. Fifty-four percent of those questionnaires were returned.⁽²⁴⁾

Table 1

Parking Management Strategies and Associated Supporting Actions

A. Parking Management Strategies

1. High rates for single-occupancy vehicles
2. Low rates for short-term, high rates for long-term parkers
3. Increase in all parking rates
4. Reduction in costs for priority vehicles
5. Short-term parking only on streets
6. No on-street parking
7. Strict enforcement of parking violations
8. Reserved parking for priority vehicles
9. Restricted parking time at all facilities
10. Residential parking permits
11. Freeze on number of parking spaces
12. Limited parking garage construction
13. Limitations on number of spaces allowed by zone
14. Parking tax on users
15. Parking stall tax on parking garage owners

B. Supporting Actions

1. Improved transit service
2. Demand responsive transit
3. Subscription service
4. Park and ride lots
5. Bicycle facilities
6. Promotion of transit use
7. Staggered work hours
8. Exclusive bus lanes
9. Peripheral parking
10. Auto-free zones
11. Priority treatment for high-occupancy vehicles

large number of mailings required. Additionally, it was felt that the responses received were representative of the population and geographic characteristics of U. S. urban areas and that they adequately represented an overview of current experience. A list of cities from which questionnaires were received is given in Appendix B.

The questionnaire data were keypunched and summarized by employing the Statistical Package for the Social Sciences.⁽²⁵⁾ The tabulated results for the 173 responses received are given in Appendix A. Although a discussion of the general findings are given in a later section of the report, specific results are discussed throughout the remainder of the text.

To supplement specific questions, space was provided on the questionnaire for additional comments, and nearly 40% of the respondents took advantage of that opportunity. The additional comments represent an interesting and cross-sectional view of parking management as perceived by urban transportation officials. A summary of typical comments is given in Appendix C.

Table 2

Questionnaire Distribution and Returns

<u>City Population</u>	<u>Number Mailed</u>	<u>Number Returned</u>	<u>Percent Returned</u>
Less than 50,000	123	42	34.1
50,000 to 99,999	173	59	34.1
100,000 to 500,000	133	58	43.6
More than 500,000	<u>29</u>	<u>14</u>	<u>48.3</u>
Totals	458	173	37.8

Note: City population is based on 1970 U. S. Census data.

OVERVIEW OF PARKING MANAGEMENT

Because every automobile trip begins and ends with the storage of the vehicle, parking management is an integral part of the urban transportation system. The attributes of auto travel are diminished if access to the urban activity center is impeded by congestion or if it is difficult to find a parking space. A review of parking studies conducted over the last 30 years has indicated that most parking policies have been oriented to provide highway capacity and parking spaces in the central business district (CBD).^(24, 26-31) Because of a variety of current urban transportation problems ranging from economics to environmental issues, new approaches to reducing the adverse effects of automobile travel have been proposed. Many of these policies advocate techniques which encourage mode shifts from auto to more efficient transportation methods such as public transit instead of the traditional solution of increasing highway capacity and the availability of parking.

The recent emphasis on implementing new parking management programs to meet current urban transportation problems has evoked considerable controversy and disagreement among planners, transportation engineers, public transit officials, business interests, politicians, and the public. Changes in parking policies are difficult to adequately develop and implement because parking affects a variety of persons with diverse interests. An overview of the parking activity, the groups affected, and associated impacts, along with a synthesis of the need for new parking policies, the techniques employed and the problems encountered when implementing these strategies, is given below.

Parking as Function of Trip Making

Urban areas attract trip makers for a variety of reasons including work, shopping, medical, school, etc. To accommodate these trips, every urban area offers one or more of the five trip-making alternatives shown in Figure 1. While other combinations of travel exist, these methods represent the primary means that people use to travel from one activity to another.⁽³²⁾

If urban trips were equally distributed in time and space or by mode, there would be greater utilization of existing facilities and fewer transportation related problems than at present. However, because most of the travel is to and from work, more than 10% of the total daily trips occur in a single peak hour.⁽³³⁾ Also, approximately 96% of all urban travel is provided by automobile, while public transit accommodates only 4% of the trips.⁽³⁴⁾ These trip characteristics not only place a burden on highway facilities to accommodate the movement of vehicles, but create a large demand for parking spaces, especially at large activity centers such as the CBD. As a result, parking is a major land use item in most cities.

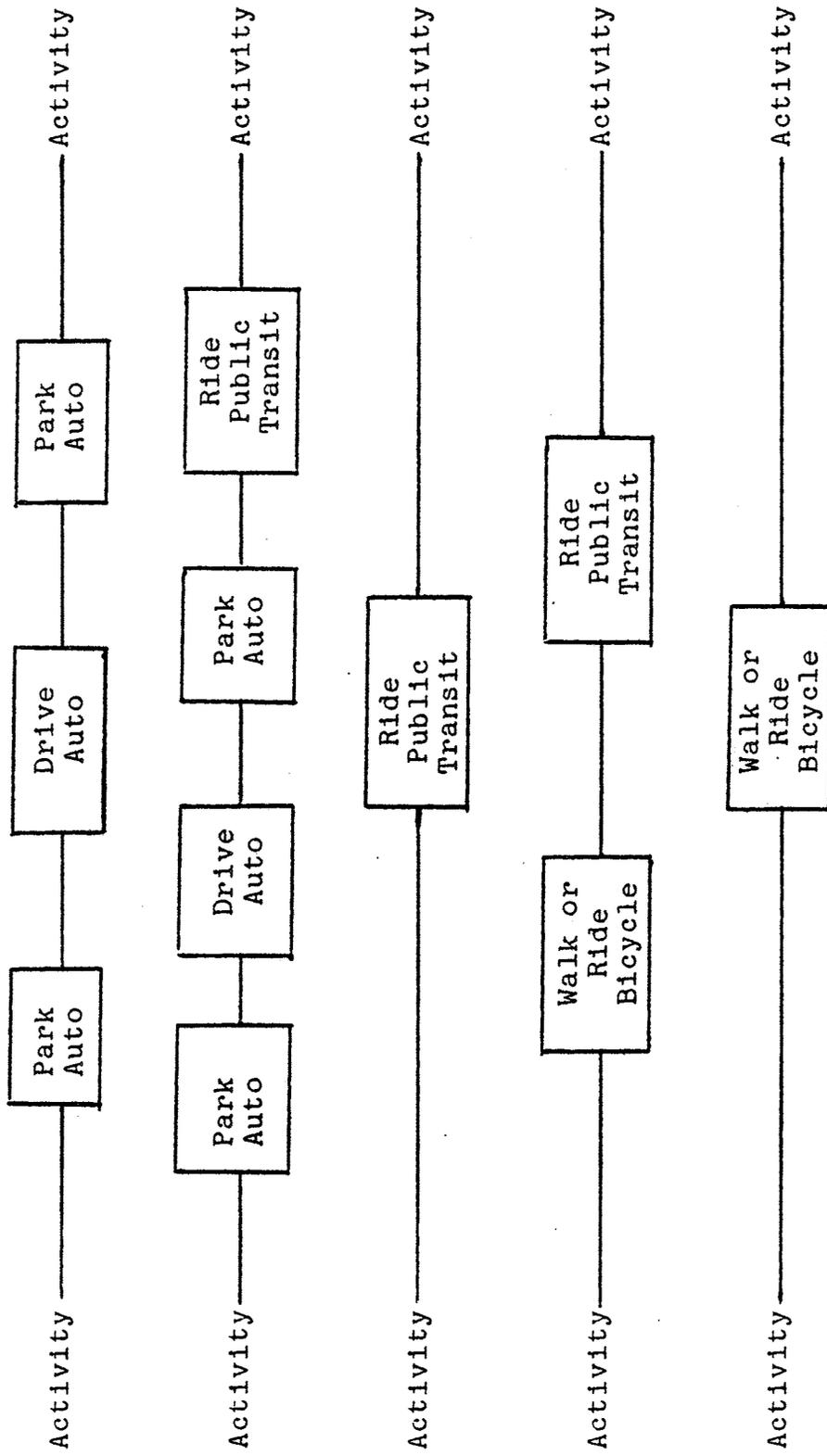


Figure 1. Alternative methods for making trips.
 (Based on a paper by Ralph Jackson(32).)

The relationship between parking supply in the CBD and area population is given in Table 3.(29) The data shown in Table 3 indicate that the number of parking spaces increases as the population increases; however, there is an exponential decrease in the number of spaces per 1,000 persons as the population increases. This relationship implies that trip makers in large cities must resort to transit and to travel modes other than single-occupancy-automobile travel because of the limited availability of land that can be used for parking.

Table 3
Parking Supply Data for Major U. S. Cities

Population Group of Urbanized Area	Type of Facility			Average Number of Total Spaces	Spaces per 1,000 Population
	Curb	Off-Street			
		Lot	Garage		
10,000-25,000	1,090 (43%)	1,530 (57%)	10 (0)	2,630	150
25,000-50,000	1,430 (38%)	2,420 (59%)	140 (3%)	3,990	120
50,000-100,000	1,610 (35%)	2,790 (60%)	260 (5%)	4,660	70
100,000-250,000	2,130 (27%)	4,760 (62%)	820 (11%)	7,710	50
250,000-500,000	2,450 (20%)	7,910 (64%)	1,940 (16%)	12,300	30
500,000-1,000,000	3,200 (14%)	12,500 (56%)	6,900 (30%)	22,600	30
Over 1,000,000	8,000 (14%)	32,200 (55%)	18,600 (31%)	58,800	20

Source: "Parking Principles", Highway Research Board Special Report 125, Table 2.3, p. 9. (29)

When motorists travel to the urban activity center they can park their auto at the curb or in off-street parking lots and garages.(29) As shown in Table 3, as the population of the city increases, the proportion of curb spaces decreases from 43% to 14% while off-street spaces increase from 57% to 86%. However, as shown in Table 4, the use of curb spaces is proportionately greater than the use of off-street facilities. For example, in small cities, curb spaces account for 43% of the total parking supply but accommodate 79% of the parkers. Although curb space, as well as curb usage, decreases as the population increases, there is a disproportionate usage of curb spaces for all population groups. As shown

in Tables 3 and 4, in cities of over one million population, curb spaces provide only 14% of the parking supply but accommodate 30% of the parkers. However, off-street spaces account for 86% of the supply but accommodate only 70% of the parkers. One major reason for this phenomenon is that motorists prefer to minimize the trip distance, including walking distance, and the cost of the trip.

The purpose of the trip affects parking characteristics.⁽²⁹⁾ A comparison of the percentages of parkers utilizing curb and off-street parking facilities by trip purpose is shown in Table 5. Shopping and personal business trips account for the majority of curb space usage, irrespective of city population. Conversely, workers utilize the majority of off-street spaces. As the population of an area increases, the percentage of shoppers using curb and lot spaces decreases; however, the use of these spaces by persons on personal business tends to remain constant. In cities with a population of over one million persons, a ban on curb parking may have little effect on shopping and work trips; however, it could have a dramatically adverse effect on personal business trips, which account for 15% of curb usage. Of course, the values given in Table 5 are average figures and the actual impact could vary from city to city.

Walking distance also influences parking characteristics.⁽³⁵⁾ As shown in Table 6, for each population group parkers walk the longest distance for work than any other trip purpose. Walking distances for all trip purposes, however, tend to increase as the population of the city increases. Parking policies which affect the location of spaces with respect to the final destination of the trip maker must consider the adverse impact the change would have on non-walk trips.

Table 4

Use of Parking Spaces

Population Group of Urbanized Area	Location of Parking Spaces		
	Curb (%)	Lot (%)	Garage (%)
10,000-25,000	79	21	0
25,000-50,000	74	24	2
50,000-100,000	68	31	1
100,000-250,000	52	42	6
250,000-500,000	54	34	12
500,000-1,000,000	33	39	28
Over 1,000,000	30	54	16

Source: "Parking Principles", Highway Research Board Special Report 125, Table 2.5, p. 11.⁽²⁹⁾

Table 5

Classification of Parkers by Facility and Trip Purpose

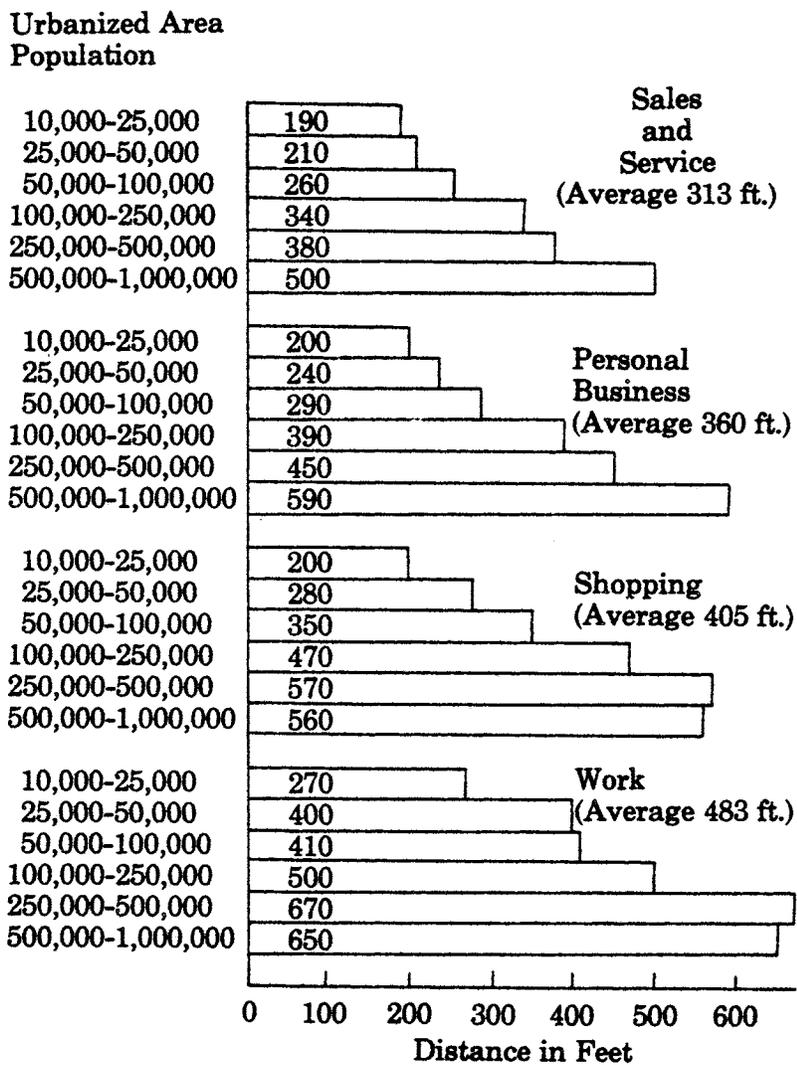
Population Group of Urbanized Area	Curb			
	Shopping (%)	Personal Business (%)	Work (%)	Other (%)
10,000-25,000	30	22	11	16
25,000-50,000	22	30	8	14
50,000-100,000	19	24	7	18
100,000-250,000	11	24	6	11
250,000-500,000	10	23	8	13
500,000-1,000,000	3	12	9	9
Over 1,000,000	3	15	4	8

	Off-Street							
	Lot				Garage			
	Shopping (%)	Personal Business (%)	Work (%)	Other (%)	Shopping (%)	Personal Business (%)	Work (%)	Other (%)
	8	1	10	2	0	0	0	0
	5	5	13	3	0	0	0	0
	5	7	12	7	0	0	1	0
	9	9	17	7	1	1	3	1
	6	7	18	3	3	3	4	2
	5	8	23	3	5	5	15	3
	4	13	29	8	3	2	8	3

Source: "Parking Principles", Highway Research Board Special Report 125, Table 2.7, pp. 12-13. (29)

Table 6

Walking Distances by Trip Purpose



Source: Parking Garage Planning and Operation, Eno Foundation for Transportation, Inc., p. 22. (35)

In most cities, the majority of parkers enter the CBD in the morning and leave in the late afternoon. (36) As shown in Figure 2, the work trip is the main reason for parking in the city. Because auto commuters arrive and leave at approximately the same time each day, they are primarily responsible for congestion, accidents, and for other detrimental impacts attributable to single-occupancy-auto travel. The time and spatial characteristics of the worker-parker also make that group the target of policies designed to reduce automobile travel by encouraging car pooling or mode shifts.

Motorists who drive to work minimize their travel costs, including the cost of parking. In the U. S., as shown in Table 7, 92.7% of the workers do not pay parking charges. (12) Furthermore, 75.6% of the automobile commuters have parking provided by their employers. These data imply that parking policies designed to reduce auto-commuting work trips by raising parking costs would have little effect unless employer provided spaces could be included in the policy.

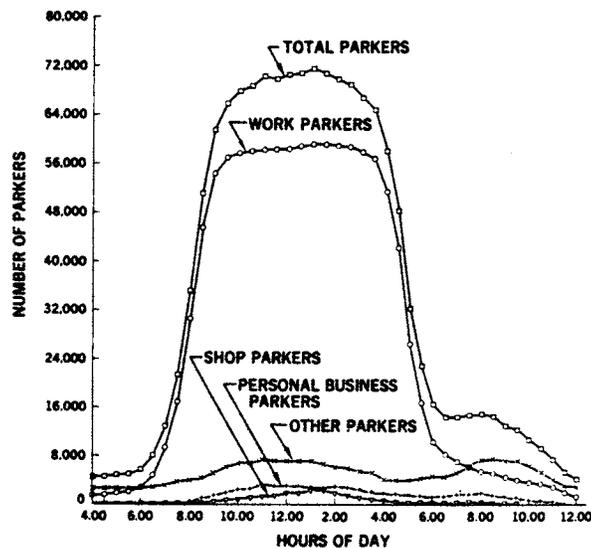


Figure 2. Parking duration by trip purpose in a typical city. Source: Highway Research Record 474, Figure 4, p. 12. (36)

Table 7
 Parking Charges Work-Auto Trips

<u>Type of Parking</u>	<u>Parking Charge</u>		Automobiles,
	<u>Yes</u>	<u>No</u>	<u>%</u>
Commercial facilities	63.1	2.3	6.0
Employer provided spaces	11.3	79.6	75.6
Fringe parking	0.0	0.6	0.5
Other lots	8.5	2.8	3.1
On-street	14.6	12.0	12.1
No all-day parking used	0.5	0.9	0.9
All other	2.0	1.8	1.8
Percent of total	7.3	92.7	100.0

Source: Transportation Research Board, Special Report 172,
 Table 6, p. 57.(12)

Groups Affected by Parking Policies

When the potential impacts of parking management strategies are considered, it can be inferred that nearly every person in the community would be affected. While this hypothesis is true to an extent, some groups are affected by parking controls more than other groups and assume a more active role when changes are planned and implemented. A list of the principal groups affected by parking changes is given in Table 8. The diversity in the concerns of these groups contributes further to the complexity of managing parking. Because the ultimate success or failure of a parking program will depend upon the participation and cooperation of these groups, it is imperative that concerns of all interested parties be addressed early in the planning process.

Of these groups, commuters, business operators, residents, public transit officials, and local political officials are usually directly affected by parking controls. The auto commuter wants to park near the place of employment with a minimum of cost; consequently, he is usually opposed to strict bans on urban parking and to high parking charges. Business operators also do not want to discourage auto travel through parking controls because they consider parking to be necessary to their livelihood. Residential communities adjacent to

major employment centers are also adversely affected when commuters park in the residential area to avoid parking costs or space reductions in the CBD. Public transit officials, especially in cities where their systems operate below capacity, usually favor parking limitations that encourage greater use of transit facilities. As might be anticipated, local political figures often have opposing views of parking management. Some officials support the development of additional spaces or free parking programs to encourage new business and economic activity in the downtown area. Other officials consider parking as an undesirable land use and support a limitation on parking in the business district.

For any given urban area or transportation related problem in the area, there is no stereotype view of parking management by any group. Each parking policy must be evaluated on an individual basis and each view must be considered in the decision-making process before the plan is finalized.

Table 8

Groups Affected by Parking Policies

Commuters
 Business operators and owners
 Residents of the urban community
 Property owners
 Parking lot and garage owners and operators
 Shoppers
 Politicians
 Police officials
 Tourists
 Transit officials
 Transportation planners
 Local transportation program administrators
 Traffic engineers
 Environmentalists

Impacts of Parking Management Strategies

Parking in an urban area is managed through regulation of the number of spaces (supply), the cost of the spaces (price), or the location of the spaces in the central area (location). A number of techniques or strategies have been developed for each of these control mechanisms. Shown in Figure 3 are seven major urban factors that can be affected by parking management policies. While the magnitude of the effect of each strategy on any given factor is dependent upon the size of the area affected, the problem being addressed, and the cooperation of the persons affected, it is clear that any strategy can impact a wide range of issues. An understanding of the complex issues involved and an evaluation of the probable impacts of each parking strategy are essential in the planning stage. It is important to note that any parking strategy can have beneficial and detrimental impacts on a variety of urban conditions. Criteria for estimating the effects of parking controls are outlined in a later section of this report.

It should be noted that the impact of many parking strategies has not been determined because these controls have not been implemented on a city-wide basis in U. S. urban areas. A research program to identify the use of parking strategies and associated impacts is in progress.⁽³⁷⁾

Parking as an Element of the Planning Process

The accessibility of the CBD or any activity center is primarily affected by the availability of travel modes and terminal facilities. While it has been long recognized that limiting and regulating parking can influence access to an area, parking has rarely been incorporated into the long-range urban transportation planning process.⁽³⁸⁾

Because of the broad impact of parking policies, it is important that planners evaluate the availability of parking within an area when forecasting future trip designations. Several methods have been proposed for including parking in the planning process and these models are shown in Figures 4, 5, and 6.⁽³⁸⁾ The models are based on the premise that an automobile must be parked before the trip purpose can be fulfilled. It is assumed that trip ends represent parking demand. When parking demand exceeds the available supply, the planner should reevaluate the transportation plan by redesigning either the roadways, the transit system, or the area's parking policy.

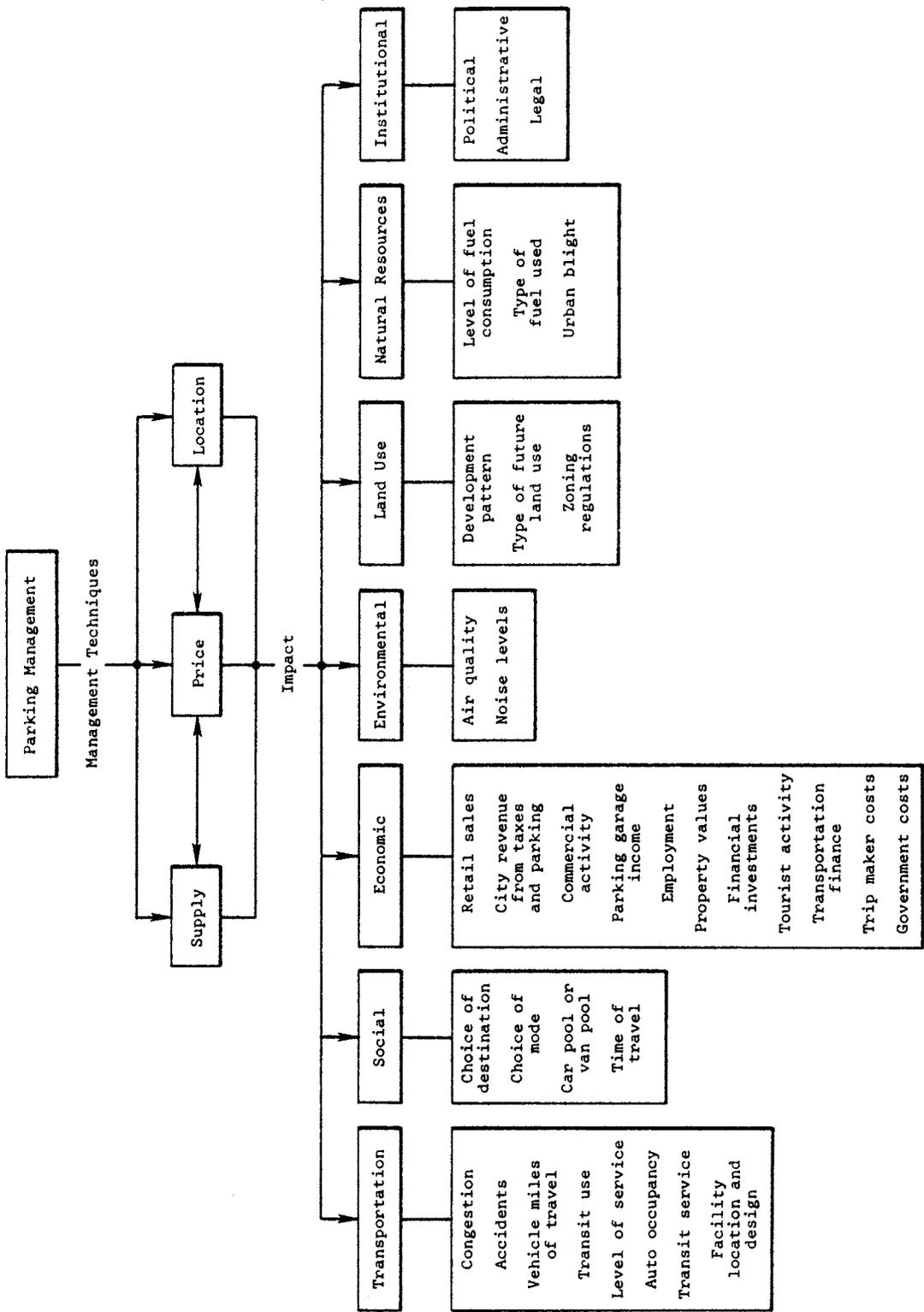


Figure 3. Impact of parking management.

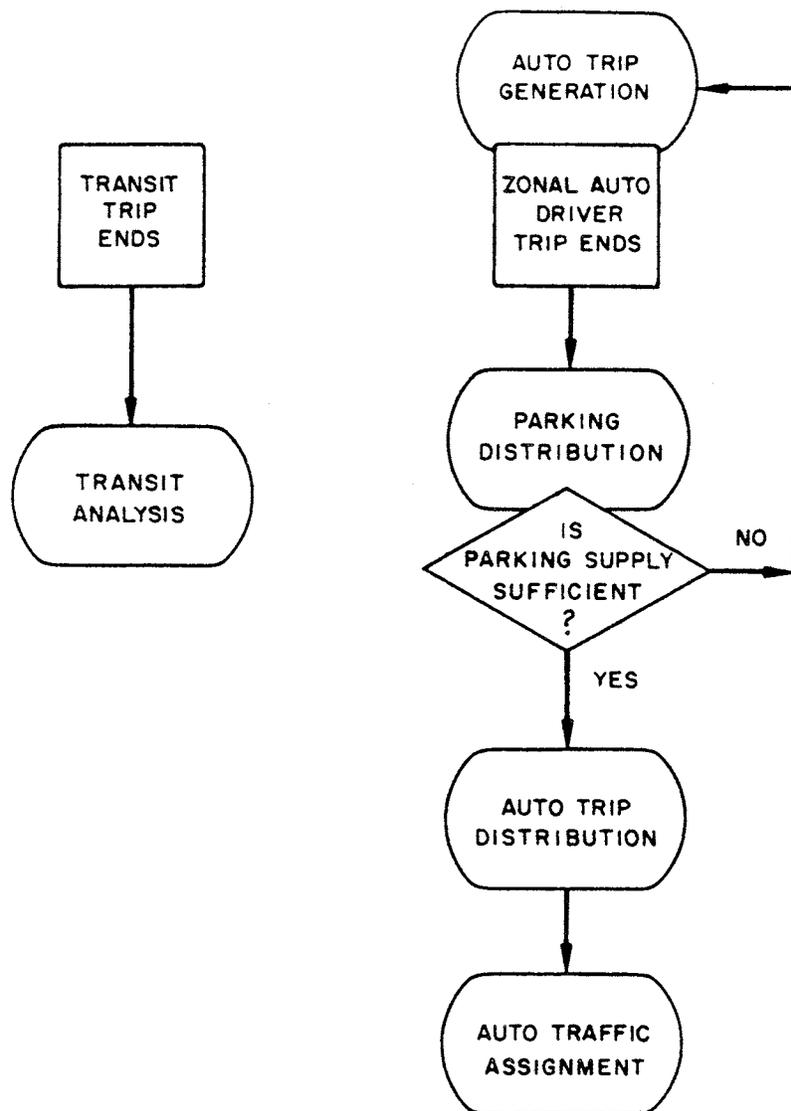


Figure 4. Model for including parking in the planning process in small urban areas. Source: Public Roads, vol. 35, no. 1, Figure 5, p. 20.(38)

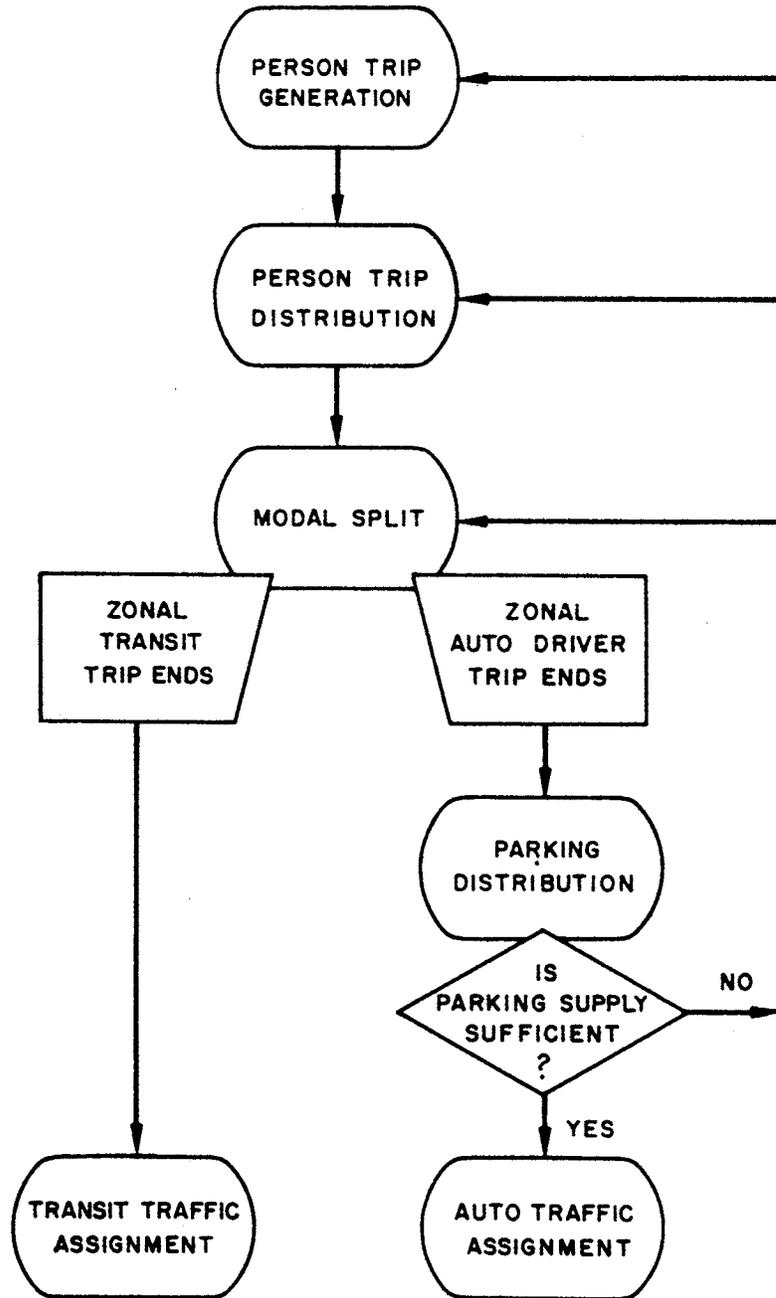


Figure 5. Procedure for including parking in the planning process using the trip interchange modal split model. Source: Public Roads, vol. 35, no. 1, figure 6, p. 21.(38)

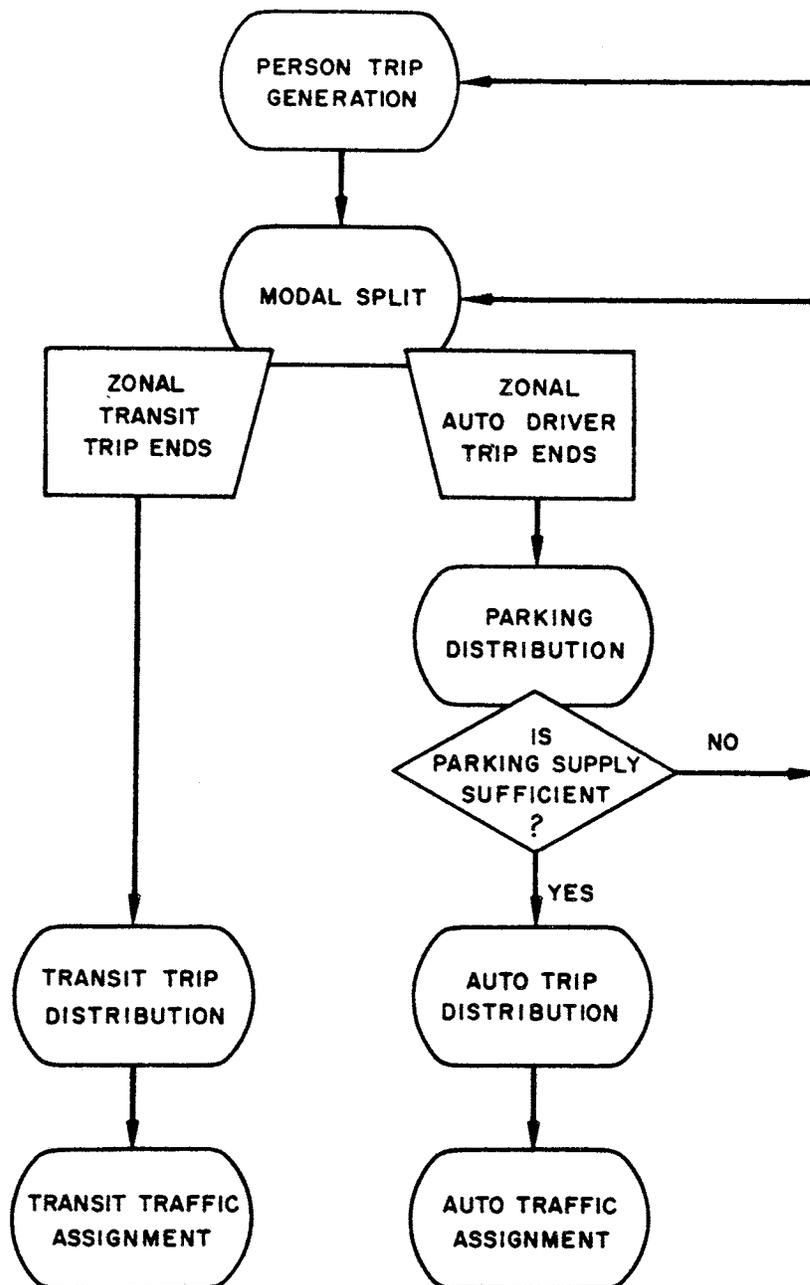


Figure 6. Procedure for including parking in the planning process using the trip end modal split model.
 Source: Public Roads, vol. 35, no. 1, figure 7, p. 22.(38)

As shown in Figure 4, in small cities motorists are not easily diverted to transit either, because there is little or no public transportation available. In this case, the planner must increase the parking supply to accommodate future demand. Using either the trip interchange or trip end models shown in Figures 5 and 6, the planner has the option of either increasing the parking availability or assigning these trips to transit.

Parking distribution models that can be used to simulate the parking process and evaluate the effects of alternative parking plans have also been developed. Most of the models are based on behavioral characteristics, i.e., walking distance, parking cost, location of parking facilities, etc., and incorporate a linear programming format.^(39,40,41,42) However, multiple linear regression, generation rate, gravity, equilibrium, and modal split models using generalized cost functions and parking characteristics have also been developed.^(43,44,45,46)

Although the basic concepts of these models are easy to understand, the processes of analyses are complex and can be accomplished only through computer iterations. Also, most of the basic input variables are difficult to model and calibrate for specific parking policies. Consequently, while parking should be incorporated into the planning process, economical and reliable procedures for accomplishing this objective have not been developed or demonstrated for widespread use. Currently, engineering judgment is the primary measure used to evaluate the effects of alternative parking policies.

New Concepts in Urban Parking Management

Historically in the U. S., parking management programs have been developed to provide adequate parking in cities. The provision of more parking spaces and more roads to accommodate automobile trips is a never ending, cyclic process. In large urban areas, it has never been possible to provide adequate roadway and storage facilities for autos. As shown in Figure 7, there is an exponential decrease in the number of parking spaces per 1,000 persons as the urban population increases. The data in Figure 7 were derived from parking studies conducted between 1955 and 1963.⁽³⁰⁾ Data collected during parking studies in 99 cities between 1960 and 1968 are compared to similar data collected in 1956 in Table 9.⁽⁴⁷⁾ These data indicate two important features of parking supply in American cities. First, as the city population increases, there simply is not enough land area available to accommodate everyone who may want to park in the central area. Secondly, the number of spaces available in cities with one million population and over has decreased. These features tend to indicate that parking availability in large metropolitan areas is naturally limited or controlled as the population

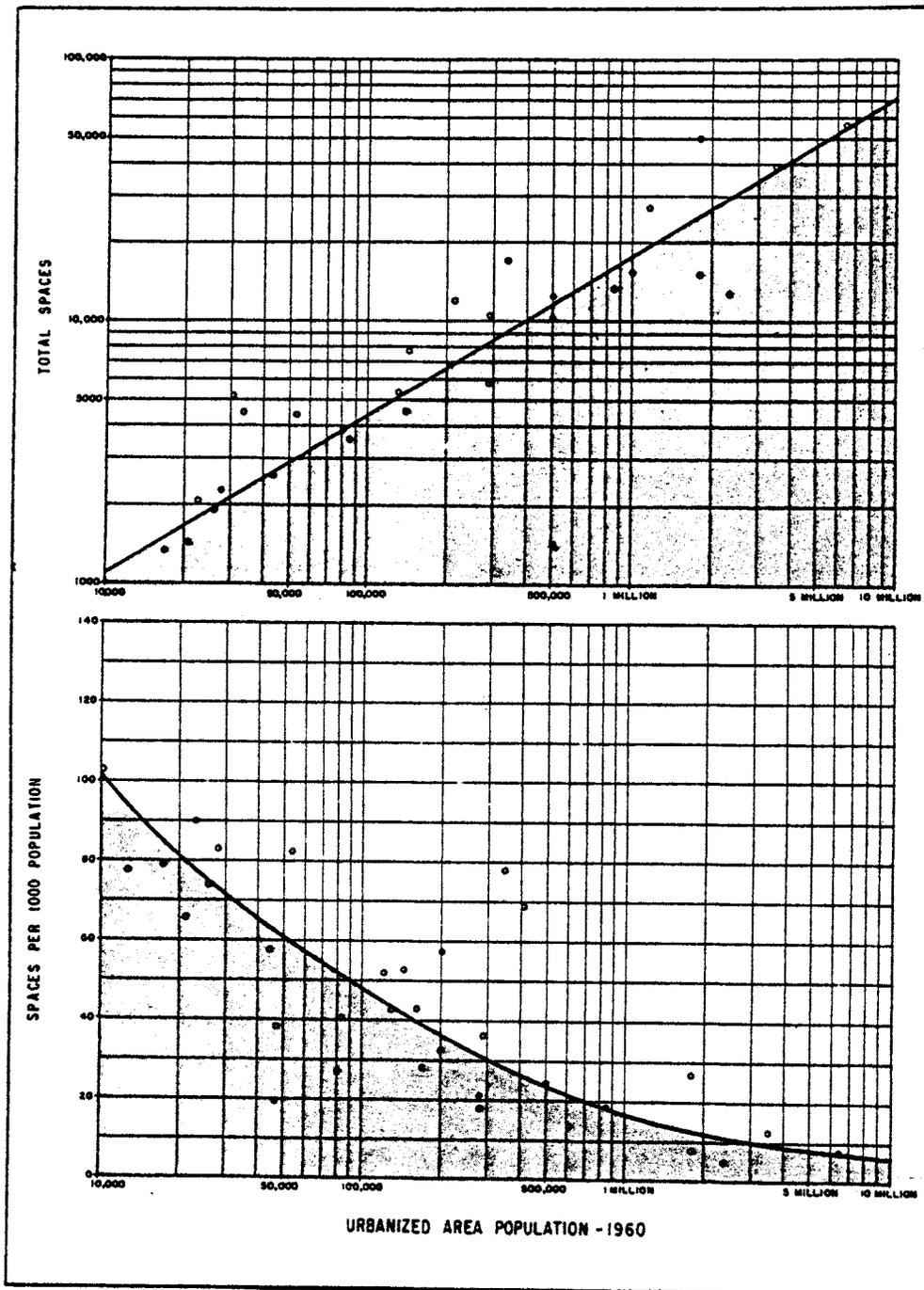


Figure 7. Relationship of parking spaces and urban population in U. S. cities.
 Source: Parking in the City Center, p. 4. (30)

Table 9

Comparison of Parking Spaces Available in Urban Areas

<u>Population Group</u>	<u>Spaces Per 1,000 Persons</u>		<u>Percent Change</u>
	<u>1956</u>	<u>1968</u>	
50,000-100,000	63.5	68.7	+ 8.2
100,000-250,000	33.2	48.5	+46.1
250,000-500,000	32.8	34.3	+ 4.6
500,000-1,000,000	24.2	31.8	+31.4
1,000,000 and over	18.1	15.9	-12.2

Source: Highway Research Record 317, Table 4, p. 42. (47)

increases within a specified boundary. Conversely, in cities with populations between 100,000 and 250,000 persons, land is still available for additional spaces and the 46.1% increase in spaces per 1,000 population indicates that parking programs generally were designed to increase the supply.

Although reductions in the number of parking spaces occur naturally as the city population increases, the impacts are not immediately evident because the change develops gradually over the years. Of course, as the cities develop public transportation must also be introduced to provide mobility to those persons who cannot use the auto for urban trips.

Environmental pollution, changing social views, reduced energy supplies, and limited economic resources are some of the major issues which have encouraged urban transportation planners in recent years to view parking management as a means of limiting auto travel. Parking policies that are designed to limit or discourage single-occupancy-auto travel are only one category of controls within the framework of urban multimodal transportation management. The concept of reducing auto travel is known as traffic limitation.⁽¹⁵⁾ There are three basic methods of limiting traffic; viz., traffic restriction, traffic restraint, and traffic avoidance.

Traffic restriction policies include methods that prevent automobile trips by the use of physical or legal barriers. These techniques include road closures, route restrictions, area permits, and limitations on driver licenses. Parking management strategies which fall within the scope of traffic restriction measures include parking

prohibitions and supply limitations. However, these controls must be implemented in conjunction with other restriction measures such as route restrictions to be strictly categorized as traffic restriction techniques.

Traffic restraint methods include all transportation policies that tend to discourage auto trips in the central area. These controls consist of policies such as vehicle taxes, high-occupancy-vehicle priority schemes, area licensing, vehicle tolls, and vehicle metering. Parking management strategies included within the realm of traffic restraint are priority parking programs, parking regulation enforcement, parking rate increases, parking taxes, and residential parking permits. Most of the traffic restraint measures must be implemented in conjunction with public transportation improvements to maintain mobility in the urban area. The purpose of these measures is to encourage a mode shift to public transit by discouraging single-occupancy-auto travel through disincentives.

Traffic avoidance methods include actions which prevent auto travel demands from initially occurring in an urban area. These methods are long-range planning strategies that include strategic land use planning and restrictive road building policies. Parking controlsthat fall into this category are imposing a freeze on downtown parking spaces, limiting the number of parking spaces allowed in a zone, and limiting parking garage construction. A recent study by the Institute of Transportation Engineers Technical Committee 6F-14 revealed that in the U. S. the potential for no or low growth policies advocated through traffic avoidance measures has declined because of the economic recession, a drop in the birth rate, and emigration.(48) Traffic avoidance methods, however, may offer growing communities effective means of regulating traffic growth gradually without imposing sudden disruptive measures.

Innovative traffic limitation programs have been implemented in foreign cities, especially in Europe, for a number of years. Documents reporting the use and effectiveness of limitation schemes are available in the literature.(5,15,49,50,51,52,53,54,55) Literature on traffic restraint and comprehensive case studies of traffic management controls in several European cities is also available.(56,57,58,59) The major advantages and disadvantages of traffic limitation measures are outlined in Table 10. While transportation management programs have been implemented in a few areas, only a few cities have a comprehensive policy of traffic limitation.(15) Most of the strategies have been designed to limit traffic in the central urban area.

Table 10

Advantages and Disadvantages of Implementing
Traffic Limitation Strategies

<u>Advantages</u>	<u>Disadvantages</u>
Reduced traffic congestion	Higher public transportation costs
Reduced air and noise pollution	Inconvenience of using public transit
Reduced traffic accidents	Increased congestion on public transit
Conservation of fuel	Decline in urban area activities
Improved pedestrian movement	Increased enforcement costs
Reduced vehicle operating costs	Increased number of agencies involved
Less demand for parking spaces	Lack of information on effectiveness
Reduced urban sprawl	Threat of transit worker strikes
Improved public transit service	Difficulty in designing a package of controls for specific areas
Less road building and maintenance	Opposition by motorists
Preservation of historic areas	
Improved land use	

Parking management controls are frequently used methods of limiting traffic. Shown in Table 11 is a summary of 19 projects in which parking strategies have been implemented, evaluated, and documented.⁽⁶⁰⁾ In most cases the parking policies were adopted to support other primary strategies such as to encourage public transit usage or to enhance priority treatments for other vehicles or bicycles. The only city with a strategy exclusively for parking management was Aachen, West Germany, where changeable message signs were installed to direct motorists to available parking spaces to reduce traffic created by motorists searching for a space.⁽⁶⁰⁾ An evaluation of the effectiveness of the measure indicated that traffic was reduced by 10%.

The application of parking strategies in U. S. urban areas is given in a later section of this report.

Table 11

List of Implemented Parking Management Projects

<i>Country</i>	<i>Project Title (Year)</i>
Denmark (03)	Copenhagen Park-and-Ride Facilities at Inter urban Train Stations (unknown)
Denmark (06)	Copenhagen Traffic Restraint in a Central Business Area (1962)
Denmark (07)	Copenhagen Traffic Restraint in a Residential Area (1975)
West Germany (01)	Aachen Route Guidance to Parking Facilities (1971)
West Germany (16)	Hamburg Public Transport Integration (1963)
West Germany (20)	Mainz Inner-City Traffic Restraint Plan (1954)
West Germany (25)	Munich Parking Policy Implementation Study (1974)
The Netherlands (04)	Haarlem Parking Control in a Residential Area (1976)
The Netherlands (06)	Enschede Traffic Restraint in a Residential Area (1975)
The Netherlands (09)	Groningen Traffic Restraint in the Central City (1977)
The Netherlands (12)	Delft Traffic Restraint in Residential Areas (1970)
The Netherlands (14)	Delft Traffic Restraint in the Central City (1970)
Sweden (10)	Uppsala Traffic Restraint in the Central Business District (1972)
U.K. (07)	Ealing/Hounslow Parking Restrictions Along a Bus Route (1971)
U.K. (09)	Formby Bus Feeder Service to a Local Railway Station (1970)
U.K. (16)	London Parking Control Policy and Experience (1958)
U.K. (31)	Nottingham Zones and Collar Study (1975)
U.K. (32)	Oxford Forecast of Use of Park-and-Ride (1973)
U.K. (37)	St Ives Park-and-Ride Scheme (unknown)

Source: Traffic Engineering and Control, February 1979, p. 6. (60)

List of Parking Management Strategies

Two major concepts of parking management have been presented. In the first concept, parking management policies were designed to provide adequate spaces for vehicles. In the second view, parking policies were adopted to limit traffic in the central area. It is inappropriate to strictly adopt either concept for a given area as the choice of a parking policy depends on the transportation and urban development objectives of the area. Thus, it is not proper to identify parking management strategies as transportation incentives or disincentives. A parking management strategy is a measure taken to alter the supply, price, or location of parking in a selected area to make the operation of the transportation system more efficient or to reduce single-occupancy-automobile traffic in the area to reduce congestion and environmental pollution, and to enhance revitalization, historic preservation, and energy conservation.

A number of measures have been proposed and implemented to manage parking. A list of 36 parking management strategies is shown in Table 12. While no single source identified all 36 strategies, the list was developed from a comprehensive review of the available literature. Of the 36 measures identified, 19 were supply strategies, 15 were price strategies, and 2 were related to the location of the parking facilities.

It is probable that no single measure would be adopted in any selected area. Typically, a combination of these strategies, along with other actions such as improving transit service, must be developed to address specific urban problems. It was beyond the scope of the study to outline groups or packages of actions, as that task has been attempted by other researchers; however, a framework for evaluating each strategy is proposed in a later section of the report. (61,62)

Need for Parking Management

In recent years, due to national awareness of environmental, energy, social, and economic problems related to single-occupancy-automobile travel, there has been increased emphasis by the federal government on encouraging improved management of the urban transportation system. Because of the potential impact parking strategies may have on reducing auto travel, parking management has become a major area of interest. It is improper to suggest that the automobile and parking facilities are the major sources of problems in urban areas. As one observer has noted, urban land use and demographic changes have resulted primarily from economic (affordable, single-home mortgages) and social problems within cities and ineffective land use planning, which in combination with the availability of the automobile have contributed to urban problems. (63)

Table 12

List of Parking Management Strategies

<u>Strategies</u>	<u>Description</u>
<u>Supply Measures</u>	
1. Eliminate on-street parking	On-street parking is prohibited along major roadways in the CBD
2. Eliminate peak-period, on-street parking	On-street parking is prohibited along major roadways during peak periods
3. Short-term, on-street parking	On-street parking is permitted only for short periods to discourage commuter parking and to encourage shopping trips
4. Parking regulations enforcement patrols	A special civilian force is created to enforce parking regulations to release police for other operations
5. Strict enforcement of regulations	Parking regulations are strictly enforced to discourage violations
6. Reserved parking for priority vehicles	Special spaces are provided for priority vehicles including taxis, vehicles of handicapped persons, etc.
7. Reserved parking for high-occupancy vehicles	Special spaces are provided for HOV including car pools and van pools
8. Restricted parking time at all facilities	Parking time is restricted at all on-street and off-street spaces to discourage commuter parking
9. Residential parking permits	Parking in residential areas is allowed only by special permit to discourage commuter parking
10. Freeze number of parking spaces	Limitations are placed on the number of spaces in the urban area
11. Limit parking garage construction	Limitations are placed on the construction of new parking garages in the city
12. Dual uses of facilities	Parking spaces are used for more than one activity, i.e., employee parking in day, nightclub parking after dark

Table 12 (cont.)

13. Late opening of lots	Parking spaces are closed until after 9:30 a.m. to discourage commuter parking
14. Bicycle parking	Special spaces are provided for bicycles
15. Priority spaces for compact cars	Special spaces are provided for small, fuel-efficient vehicles
16. Transit station parking	Special lots are provided at transit stations to encourage public transit trips
17. Reduce transit station parking	Transit station parking spaces are reduced or not provided to encourage use of bus feeder facilities
18. Zoning law limits	Zoning laws are imposed to restrict developers from providing a maximum number of spaces instead of a minimum number
19. Parking information systems	Changeable message signs are installed to direct parkers to available spaces to reduce traffic created by persons searching for a space

Price Measures

20. Short-term free parking	On-street parking is permitted free of charge to encourage shopping trips to the central area
21. Minimum parking fee	A minimum fee is charged for off-street spaces which previously were provided at no cost to the user
22. Parking tax	A special parking tax is levied on all parking charges to increase the cost of parking
23. Increase all parking rates	Parking rates are increased for all spaces in the central area
24. Discriminating hourly rates	Parking rates are altered to provide low cost for short-term parking and high cost for long-term parking

Table 12 (cont.)

25.	Merchant stamp validation	Merchants offer free parking to shoppers who have their parking stub validated after purchasing goods
26.	Meter on-street spaces	Parking meters are installed to increase the cost of on-street parking
27.	Reduced fees for high-occupancy vehicles	Reduced parking costs or free parking is provided for car pools and van pools
28.	Straight-line parking rates	A constant rate per unit time is charged to ensure long-term parkers pay the same rate as short-term parkers
29.	Parking stall tax	A tax is imposed on each parking space to increase the cost of employee parking
30.	In-lieu parking regulations	Developers are required to contribute money to transit in lieu of constructing a proportion of total spaces conventionally required
31.	High rates for single-occupancy vehicles	The cost of parking is increased for single-occupancy vehicles and the funds are used to lower costs for high-occupancy vehicles or public transit
32.	Parking surcharges	Special parking fees are charged for parking in congested areas
33.	Garage/lot tax	A special tax is charged to garage/lot owners for each parking space to increase the cost of parking
34.	Equalized rates	The same parking rates are charged for on-street and off-street spaces

Location Measures

35.	Peripheral parking	Special parking areas are provided near the perimeter of the activity center, usually within walking distance of the CBD
36.	Park and ride facilities	Parking lots are provided along major transportation routes and express transit carries passengers to the central area

The federal agencies that have been most concerned with parking management are: (1) Environmental Protection Agency (EPA), (2) Federal Highway Administration (FHWA), (3) Urban Mass Transportation Administration (UMTA), and (4) Department of Energy (DOE). The role that each of these agencies has in parking management is summarized below.

Environmental Protection Agency

The concept of using parking management strategies to limit automobile traffic in American cities was initiated on the national level by the EPA. With the passage of the Clean Air Act of 1970, the EPA promulgated national air quality standards for six pollutants. Emissions from motor vehicles, primarily carbon monoxide and hydrocarbons, were exceeded in 66 urban areas.⁽⁶⁴⁾ After implementation of controls on new automobiles and stationary sources, additional transportation controls were needed in 30 areas to meet the national air quality standard. Because parking controls have the potential of reducing auto trips and increasing the use of public transit, the EPA required that parking management and other transportation control techniques be used to meet the air quality standards.⁽³⁾ The regulations on parking management were short-lived as demonstrated by the timetable shown in Table 13. Because of strong opposition from public, business, and political sources, the EPA rescinded the parking management regulations on July 15, 1975.⁽⁸⁾ Other factors that influenced the decision were:^(6,64)

1. The regulations were based on an invalid set of assumptions regarding relationships between vehicle miles of travel and auto emissions.
2. The proposed strategies were not realistic and if implemented would not necessarily reduce vehicle miles of travel or emissions.
3. There was a lack of information regarding the effectiveness and costs of various transportation strategies and the problems they would entail.

On August 7, 1977, the Clean Air Act Amendments of 1977 were enacted by Congress and signed by the President. Unlike the 1970 legislation, the new act requested the EPA and the Department of Transportation (DOT) to work together to develop new air quality programs. The actual programs will be developed by the local transportation and air quality agency. Areas which were not in compliance with air quality standards by January 1, 1979, must submit a transportation control plan by December 31, 1982. The Act also provides a 5-year extension to 1987 if the state is satisfactorily complying with other statutory requirements.

Table 13

Evolution of EPA Parking Regulations

<u>Federal Register Date</u>	<u>Subject</u>
November 12, 1972	Original Transportation Control Plan, including Parking Management
January 4, 1974	Changed criterion from 50 to 250 space minimum size
January 15, 1974	Delayed effective date to January 1, 1975. Rescinded surcharge requirement
August 22, 1974	Proposed changes to Parking Management Regulation, clarified delegation, stressed plans, and added VMT minimization option
August 27, 1974	Correction to Table 11, Appendix B of August 22, 1974 Federal Register
October 15, 1974	Postponement of Parking Management compliance date of July 1, 1975
January 14, 1975	Parking Management Regulations suspended until further notice pending amendment of Guidelines
July 3, 1975	Suspension of the EPA Indirect Source Regulations indefinitely
July 15, 1975	Suspension of Parking Management Regulations pending further congressional guidance

Source: Transportation Engineering Journal, vol. 102, no. TE4, p. 873. (10)
American Society of Civil Engineers, November 1976.

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Parking management strategies are listed in the 1977 amendments as possible transportation control strategies. Specifically mentioned in Section 108 of the Act are programs to control on-street parking and programs to construct new parking facilities and operate existing parking facilities for the purpose of park and ride lots and fringe parking.

Whether or not the new transportation control plans will be successful can be debated. The emphasis on local development and involvement in planning control measures should enhance the development of realistic alternatives; however, the primary objective, the reduction in vehicle miles of travel (VMT), may not be accepted by the public.⁽⁶⁵⁾ There is also some question as to whether transportation controls can improve air quality in all urban areas.⁽⁶⁶⁾

A number of researchers have examined the impacts of using parking management strategies to reduce VMT as a means of improving air quality.^(11,13,67,68,69,70,71,72) In these studies, computer models have been used to estimate the impacts of the control measures. No study was found where the actual relationship between vehicle miles of travel and air quality level has been measured using a controlled before and after experimental design. Research to verify that VMT is an appropriate basis for predicting air quality is needed.⁽⁷³⁾

There is little doubt that parking management strategies can be used to reduce automobile trips. However, the total impacts on air quality, along with the impacts on energy, economics, and motorist attitudes, need to be demonstrated through their implementation in a number of urban areas.

Federal Highway Administration and Urban Mass Transportation Administration

In the interest of attaining broad local and national goals of conserving energy, improving the environment, providing equity for transit dependents, and preserving the urban area, on September 17, 1975, the FHWA and UMTA jointly promulgated regulations for the development of a Transportation Improvement Program for each urban area.⁽¹⁾ An integral part of the Transportation Improvement Program is the Transportation System Management (TSM) element. The main objective of TSM is to plan for the implementation of low-cost, short-range measures that will achieve maximum efficiency and productivity for the urban transportation system. Specifically, the TSM element requires —

1. provisions for the short-range transportation needs of the urban area by making efficient use of existing transportation resources and for the movement of people in an efficient manner; and

2. the identification of traffic engineering, public transportation, regulatory, pricing management, operational, and other improvements to the existing urban transportation system, but not including new transportation facilities or major changes in existing facilities.

One of the most important features of TSM is the recognition of the unique characteristics, needs, and goals of each urban area. Thus, a TSM element may incorporate a number of strategies to meet the transportation and development objectives for a community.

Parking management is identified as one of the TSM techniques that can be used to meet short-term transportation goals. Specific strategies for managing parking are given below.

1. Elimination of on-street parking, especially during peak periods
2. Regulation of the number and price of public and private parking spaces
3. Favoring of short-term users over all-day commuters in the provision of parking
4. Provision of fringe and transportation-corridor parking to facilitate transfer to transit and other high-occupancy vehicles
5. Strict enforcement of parking restrictions

The extent to which local transportation planners are incorporating parking management strategies into their TSM element has not been determined. An evaluation of 40 TSM elements submitted by Metropolitan Planning Organizations revealed that —

1. of the 40 plans submitted, only 10 had been adopted;
2. little effort was made to develop a strategy for solving urban transportation problems;
3. no analysis was undertaken to evaluate the impact of TSM projects; and
4. there is much confusion as to what a TSM document should contain.⁽⁷⁴⁾

The study results suggest a need for additional guidelines, especially guidelines describing the process of selecting and combining strategies and techniques for evaluating the impacts of alternative transportation measures. Considerable research is under way to improve the TSM planning process. (75)

Through the TSM element, the DOT has initiated a strong incentive for local planners to implement transportation controls to enhance the efficiency and use of existing transportation facilities. The extent to which the measures will be implemented and the success of these strategies are yet to be determined.

Department of Energy

To date the DOE has not promulgated specific transportation regulations designed to conserve energy. However, another oil embargo or a sharp increase in energy consumption could conceivably necessitate the implementation of strict transportation control plans.

Most of the transportation management techniques, including parking management strategies, that are imposed to increase the efficiency of existing transportation facilities have some energy conservation potential. The effectiveness of strategies or combinations of strategies which could maximize energy conservation for specific conditions in an urban area have not been identified. In fact, the extent to which transportation controls have been implemented or have been planned for implementation in the U. S. has not been determined. In view of the national energy problem, research to determine the energy-saving potential of various controls should be given a high priority.

Local Area Needs for Parking Management

In contrast to federal policies which encourage the development of transportation control plans, the need for transportation management is derived from problems found in each urban area. To examine the magnitude of local transportation related problems as perceived by urban officials responsible for parking management, the respondents to the questionnaire survey were asked to rate specific problems on a 5-point scale (Question 3 of the survey shown in Appendix A). The results of the survey are shown in Table 14. It should be noted that a uniform quantitative measure was not defined for any problem; thus the results are subjective evaluations of problems perceived on the local level. Of the five problems identified, the inefficient use of energy was rated the most serious one. An analysis of the data, given in Appendix A,

Table 14

Magnitude of Transportation Related Problems as Perceived by 173 City Officials in Urban Areas

Categories	No Problem	Minor Problem	Considerable Problem	Major Problem	No Reply
Traffic congestion	12	53	17	15	7
Traffic accidents	3	56	23	8	9
Air pollution	43	66	16	8	8
Traffic noise	34	90	7	1	8
Inefficient use of energy	9	37	35	11	11
Other	0	0	3	9	160

indicates that the energy problem was rated as the most serious for each city population group. Traffic congestion and accidents were rated behind energy as major problems. Air pollution was felt to be a considerable or major problem in only 24 areas (13.9% of the cities). Other major problems listed were the need for more highways and parking facilities and the lack of funding for public transportation. One local problem listed in the survey was the need to regulate commuter parking in residential areas.

The survey data indicate that the majority of local officials do not perceive many of the urban transportation related problems as being major problems. Most of the respondents, however, did indicate an interest in receiving additional information on parking management. A summary of their views related to local problems and parking management strategies is given in Appendix C.

Problems With Implementing Parking Management Strategies

No transportation program, irrespective of the potential benefits or need, can be formulated and implemented without creating problems or disadvantages. Because parking affects a large number of different interests, there are a wide range of factors that tend to discourage the implementation of many parking strategies. Some of the factors that have been recognized as impeding the development and use of parking controls are summarized in Table 15. While a few of the problems created by these factors are real, some are imagined and can easily be resolved. The major problem is that widespread implementation of various strategies has been limited in American cities and not enough information exists to adequately identify the key issues or specific problems that may be encountered in an urban area. Until further experimentation is conducted, each of the factors must be given careful consideration in the development of comprehensive parking policies.

Most of the factors, which are categorized into five groups in Table 15, are related to parking management in general and do not address problems encountered when implementing specific strategies. Factors related to specific parking controls are addressed in the next section of this report. Also it should be carefully noted that the factors cited encompass the full spectrum of parking management problems, and that, consequently, for any given urban area or parking strategy only a few of the impediments may be applicable.

Table 15

Summary of Factors That Discourage Implementation
of Parking Strategies

<u>Category</u>	<u>Factor</u>
Institutional	1. Parking strategies place an unequal burden on low-income drivers
	2. People resent policies imposed by governmental agencies
	3. Most parking facilities in large urban areas are privately owned and not subject to government regulation
	4. Public, political, and business interests generally oppose restrictive parking controls
	5. Existing public parking agencies are subjected to fragmented control requiring a number of agencies to make critical management decisions
	6. Complex priority parking schemes and rate structures are difficult to administer and enforce
	7. Even simple parking controls take a long time to implement if legislative action is required
	8. Most feasible parking controls have already been implemented
	9. Most agencies do not have the trained personnel needed to deal with a variety of issues and impacts required for developing and administering effective parking policies
	10. The absence of traffic management in favor of auto use incentives has worked against reliable public transit service and capacity
	11. Parking controls can have diverse effects on an urban area
	12. Unpopular restrictive parking measures would create a reluctance on the part of agency officials to enforce regulations and to collect associated taxes and fines

Table 15 (cont.)

- | | | |
|----------|-----|---|
| | 13. | Parking controls are not applicable to the transportation related problems of the area |
| | 14. | Parking restrictions are prohibited by city and/or state laws |
| Social | 1. | Downtown parking restrictions impose hardships on adjacent residential areas |
| | 2. | Public interest and involvement in environmental issues has declined in recent years |
| | 3. | Auto drivers will not switch to public transit because service is not reliable |
| | 4. | Parking restrictions infringe upon constitutional guarantee of the freedom of mobility |
| | 5. | Many parking regulations are difficult to understand and to comply with |
| | 6. | Parking controls discriminate against persons who are employed in the affected area |
| Economic | 1. | Restrictive parking strategies will have a drastic negative financial impact on the parking industry |
| | 2. | Parking limitations will reduce government revenues generated by parking charges |
| | 3. | Restrictive policies will disrupt financial commitments made to establish off-street parking facilities |
| | 4. | Parking limitations would greatly reduce sales and lead to decline of the central business area |
| | 5. | Agencies do not have the funds to administer or enforce parking regulations |
| | 6. | City tax structures often act as an incentive to creating parking space development |
| | 7. | Existing parking rates encourage long-term parking |

Table 15 (cont.)

Land Use

1. Restrictive parking policies would discourage downtown development and enhance the development of fringe areas
2. There would be a proliferation of low-density, small-scale developments outside of areas subject to strict parking limitations that would create automobile travel and the need for parking in these areas
3. Zoning regulations in cities are often ineffective and many codes encourage rather than discourage parking development
4. Existing land use patterns encourage auto travel and necessitate that adequate parking be provided

Effectiveness

1. Evaluation of the effectiveness of various parking strategies has been limited
2. Parking restrictions will not be effective because:
 - a) There is a surplus of public and private parking in most urban areas
 - b) Nationwide, 92.7% of commuter auto trips park free
 - c) Parking fees are low, averaging \$1.75 per day in American cities
 - d) Increases in parking fees, even when coupled with free bus service, have little effect on the choice of travel mode
 - e) There are no perceived problems in most urban areas that require restrictive parking measures
 - f) Alternative transportation services are not available
 - g) Only a fraction of auto trips in an urban area result in parking downtown
 - h) Parking strategies are not needed in small cities, areas without a defined central business district, or in areas with low population densities
 - i) Most downtown parking is under private control

Table 15 (cont.)

3. There are insufficient data on which to assess the potential benefits of parking strategies
4. There are no standard techniques or measures for evaluating the effectiveness of parking controls

Institutional factors that discourage implementation of parking strategies comprise a broad range of problems. Perhaps the most difficult problem to overcome is the opposition of public, political, and business interests to parking controls. While some of the opposition may never be mollified, one method of dealing with the problem is to identify the specific issues that lead to opposition. Much of the opposition may be due to a general fear of the unknown effects of the policy which results in a basic resistance to change. These fears can be alleviated by incorporating all interest groups in the early planning stages of the policy and by demonstrating the impacts of similar policies in other areas. Also, experimentation of the plan in a limited area (several blocks) prior to implementation on an areawide basis would provide an opportunity for the groups to become familiar with the concept and its associated impacts. The gradual application approach would also assist the agency in assessing the effects of the policy and allow refinements before full-scale implementation.

Another major institutional factor that discourages the implementation of a comprehensive parking management program is fragmented control of parking among many city agencies. The broad range of agencies involved in parking was substantiated by a review of the responses to the questionnaire survey for this study. It revealed that the 173 respondents represented the following 12 distinctive governmental departments.

1. City traffic engineers
2. City planning directors
3. Transportation directors
4. Traffic engineering managers
5. City engineers and managers
6. Directors of public works
7. Directors of parking
8. Superintendents of streets
9. City administrative assistants
10. City engineering liaison officers
11. Chiefs of police
12. Directors of general services

The range of agencies responsible for parking management suggests that parking is generally not given departmental status in most areas. This diversity in management responsibility that requires the cooperation of a number of agencies to formulate parking policies is a real impediment to implementing restrictive parking strategies. Recognition of the need for parking management and the potential benefits from effective controls are perhaps the best incentives for encouraging reorganization and the creation of a parking agency.

Social impediments to implementing parking strategies deal primarily with the effect the strategy has on the individual. There have been criticisms that transportation decision makers are paying too little attention to the freedom of independent personal mobility by applying traffic limitations.⁽⁷⁶⁾ Whether or not parking strategies are discriminating against individuals or interest groups is an issue that must be decided through the judicial process.

The major social issue affecting parking is the problem of encouraging auto drivers to switch their trips to public transit. The problem is multifaceted and there are serious difficulties involved. Much behavioral research has been conducted to examine incentives for encouraging mode changes and the reasons people prefer to use their automobiles.^(77,78,79,80,81) The primary factors that have been shown to affect mode choice are cost, comfort, time, walking, parking availability, parking costs, and auto availability. Trip costs play an important role in mode choice for shopping. Two of the strongest incentives found that would encourage drivers to switch to public transit relate to the availability and price of gasoline. A 1975 attitudinal survey of existing and potential transit users in New Haven, Connecticut, revealed that gasoline rationing and increasing the price of gasoline above \$1.00 per gallon⁽⁸²⁾ would give the necessary encouragement. Increases in parking costs, even when supplemented with free bus service, had little effect on mode choice, as shown in Table 16. Fuel constraints coupled with increases in parking costs would have to be imposed before motorists would be diverted to public transit. It has also been shown that the unavailability of fuel rather than fuel cost was the major cause of increased auto occupancy during the 1973-74 oil embargo.⁽⁸³⁾ Although there is some evidence that major increases in parking costs can influence mode choice, most of the auto trip reductions have been temporary. The major driver response has been to purchase more-fuel-efficient automobiles.⁽⁸⁴⁾ Continuing efforts of American automobile manufacturers to produce more-fuel-efficient cars could further reduce motorist incentives for using public transit. It appears that disincentives to automobile use will cause shifts to other modes only to a limited extent.⁽⁸⁵⁾

Table 16

Impact of Constraints on Automobile Use
(Greater New Haven Transit Study — 1975)

TYPE OF CONSTRAINT	CAR DRIVERS TAKING BUS ^a	
	Number	Per- cent
Gasoline cost \$1.00 or more per gallon	40	24.3
Gasoline rationed to 10 gallons per week	20	12.1
Gasoline rationed and cost \$1.00 or more per gallon	<u>50</u>	<u>30.3</u>
Subtotal Gasoline-Related	110	66.7
Parking cost increased by \$1.00	1	0.6
Free bus and parking cost increased	13	7.9
Gasoline cost \$1.00 or more per gallon and parking cost increased \$1.00	9	5.4
Gasoline rationed, cost \$1.00 or more per gallon, and parking cost increased by \$1.00	15	9.1
Gasoline rationed and parking cost increased by \$1.00	4	2.4
Gasoline rationed or cost \$1.00 or more per gallon, parking cost increased by \$1.00, and bus ride free	<u>13</u>	<u>7.9</u>
Subtotal Parking Related	55	33.3
GRAND TOTAL	165	100.0

^aUnexpanded responses, all locations combined, constrained mode change by car drivers only.

Source: Transportation Research Record 625, Table 4, p. 3. (82)

A number of economic factors have been identified as deterrents to the implementation of parking controls. Of these factors, the financial impact that controls may have on the downtown area is the most difficult to deal with. The amount of parking in the CBD has been shown to have a direct empirical relationship to the economic activity of the area.⁽²⁷⁾ Economic indicators such as sales are affected by many factors other than parking. Congestion decreases the accessibility of the downtown area and may also divert trips to other shopping areas. The overall impact of parking policies on the economic activity of the affected area must be carefully evaluated before, during, and after the implementation of parking strategies. However, caution should be used in evaluating retail sales as a measure of economic activity. A recent study in Richmond, Virginia, revealed that in an 18-month period retail sales declined when compared to sales figures in the state during a free downtown parking experiment.⁽⁸⁶⁾ City merchants, however, felt the program was highly successful as their average sales increased \$3,818 per month during the experiment.

Parking policies have a definite impact on land use development.⁽²⁴⁾ Area zoning policies should be carefully reviewed and amended if necessary to reduce fragmented development of parking facilities that encourage additional auto travel. Artificial restrictions that would discourage downtown redevelopment in favor of fringe development should also be avoided, unless mobility in the central area can be maintained through increased transit ridership or multiuse of existing parking facilities.

Perhaps the greatest impediment to implementing parking strategies in urban areas is the lack of sufficient information on which to judge the effectiveness of the measures. Through controlled experimentation and demonstration projects, new data can be obtained and this impediment can be reduced. These data may also be useful to persons seeking to overcome many of the other barriers that currently prevent the implementation of innovative parking management strategies.

SURVEY OF PARKING MANAGEMENT STRATEGIES

The purpose of the survey questionnaire was to identify the type of parking strategies in use or planned for implementation in American cities and to determine why they were selected, how they were evaluated, and what problems were encountered. Although 36 parking strategies were identified during the literature review (see Table 12) only the 17 strategies shown in Table 17 were specifically included in the survey form. This limitation was necessary to reduce the length of the questionnaire and the time required for a respondent to complete it. Given below are the general results of the questionnaire. Following the summary is a discussion of each parking management strategy listed in Table 17.

Table 17

Parking Management Strategies Included
in the Questionnaire Survey

<u>Category</u>	<u>Strategy</u>
Supply Measures	Short-term, on-street parking only No on-street parking Strict enforcement of regulations Reserved parking for priority vehicles Restricted parking time at all facilities Residential parking permits Freeze on number of parking spaces Limit on parking garage construction Zoning law limits
Price Measures	High rates for single-occupancy vehicle Discriminating hourly rates Increase in all parking rates Reduced parking costs for priority vehicles Parking tax on users Tax on parking garage owners
Location Measures	Construction of park and ride lots Provision of peripheral parking

General Results of Questionnaire Survey

The composite results of the questionnaires received from 173 city officials are given in Appendix A. As previously discussed, the responses represent geographical and population distributions found in American urban areas. Consequently, the results may be interpreted as being representative of the state of the art in the U. S.

The transportation related problems given in question 3 were also discussed in a preceding section of the report.

In question 4, the respondents were asked if their city had a formal parking management plan whose primary objective was to limit the parking supply or increase parking costs so that auto users are persuaded to shift to other transportation modes or to increase auto occupancy. Of the 173 respondents, only 5 officials indicated they had a parking management plan to limit single-occupancy-auto use. The officials represented Los Angeles; St. Louis, Missouri; Cambridge, Massachusetts; and Portland and Salem, Oregon. Parking management plans were received from officials in Los Angeles, St. Louis, and Portland. (87,88,89) A review of the plans revealed the following.

1. The Los Angeles program is under the guidance of an 11-member, private sector steering committee and its objectives are to conserve energy, improve air quality, reduce peak-period traffic congestion, and preserve land in major activity centers for uses other than parking. The approach to parking management is one of providing economic incentives as opposed to strict disincentives to limit traffic. The primary strategy is the development of remote park and ride facilities and supporting express bus service, subscription busses, van pools, and car pools. Commercial and industrial properties located in the downtown area are permitted to reduce their current on-site parking spaces by making a financial commitment to the park and ride program. The concept of funding remote parking instead of constructing the required number of spaces in the central area is known as in-lieu parking regulations.
2. Parking management strategies ranging from providing a parking information system to reducing parking rates for car pools were examined to determine which measures were applicable to the St. Louis area. The findings of the study revealed that few parking management strategies were implemented in the area, as no significant problem was perceived at the local level. The regional planning agency has encouraged car pooling and has established reserve bus lanes to conserve energy and reduce auto emissions. It was felt by the authors that parking management strategies will be used as changes occur in land use and traffic congestion.
3. In Portland, Oregon, the city council has adopted a parking management plan to support the goals and guidelines of its downtown development plan. The parking

policy provides for a limit on the number of spaces in the downtown area; the development of multiuse parking facilities; the removal of curb parking spaces; an increase in the number of short-term parking spaces in the retail area; and a reduction in long-term parking by improving transit services and bicycle facilities. The plan is being administered by the Bureau of Planning.

The plans indicate that there is a recognition that parking management strategies can be successfully implemented on an area-wide basis to improve traffic and environmental conditions in urban areas. The extent and type of strategy implemented appears to be a function of the perceived problems at the local level and the goals of development in each area.

The responses to question 5 gave further insight to the development of parking management plans in American cities. Of the 173 respondents, 27 (15.6%) officials indicated that parking management studies had been conducted in their cities. Furthermore, replies to question 6 revealed that studies of parking strategies are being conducted in 38 (22%) of the cities. A review of the 17 study reports that were enclosed with the completed questionnaires revealed the following observations.

1. Nine of the studies were conducted to examine existing parking characteristics and to determine future parking needs and methods for financing additional off-street facilities. Parking studies for the City of Coronado, California, (population 21,400) and Anniston, Alabama, (population 34,500) were characteristic of this approach.^(90,91) However, the same methodology was employed for the cities of Jersey City, New Jersey, (population 263,000) and Fort Worth, Texas, (population 390,000).^(92,93) The primary strategy recommended in these studies was to meet future parking needs by constructing off-street lots and garages. This technique reduces congestion created by on-street parkers and thus improves the operational efficiency of automobile traffic.
2. In the other eight parking studies, reductions in the number of downtown parking spaces planned for the future and a lessening of intensive development were recommended. For example, in Bellevue, Washington, (population 65,000) the studies recommended reductions in parking space requirements in the central business area and the encouragement of car pools and van pools.⁽⁹⁴⁾

Also recommended was the construction of peripheral parking facilities supported by shuttle bus service for workers in the business sector. The Honolulu, Hawaii, (population 704,500) parking study also resulted in a recommendation to meet future parking deficiencies by providing express bus service to peripheral parking facilities.⁽⁹⁵⁾ In Albany, New York, (population 115,000) recommendations were made to place a surcharge on commuter parking to reduce on-street, long-term parking for commuters and permit the spaces to be used by shoppers.⁽⁹⁶⁾ Future development and improvement of transit to minimize commuter traffic in the business district was also recommended.

The San Francisco (population 660,000) parking study was conducted to examine methods of reducing vehicle emissions and included the examination of a wide variety of parking strategies ranging from discouraging the demolition of residential and commercial buildings for construction of parking facilities to providing fringe parking lots with shuttle bus service.⁽⁹⁷⁾ It is interesting to note that although reduced traffic congestion and air pollution and the conservation of energy were considerations in these recommendations, one primary incentive was economic; viz., the implementation of measures that do not require large capital outlays of public funds for parking facilities.

Question 7 of the survey requested the respondents to rate the status of 15 parking management strategies and 11 supporting strategies in their city. An average of 62% of the 173 respondents noted they had not considered using any of the 15 parking strategies, while only 36% replied that they had not considered using the 11 supporting strategies. This difference may be attributed to the general feeling that incentives are more acceptable to the public than are strategies which tend to limit auto use. Only 9% of the respondents suggested that parking strategies were being considered, while 21% indicated that the supporting strategies were under consideration. It is interesting to note, however, that only 4% suggested that the parking strategies had been considered and rejected, while 5% replied that the support strategies had been considered and rejected. Only 2% of the parking strategies and 6% of the support strategies were programmed for implementation. An average of 11% of the parking strategies were in use, while 19% of the support strategies were being utilized.

A review of the replies by population group indicated that the average responses did not significantly vary by population. The

survey results indicate that while a majority of the parking strategies had not been considered, very few of the measures had been considered and rejected. Thus, the potential for applying parking strategies in American cities in the future appears promising. A discussion of the survey results for each parking strategy and support strategy is given in subsequent sections of the report.

Question 8 of the survey requested the city officials to give specific reasons why the parking management and support strategies listed in question 7 had not been considered. Only 3% of the respondents suggested that the measures were prohibited by city or state law, 7% noted that the controls could not be enforced or were ineffective, and 6% replied that funds were not available for implementing the measures. The primary reasons given for not considering the strategies were political, public, and business opposition (44%) and the inapplicability of the controls to the cities' problems (37%). Other reasons given for not implementing the controls were that no alternative travel modes were available and that there was no control of private off-street parking spaces. The specific reasons for not considering each of the parking strategies are summarized in Table 18. A discussion of the reasons for not considering each parking measure and a summary of the results for each support strategy are given in subsequent sections of the report.

The city officials were asked to give reasons why, as stated in their responses to question 9, strategies had been considered and rejected. The primary reasons listed were public, political, and business opposition (54%), the inapplicability of the controls to city problems (12%), and the unavailability of funds for implementation (10%). The reasons for considering and rejecting each parking strategy are summarized in Table 19. A discussion of these reasons and the results for each support strategy are given in subsequent sections of the report.

Question 10 requested the officials to list specific reasons why each strategy was planned for implementation or why it was being used. A tabulation of the responses is given in Table 20. The primary reason for using the measures were to improve traffic flow (18%), reduce congestion (18%), and increase the use of transit (17%). Reasons cited in the "other" category were to benefit businesses, to increase city revenue, or to respond to requests by businesses and the public. The reasons for selecting each parking strategy for implementation or using the strategy are given in Table 21. A discussion of these reasons for each parking measure and for the support strategies is given in subsequent sections of the report.

Table 13
Reasons Parking Strategies Not Considered for Implementation

Measure	Arguments Against Measure										Totals
	Prohibited by local ordinance	Prohibited by state law	Cannot be enforced	Ineffective	Not applicable to problem	Public opposition	Political opposition	Business opposition	Funds not available	Other	
Supply Measures											
Short-term on-street parking only	0	0	4	4	30	22	13	14	3	4	94
No on-street parking	2	0	2	3	36	28	17	26	3	3	120
Strict enforcement of violations	0	0	1	1	19	6	5	1	6	3	42
Reserved parking for priority vehicles	3	1	9	6	56	20	13	17	4	5	134
Restricted parking time at all facilities	3	0	7	9	54	30	20	32	5	7	167
Residential parking permits	3	3	8	6	59	25	20	10	4	5	145
Freeze number of parking spaces	3	0	1	6	62	31	28	38	4	8	133
Limit on parking garage construction	4	2	3	6	67	25	26	31	7	8	179
Zoning law limits	11	3	1	8	65	23	24	25	5	7	172
Totals	53	9	36	49	448	210	166	194	41	50	1,236
Price Measures											
High rates for single-occupancy vehicle	3	2	19	10	59	52	31	37	10	8	231
Discriminating hourly rates	1	0	6	3	53	34	21	22	5	7	157
Increase in all parking rates	3	0	0	6	46	31	21	25	4	6	142
Reduced parking costs for priority vehicles	2	1	10	10	64	21	15	15	7	6	151
Parking tax on users	3	3	3	6	57	41	31	32	6	5	139
Tax on parking garage owners	3	4	0	6	77	23	28	33	5	3	192
Totals	15	12	38	46	356	202	147	169	37	40	1,062
Location Measures											
Construct Park and Ride Lots	0	0	0	2	32	5	4	4	11	3	61
Provide Peripheral Parking	0	0	0	6	37	9	5	6	8	4	75
Totals	0	0	0	8	69	14	9	10	19	7	136

Table 13

Reasons Parking Strategies Considered
for Implementation and Rejected

Measure	Arguments Against Measure											Totals
	Prohibited by local ordinance	Prohibited by state law	Cannot be enforced	Ineffective	Not applicable to problem	Public opposition	Political opposition	Business opposition	Parking enterprise opposition	Funds not available	Other	
Supply Measures												
Short-term on-street parking only	0	0	1	0	1	3	2	4	0	0	0	11
No on-street parking	0	1	2	0	1	9	9	14	1	0	0	37
Strict enforcement of parking violations	0	0	1	0	0	1	1	3	0	1	0	7
Reserved parking for priority vehicles	2	0	3	0	0	0	0	0	0	0	0	5
Restricted parking time at all facilities	0	0	0	0	1	1	0	3	1	0	0	6
Residential parking permits	4	4	2	2	2	4	2	0	0	0	1	21
Freeze on number of parking spaces	0	0	1	1	2	2	3	3	1	0	0	13
Limit on parking garage construction	1	0	0	0	0	1	3	4	2	0	0	11
Zoning law limits	2	0	0	0	0	0	1	1	0	0	0	4
Totals	9	5	10	3	7	21	21	32	5	1	1	115
Price Measures												
High rates for single-occupancy vehicle	0	0	1	0	1	1	2	1	1	0	0	7
Discriminating hourly rates	0	0	0	1	3	2	2	1	1	0	0	10
Increase in all parking rates	0	0	0	0	0	6	7	6	2	0	0	21
Reduced parking costs for priority vehicles	0	0	0	0	1	0	1	2	0	0	0	4
Parking tax on users	1	2	2	1	0	2	1	2	2	0	0	15
Tax on parking garage owners	0	0	0	1	1	1	2	5	2	0	0	12
Totals	1	2	3	3	5	12	15	17	3	0	0	57
Location Measures												
Construct Park and Ride Lots	0	0	0	0	1	2	0	0	0	1	2	6
Provide Peripheral Parking	0	0	0	0	2	0	0	0	0	1	0	3
Totals	0	0	0	0	3	2	0	0	0	2	2	9

Table 20

Reasons Parking and Support Strategies Were Implemented

<u>Reason</u>	<u>Number of Responses</u>	<u>Percent of Responses</u>
1. Improve traffic flow	252	18
2. Reduce congestion	245	18
3. Improve air quality	130	9
4. Reduce noise level	65	5
5. Reduce energy consumption	138	10
6. Increase use of transit	240	17
7. Increase auto occupancy	72	5
8. Reduce accident hazards	93	7
9. Other	144	11
	<hr/>	<hr/>
TOTAL	1,379	100

The respondents were requested in question 11 to list specific parking management strategies that had been implemented and found to be effective. Only 9 (5%) of the officials indicated that they had implemented parking strategies which were later found to be ineffective. The ineffective strategies were installing curb parking meters, requiring overnight parking permits, imposing no parking restrictions, and implementing residential parking permits. The major reasons cited for failure of these measures were opposition from public and business officials and changes in the demand for parking. The results of the responses indicate that experience with ineffective parking strategies is limited to a few urban areas.

Question 12 requested respondents to give their views on the effectiveness of parking management strategies. Of the 173 replies, 44 (25%) indicated parking strategies were not a solution to their cities' problems, 34 (20%) noted that the strategies were not applicable, while 18 (10%) felt they were short-term solutions and 33 (19%) suggested they were long-term solutions. The results of the replies indicate that in at least 29% of the urban areas the officials feel parking management may be effective in addressing transportation related problems.

Table 21
Reasons Parking Strategies Were Implemented

Measure	Arguments For Measure									Totals
	Improve traffic flow	Reduce congestion	Improve air quality	Reduce noise level	Reduce energy consumption	Increase use of transit	Increase auto occupancy	Reduce accident hazards	Other	
Supply Measures										
Short-term on-street parking only	10	11	4	3	2	2	4	3	30	69
No on-street parking	54	23	7	3	5	7	2	15	7	101
Strict enforcement of parking violations	35	27	4	4	4	7	4	12	32	129
Reserved parking for priority vehicles	7	7	1	1	2	5	5	6	9	43
Restricted parking time at all facilities	6	7	1	2	1	4	2	1	5	27
Residential parking permits	2	6	4	3	3	4	4	1	8	35
Freeze on number of parking spaces	1	3	3	1	3	3	2	1	0	17
Limit on parking garage construction	1	1	2	0	1	2	1	0	2	10
Toning law limits	7	7	3	0	3	4	1	5	1	31
Totals	103	92	29	17	24	58	25	42	92	462
Price Measures										
High rates for single-occupancy vehicles	2	1	1	0	1	1	1	1	0	9
Discriminating hourly rates	8	7	3	2	3	5	3	3	3	37
Increase in all parking rates	5	7	1	0	1	6	3	1	10	34
Reduced parking costs for priority vehicles	3	4	1	0	2	0	1	1	1	13
Parking tax on users	2	1	1	1	1	1	2	0	5	14
Tax on parking garage owners	1	0	0	0	0	0	0	0	0	1
Totals	21	20	7	3	8	13	10	6	19	107
Location Measures										
Construct Park and Ride Lots	10	10	7	3	14	25	4	3	2	78
Provide Peripheral Parking	14	15	7	3	7	11	3	6	0	66
Totals	24	25	14	6	21	36	7	9	2	144

City officials were requested in question 13 to list parking strategies that were being used successfully in their area and to give reasons for the success. A summary of the results is given in Table 22. Although a variety of successful strategies were given, imposing time limitations on curb spaces, developing fringe lots and bus service, raising parking costs, and strictly enforcing parking regulations were cited in the largest number of responses. The responses indicate that even in the face of difficulties in implementing parking strategies, they have been successfully used, perhaps to a limited extent, to address transportation related problems in some American cities.

Table 22

Summary of Successful Parking Strategies

<u>Parking Strategy</u>	<u>Reason for Success</u>
Provide short-term on-street parking	Best method of serving businesses
Residential parking permits	Effective method of providing parking for urban residents
Strict enforcement of regulations	Improves traffic flow and provides spaces for shoppers
Provide park and ride facilities	Reduces parking demand and traffic in the CBD
Remove on-street parking	Increases roadway capacity
Raise parking costs	Discourages long-term parking and encourages shopping trips
Provide off-street parking	Reduces on-street parking spaces
Close parking lots until 9:00 a.m.	Avoids long-term parking in prime business areas
Merchant tokens for parking lots	Eliminates on-street parking in the CBD
On-street parking bans during peak traffic periods	Improves traffic flow
Reserved parking for priority vehicles	Increases efficiency of spaces and reduces parking demand
Provide angle parking	Provides more parking spaces

Question 14 requested the officials to list measures they used to evaluate the effectiveness of parking strategies. Thirty-two (18%) of the respondents indicated they did not measure the effectiveness of the strategies, while 47 (27%) used engineering judgment. Of the measures employed, 35 (20%) monitored traffic volumes, 32 (18%) examined enforcement problems, and 23 (13%) used traffic accident studies. Of the 173 respondents, only 81 (47%) indicated that data had been collected for evaluative purposes. Thus, it is apparent that in many cities the effects of using various controls on an areawide basis are not known.

The respondents were asked in question 15 if legal problems were being encountered in using parking management strategies in their city. Eighty-seven (50%) replied that no legal problems were being encountered and only 20 (12%) noted that they did have legal problems. The problems included the constitutionality of residential parking permits, obtaining approval for parking sites, and imposing controls on private parking facilities. The ruling on the residential parking permit program is discussed in detail in a subsequent section of the report. Generally, it appears that there are few legal problems that would prohibit the use of most parking management strategies in U. S. urban areas.

Question 16 requested the respondents to indicate if changes in the state or city codes had been made to permit the implementation of a parking strategy. Of the 173 replies, 108 (62%) had not made any changes in the codes, while 27 (16%) indicated that changes had been made. Amendments to the codes included changes to allow on-street parking bans; zoning changes in parking regulations; changes in parking prices; establishment of parking authorities; legislation for residential parking programs; changes to allow a parking stamp validation program; revisions to limit the number of parking spaces permitted; and changes to allow preferential parking for the handicapped.

Question 17 asked city officials if litigation to allow implementation of a parking strategy was under way or under consideration. Only 5 (3%) of the respondents noted that litigation was under way to implement a residential permit parking program.

The responses to question 18 are summarized in Appendix C. Generally, many of the officials expressed an interest in receiving additional information regarding parking management. Of the 173 respondents, 140 (81%) noted in question 19 that they would like to receive a copy of the final report.

Parking Management Supply Strategies

Supply controls are those parking management strategies that affect the restriction, removal, or reallocation of parking spaces to increase roadway capacity, discourage work-commuter parking and encourage shopping trips, provide parking for residents of the urban area, and encourage trip making by high-occupancy vehicles. The goals of these strategies include energy conservation; revitalization of the CBD; reductions in auto emissions, noise levels, and traffic accidents; and improvements in land use in the urban area by reductions in the parking demand. One or more of these strategies — e.g., prohibiting on-street parking coupled with strict enforcement of the regulation and a residential permit parking program — can be implemented in most urban communities. Given below is a discussion of the 9 parking supply strategies examined in the questionnaire survey.

Short-Term On-Street Parking Only

One method of increasing parking availability in an urban area is to impose time limit restrictions on curb spaces. Although short-term parking restrictions will not increase the number of spaces, the control does provide efficient use of existing spaces by creating a high turnover of users.

The implementation of short-term restrictions usually includes limiting parking to a period of one or two hours; however, 5-, 10-, and 15-minute restrictions are sometimes used at post offices, banks, and other commercial areas where the parking demand is unusually heavy. The time limit and the area included in the program should depend upon the availability of adjacent off-street parking in the business district and the type of retail activity. Short-term restrictions can be implemented to include the entire CBD of a large metropolitan area or to encompass only arterial streets or specific blocks in small urban centers.

To be effective, short-term restrictions should be accompanied by strict enforcement of the regulations. Also, before the restrictions are imposed alternatives for the long-term parker must be available. These alternatives may include improving transit service, constructing peripheral lots or park and ride facilities, or providing adequate off-street spaces. Failure to consider the needs of the long-term parker may result in numerous violations of the curb time limitations or in the relocation of the parker to nearby residential communities or other areas unaffected by the strategy, which can create parking deficiencies in these areas.

120

The results of the questionnaire survey indicate that short-term parking restrictions are one of the most widely used parking management strategies in the U. S. Fifty-nine (34%) of the respondents reported that the strategy is being used, while plans for implementing time limits have been developed in 3 cities, and 19 cities are considering the measure. The primary reasons the officials listed for using this strategy are to reduce congestion, improve traffic flow, increase parking turnover, and improve the accessibility of businesses in the retail area. Only 2 respondents felt that time limitations on curb parking would cause workers to shift to transit in their area. Thus, time restrictions implemented as a single measure may not be sufficient to increase the use of transit in many American urban areas.

Short-term curb parking is not being considered for implementation in 65 (38%) urban areas. Nearly one-half of the respondents in each of the population categories of less than 500,000 people suggested that they had not considered using short-term curb parking restrictions; however, for locations with populations greater than 500,000 persons, metropolitan Montgomery County, Maryland, was the only urban area not considering implementation of the strategy. The control was considered and rejected in only 5 urban areas. The major reasons cited for not considering the measure were public, political, and business opposition and the inapplicability of the control to their problem.

No On-Street Parking

The elimination of curb parking spaces is one way of achieving a reduction in the parking supply in an urban area. The removal of on-street parking traditionally has been imposed on major traffic routes and narrow streets to increase capacity, reduce traffic congestion, and improve traffic and pedestrian safety.

The area affected by the prohibition may range from a block or two in a congested zone to major street corridors. Parking bans may be implemented on an areawide basis; however, considerable planning must be undertaken in advance of the restriction to accommodate trips by persons affected by the ban. The effects of the ban may be severe on the retail sector unless adequate provisions are made for convenient off-street parking for shoppers and other non-work auto activities.

Curb parking bans must be augmented with a strict enforcement program to be effective. Also, it is important to make alternative parking or trip making methods available to the short- and long-term parker. When parking bans are implemented on an areawide basis, care must be exercised to ensure that the parkers do not relocate to nearby residential areas and create parking deficiencies in those locations.

Based on the questionnaire survey data, provisions for eliminating on-street parking have been imposed in 30 urban areas (17%). The strategy is being considered for implementation in 17 cities and is programmed for implementation in 7 localities. The major reasons cited for using curb parking bans are to improve traffic flow, reduce congestion, and reduce accident hazards. Only 7 respondents felt that parking bans would improve air quality or increase the use of transit and only 2 officials felt that auto occupancy would be affected in their city. Consequently, the use of parking bans to achieve national environmental or energy goals has not been perceived to be effective on the local level.

Curb parking prohibitions have not been considered for implementation in 79 cities (46%). For cities of less than 50,000 persons, 60% of the respondents indicated they had not considered imposing parking bans while for urban areas greater than 500,000 this figure was only 21%. This result can be explained by the observation that curb spaces are the predominate form of automobile parking in small cities; however, in large centers, on-street parking must be prohibited to allow for the movement of traffic. Only 18 cities (10%) have considered and rejected the implementation of a parking ban. The reasons cited for not prohibiting on-street parking were public, political, and business opposition and the inapplicability of the control to solving problems. Only 2 respondents indicated that curb parking bans are prohibited in their area by city ordinance.

Strict Enforcement of Parking Regulations

The success of any parking management strategy is dependent upon enforcement. Illegal parking in urban areas in the U. S. is a major transportation problem. For example, in Washington, D. C. it has been estimated that 25 million parking violations occur each year.⁽⁹⁸⁾ In a typical block in the downtown area, approximately 10 vehicles were found to be violating parking regulations. Also fines for only one-half of the 1.5 million tickets that were issued for violations were actually paid. The results of a recent survey taken in Fort Worth indicate that on a typical day in the downtown area, 27 out of 100 autos are parked illegally, and that of the 27 violators, only 3 are issued a ticket.⁽⁹³⁾

The purpose of a strict enforcement program is to enhance the effectiveness of parking and other traffic regulations. The program not only requires personnel to identify violators and issue citations, but appropriate fines and streamlined court and collection procedures to discourage violations. In attempting to reduce parking violations, it is essential that illegal parkers be informed

that they have a high probability of receiving a citation and that they will be required to pay the fine. While strict enforcement is implemented to ensure parking turnover, elimination of double parking, etc., to increase the effectiveness of parking strategies, by-products of the program are reduced traffic congestion, increased traffic and pedestrian safety, and additional revenue to the city.

The results of the nationwide survey indicate that strict enforcement of parking regulations is the most frequently used parking management strategy. Eighty-six (50%) of the city officials reported that strict enforcement programs have been implemented in their area and increased enforcement plans have been programmed for implementation in 12 areas. Furthermore, programs are being considered for implementation in 20 urban areas. The major reasons given for using strict enforcement programs were to reduce traffic congestion, improve traffic flow, increase parking turnover, and provide city revenue. Most of the respondents felt that the enforcement programs would not encourage car pooling or a shift to public transit.

Strict enforcement of parking regulations is not being considered in 33 (19%) cities. The primary reason given for not using the program was that it was believed not to be applicable to the area's transportation problem. Only 2 cities had considered and rejected the use of strict enforcement. The reason given for not using the strategy was opposition from the business community.

Reserved Parking for Priority Vehicles

One method of encouraging car pooling and van pooling and reducing parking demand is to provide reserved parking spaces for high-occupancy vehicles. Reserved parking for priority vehicles is usually provided in areas where there is a deficiency in the number of parking spaces. This strategy does not provide a change in the parking supply, but the control does permit improved efficiency in the use of existing spaces by increasing the number of occupants per space.

The purpose of reserving on- and off-street spaces for high-occupancy vehicles is to encourage ride sharing, especially for employees in the downtown area. When applied on an areawide basis, the strategy can reduce the number of single-occupancy automobiles during peak travel periods. This strategy also could provide additional spaces for non-work trip purposes such as shopping. The ultimate goal of the strategy is to reduce peak period travel — which could improve environmental quality and reduce fuel consumption — and to increase economic activity in the business district.

The results of the questionnaire survey indicate that reserved parking for priority vehicles is being used in only 20 (12%) cities and implementation has been planned in only 1 area. The measure is being considered for implementation in 19 (11%) cities. A higher percentage (35%) of the urban areas of over 500,000 persons than of less populated areas have implemented priority parking programs. The major reasons cited for using this strategy were to improve traffic flow, reduce congestion, increase auto occupancy and transit use, and provide additional spaces for shoppers in the downtown area. Only a few respondents felt the strategy could aid in reducing air pollution and energy consumption.

Reserved parking for priority vehicles was not being considered in 108 (62%) of the urban areas; however, the measure was considered and rejected in only 4 cities. The reasons given for not using priority parking were that the control was not applicable to the area's problem and public, political, and business opposition. Only 9 respondents did not consider the measure because they felt it could not be enforced, and 3 officials noted that the measure was rejected because they felt it could not be enforced. Implementation of the strategy was prohibited by city code or ordinance in only 3 areas.

The effectiveness of priority parking programs has been reported upon by a number of investigators. In most of the studies, only the number of persons who switched to car pools or van pools was examined. For example, the implementation of priority parking and car pool matching at Hallmark Cards in Kansas City, Missouri, increased the number of three-person car pools from 132 to 258.⁽⁸¹⁾ A similar program implemented at the Pentagon in Washington led to 4,960 car pool permits being obtained for the 10,000 available spaces. A preferential parking space program implemented at the Government Employees Insurance Company in Bethesda, Maryland, resulted in issuing 340 permits which increased vehicle occupancy to 2.0.⁽⁸¹⁾ Construction of a commuter car pool parking facility in American Fork, Utah, eliminated the problem of vehicles parked on the shoulder and doubled the number of commuters in the area.⁽⁹⁹⁾

Restricted Parking Time at All Facilities

Imposing time limitations on curb and off-street spaces is one method of regulating the parking supply in an urban area. Time restrictions are usually implemented in areas where parking demand in the retail area is greater than the number of spaces available. This measure does not alter the total number of spaces in the area, but the time limitation does favor short-term parking needs over those of the long-term parker.

The purpose of limiting the duration of parking at all downtown parking facilities is to discourage all-day parking for single-occupancy auto commuters in order to provide adequate spaces for non-work trip purposes. The basic assumption employed in this strategy is that the worker-commuter will switch to transit or other modes because of the difficulty of obtaining a parking space. In addition to providing more spaces for short-term parkers to increase retail activities, the objective of this strategy is to reduce peak period travel to enhance the accessibility of the downtown area and reduce emissions and fuel consumption. By increasing turnover, the control can also provide additional revenue from parking fees, assuming there are no changes in parking rates and short-term parking demands would be sufficient to utilize the existing spaces.

Respondents to the questionnaire survey indicated that parking time was restricted at all facilities in 20 (11%) cities. The measure has not been programmed for implementation in any area; however, 12 cities are considering implementation. The reasons cited for implementing time limitations on long-term parking were to improve traffic flow, reduce congestion, and increase the use of transit.

Time limitations on long-term parking were not being considered for implementation in 112 (65%) of the cities; however, the measure had been considered and rejected in only 5 areas. The major reasons given for not implementing the strategy were public, political, and business opposition to the plan and the inapplicability of the control to their problem.

The impacts of implementing time restrictions on parking are primarily dependent upon the ownership of parking facilities. The control could have a major effect in cities where parking ownership and management is public. In areas where facilities are predominantly under private ownership, the effects may be negligible. Although respondents to the nationwide survey reported that time limitations were imposed on all parking facilities, a review of parking availability in several of these areas revealed that a substantial portion of the parking supply was under private control. Thus, the overall impacts of time limitations in these areas may be minor.

One case study of the effects of restricting long-term parking in the downtown area was reported for Pittsburgh.⁽¹⁰⁰⁾ During a three-day strike by parking operators in August 1972, 80% of the city's parking lots and fringe areas were closed. As a result of unavailability of spaces, 12% of the commuters switched to transit and morning peak period traffic was reduced by 24%. In the Pittsburgh experience, adequate transit capacity was available to accommodate commuters. Following the strike, commuters immediately returned to the travel modes they had used prior to the strike.

Restrictions on long-term parking have also been considered in the San Francisco area.⁽⁹⁷⁾ The following impacts were estimated if parking limitations on long-term users were implemented.

1. Approximately 65,000 auto commuters would be affected by the program.
2. The public transit system would have to carry 100,000 additional passengers in the peak periods.
3. Significant travel cost savings by the commuter could be achieved.
4. A significant reduction in auto work trips could occur.
5. An estimated \$97,500 per day in revenues from long-term parkers would be lost, unless short-term parkers utilized the available spaces.

The program was not recommended for implementation because it was felt that the strategy would not have political support from all the urban centers in the region and because only 17% of the downtown spaces were managed by the city.

The areawide impacts of reducing parking supply in downtown Washington were recently examined.⁽¹⁰¹⁾ It was estimated that eliminating single-occupancy-auto travel by reducing parking supply for downtown work trips would increase transit ridership by 47% and reduce work vehicle miles of travel by 56%. An increase of 16% in non-work trips was anticipated. The overall effect of the strategy on fuel consumption was estimated to be an 11% saving in gallons consumed per day.

Implementation of time restrictions on long-term parking spaces requires careful planning and considerable political support. The question of discriminating against commuters has discouraged implementation of this strategy; however, a recent U. S. Supreme Court decision established that commuters were a distinct class and the city of Pittsburgh was constitutionally entitled to require auto commuters to switch to public transit or pay all-day parking penalties.⁽⁶²⁾ Because of the wide range of impacts and the controversial issues which must be addressed, the most feasible method for improving the chances for success of this strategy is to plan implementation in stages over a long time period. In some cities, an implementation period of 10 years or more may be needed. One way of determining the feasibility of the strategy would be to select a several-block area in the retail sector and close a large

percentage of the parking facilities until after 10:00 a.m. Advance notice of the experiment should be given to allow commuters to seek new travel arrangements. The experiment should not be attempted unless parking demand exceeds capacity in the area and unless adequate transit service is available for commuter trips.

Residential Parking Permits

Parking space deficiencies typically occur in residential areas located adjacent to commercial, employment, university, or other major trip centers which do not have sufficient spaces to accommodate demand. Use of spaces by commuters often creates congestion in residential areas and interferes with the parking needs of residents.

To preserve the character of the neighborhood and allow on-street parking by residents, residential parking permit programs have been implemented in many American cities. The programs are special cases of vehicle permit schemes used to restrain traffic. The use and impacts of other permit measures such as area licensing and permit systems have been addressed by other researchers and will not be discussed in this report.(102,103,104) Generally, permit parking programs are implemented to increase parking availability in residential areas rather than to restrain traffic.

The results of the nationwide questionnaire survey revealed that residential parking permits were being used in only 9 (5%) urban areas. The measure was being considered for implementation in 18 cities and was programmed for implementation in 9 areas. The major reasons given by the respondents for using residential permits were to provide spaces for residents and to reduce traffic congestion. Officials in 107 (62%) cities suggested that they had not considered using permits and 14 officials noted they had considered and rejected the measure. The major reasons given for not using the strategy were public and political opposition and the inapplicability of the control to the city's problem.

Another reason given for not using residential permits was the U. S. Supreme Court case concerning a parking program in Arlington, Virginia. The Court decision was pending at the time the survey was conducted. On October 11, 1977, the Court released its decision upholding an Arlington County ban on nonresidential parking on designated streets. The Court noted that a community may restrict on-street parking available to commuters to encourage the use of public transit and car pooling.(105) Since the Supreme Court decision, a dramatic increase in the number of cities implementing residential parking permit programs has been reported.(106)

Although residential parking permit programs are not expensive to implement and administer, planning could take several years. In developing the program, careful consideration should be given to defining the area of implementation; i.e., imposing restrictions in a small sector may cause nonresidents to relocate to adjacent residential streets. Also provisions must be made to accommodate the needs of visitors and merchants in the area.

Before and after studies are being conducted by the Urban Institute to evaluate the effects of residential parking permits.⁽¹⁰⁷⁾ The results of the research will be useful in evaluating potential impacts of programs being considered for implementation in other urban areas.

Freeze on Number of Parking Spaces

One method of limiting the growth of traffic in downtown areas is to impose a freeze or restriction on the number of parking spaces. In addition to reducing future auto trips which terminate in the central area, it is assumed that this action will reduce vehicle miles of travel which, in turn, may improve environmental conditions and conserve energy. Space that otherwise would be utilized for parking can be used for more productive purposes under the no growth policy.

The implementation of a freeze on parking spaces is usually accomplished over a long time period. Because space limitations can have a negative impact on the retail sector by encouraging shoppers to patronize outlying shopping centers, special care should be taken to provide adequate space for short-term parking. It is also important that alternative travel arrangements be made for commuters.

Parking freezes are generally implemented by restricting the number of spaces. As existing facilities become obsolete, the spaces are placed in a bank and may be allocated to new development. To allow for increased mobility in the downtown area, peripheral garages and park and ride facilities should be provided in fringe areas.

Respondents to the nationwide questionnaire survey indicated that parking supply freezes are in use in only 3 (2%) areas: High Point, North Carolina; Honolulu, Hawaii; and Portland, Oregon. The measure has been programmed for implementation in Cambridge, Massachusetts, and is being considered for implementation in 16 urban areas. The major reasons cited for imposing a freeze on the parking supply are to reduce traffic congestion, improve air quality, reduce energy consumption, and increase the use of transit.

Parking freezes are not being considered in 126 (73%) cities. The strategy has been considered and rejected in only 5 communities. Reasons given for not using the measure were public, political, and business opposition and the inapplicability of the control to the city's problems. Five officials noted that parking freezes were prohibited by city ordinance in their areas.

The only documented proposal identified during the literature search was the plan to limit parking spaces in the Boston metropolitan area. (108,109) The purpose of the parking freeze and the expanded transit parking program was to restrict the use of automobiles in the city center to reduce environmental pollution. The plan required a freeze on auto parking spaces and development of 15,000 additional transit parking spaces. Information regarding implementation and the impacts of the plan could not be found.

Because of the possible effects use of this strategy could have on commuters and downtown businesses, considerable coordination with local officials and the public is essential in considering its use. Areas with extreme parking deficiencies and limited space to construct new facilities would be best suited for implementation of a parking freeze.

Limit on Parking Garage Construction

Another method designed to limit the growth of automobile traffic in downtown areas is to impose a limit on parking garage construction. The objective is to reduce the number of auto trips with downtown trip ends and thereby reduce traffic congestion, enhance the environment, and conserve fuel. The strategy would encourage development of valuable land in the city for more productive purposes than parking.

The results of the questionnaire survey indicate that limiting the construction of parking garages has not been widely accepted in the U. S. Only High Point, North Carolina; Bethlehem, Pennsylvania; Portland, Oregon; and New York have implemented limits on parking garages. The measure has been programmed for implementation in Cambridge, Massachusetts, and is being considered for implementation in 10 urban areas. Reasons given for limiting garage construction were to improve air quality and increase the use of transit.

Limitations on parking garages have not been considered for implementation in 130 (75%) cities; however, the strategy has been considered and rejected in only 6 areas. The major reasons given for not implementing the control were public, political, and business opposition and the inapplicability of the measure to the city's problem. Such limitations were reported to be prohibited by city ordinance in 4 areas.

The effects of restricting construction of new parking garages was examined in a recent study conducted in Denver,⁽⁷¹⁾ where it was estimated that the strategy could reduce total area-wide vehicle kilometers of travel by 3.2%. Also it was suggested that the measure could reduce areawide work kilometers of travel by 6.8%.

Zoning Law Limits

Zoning laws in American cities have historically been enacted to provide an adequate supply of parking at major activity centers.^(24,29) The purpose of the legislation has been to force developers to provide off-street parking facilities so that public funds would not be needed to construct spaces for private enterprise. Specifications typically have been written to require that developers provide a minimum number of spaces for each type of land use.

In recent years some cities have redefined zoning laws to place a limit on the number of spaces that can be provided instead of requiring a minimum number of spaces,⁽¹¹⁰⁾ the purpose being to limit the number of vehicles in the downtown area so as to reduce traffic congestion and air pollution. Regulations limiting the number of spaces would also allow for the development of land for more productive purposes than parking.

Respondents to the nationwide survey indicated that maximum zoning limitations have been implemented in 10 (6%) urban areas. The measure has not been programmed for implementation in any city; however, implementation is being considered in 16 communities. The major reasons given for imposing zoning limits are to reduce congestion and traffic accidents. The strategy is not being considered for implementation in 123 (71%) areas, while only 2 cities have considered and rejected its use. Officials suggested they have not considered using the strategy because of public, political, and business opposition and because the control is not applicable to the city's problem. Maximum zoning limitations were reported to be prohibited by city ordinance in 11 urban areas.

Because maximum zoning limits have only recently been used in American cities, no information was found in the literature concerning the impacts of the measure. The results of a study conducted in the Washington metropolitan area indicated that if zoning controls were used to limit parking supplies and land use plans were used to encourage transit oriented trips, auto trips would be reduced by 185,000 by the year 1990.⁽¹¹⁾ The authors rated zoning controls as the most effective strategy because they are long-term

measures which gradually change growth patterns away from auto trips to transit. They also felt that zoning controls would be relatively easy to implement because zoning does not impose immediate hardships on any single group.

Parking Management Pricing Strategies

Price controls are parking management measures that attempt to reduce the effects of transportation related problems in an urban area through the use of selective pricing mechanisms. The basic objective of these strategies is to reduce single-occupancy-work trips to the downtown area. Strategies in this classification include high parking rates for single-occupancy vehicles, low rates for short-term parkers coupled with high rates for long-term users, a general increase in all parking rates, and taxes on users and operators of parking facilities. Given below is a discussion of the six parking price strategies examined in the questionnaire survey.

High Rates for Single-Occupancy Vehicles

The single-occupancy vehicle has been identified as the major contributor to peak period congestion.⁽⁶¹⁾ Single-occupancy-auto travel is an inefficient use of roadway capacity and it has been argued that the auto driver does not pay for the delay imposed on other road users.⁽¹¹¹⁾ Charging high parking rates for those who commute alone in an automobile is based on the concept that a sufficient number of drivers will be encouraged to use alternative travel modes. This strategy should be considered in congested areas where long-term parking deficiencies exist.

Implementation of this control consists of increasing parking rates in areas which attract a high volume of work trips. Price increases could be imposed on a daily or monthly basis. The regulation is best suited for lots and garages with parking attendants since enforcement would be difficult for unattended spaces. To be effective, the strategy should be implemented on an areawide basis as it has been demonstrated that a rise in parking fees generally redistributes congestion away from the core areas to adjacent areas.⁽¹¹²⁾ Thus, if the program was implemented in a small portion of the downtown area, auto drivers would simply park outside of the affected area and walk to their destinations.

The results of the nationwide survey indicated that the city of Laredo, Texas, has implemented this measure and plans for implementation have been developed in Hartford, Connecticut. The strategy is being considered for implementation in 12 urban areas. The

major reason given for using this strategy was to improve traffic flow. The measure has not been considered in 134 (77%) cities; however, it was considered and rejected in only 3 urban areas. The major reasons cited for not charging higher parking rates for single-occupancy vehicles were public, political, and business opposition and the inapplicability of the control to the city's problem. Another major reason for not using the measure was that it could not be enforced. The control was prohibited by city ordinance in 3 areas.

There is no empirical evidence upon which to judge the effectiveness and problems related to imposing higher parking charges for single-occupancy drivers. Several barriers must be overcome before this strategy will be considered for implementation. The problem of enforcing the regulation is difficult from an administrative standpoint and could be expensive if additional personnel are needed to examine auto occupancy and collect revenues. There is also little evidence to suggest that particular rate which would discourage single-occupancy auto use. There is also the question of equity of the charges to low income drivers who may not be able to use alternative transportation services. Finally, another major problem with all parking price strategies is that most of the parking facilities in the U. S. are privately owned. If higher rates at public facilities are imposed, it may be economically beneficial for private facilities not to impose the increases because the demand for their facilities could increase to capacity. Experimental projects designed to examine these issues may greatly enhance the use of this strategy.

Discriminating Hourly Rates

In many American cities hourly parking rates decrease with an increase in the length of time the vehicle is parked. For example, a typical rate structure would consist of a \$0.75 charge for the first one-half hour and a \$0.20 charge for each additional one-half hour.

One method of discouraging the long-term parker in favor of the short-term parker is to reverse the rate schedule so long-term parkers pay higher hourly rates. This measure could increase non-work trips for shopping and business purposes, especially if the short-term rates were reduced below existing levels. Assuming there is a high percentage of long-term parkers who could be diverted to transit, the strategy could reduce peak period congestion. Because shopping trips may increase, it is doubtful if total vehicle travel would be affected. Downtown merchants and garage operators may favor the rate change if short-term shopping trips increase. The control should be implemented on an areawide basis to discourage long-term parkers from parking in the peripheral area outside the central section.

Respondents to the questionnaire survey indicated that discriminating hourly rates favoring the short-term parker have been implemented in 12 (7%) urban areas and the measure is programmed for implementation in 3 communities. Also the use of revised rate structures is being considered in 23 cities. The major reasons given for using the measure were to improve traffic flow, reduce congestion, and to increase the use of transit. The strategy was not being considered for implementation in 108 (62%) areas and was considered and rejected in only 6 cities. Reasons cited for not changing the parking rate structure were public, political, and business opposition and the inapplicability of the control to the city's problem. The measure is prohibited by city ordinance in only 1 community.

Although rate structure revisions favoring the short-term parker have been implemented in American cities, there is little documented evidence of the effectiveness of this strategy on an areawide basis. An example of possible effects occurred in downtown Philadelphia when garages revised their parking rates by charging a higher price for long-term parking.⁽¹⁸⁾ The results of the experiment revealed that short-term parking increased 15% to 20%. There also was a decrease in long-term parking; however, the increase in revenue from short-term users exceeded losses from long-term parkers.

Increase In All Parking Rates

One method of restraining traffic in urban areas is to increase the cost of parking at all on- and off-street facilities. The elimination of free and low cost parking could cause drivers to divert to transit or to car pools. If the rate increases were effective in encouraging a shift to more efficient transportation modes, vehicle miles of travel, air pollution, energy conservation, and other transportation related problems would be improved. In most areas mass transit capacity would have to be greatly increased to accommodate the additional demand.

Results of the nationwide survey revealed that 10 (6%) urban areas have imposed higher rates for parking. The measure has been programmed for implementation in 7 cities and is under consideration in 31 (18%) communities. The major reason cited for increasing the parking rates were to raise revenue, reduce traffic congestion, and increase the use of transit. Rate increases were not being considered in 92 (53%) cities and the measure was considered and rejected in 12 areas. Reasons given for not increasing rates were public, political, and business opposition and the inapplicability of the city's problem. Rate increases were prohibited by city ordinance in 3 areas.

A review of parking charges in several U. S. cities revealed that doubling parking costs would decrease automobile trips by only 22% in the control area. (113) It was concluded that major increases in the cost of parking would offset only one to two years of the normal growth of traffic.

Estimates of parking cost increases in Toronto were made using an econometric model. (114) The study results indicated that a 10.0% increase in parking costs would reduce automobile use by 3.1%. Also, the research revealed that if the charges were applied in a small area of the business district, the net effect on auto use would be negligible because parkers would relocate outside of the affected zone.

An evaluation of parking management strategies for the Denver metropolitan area revealed that a 100% increase in the price for all-day parking at commercial facilities would reduce areawide vehicle kilometers of travel by only 0.13%. (71)

The anticipated effects of increasing parking rates on automobile vehicle miles of travel and emissions in four cities are shown in Table 23. Also, the estimated effects of increasing parking costs on auto use and transit trips in Washington, D. C. are shown in Table 24. These studies suggest that moderate increases in parking costs are price inelastic with respect to parking demand; i.e. that price increases will cause a small decrease in parking demand.

The problem of municipalities imposing rate increases on private garages is also an argument against using this measure. Additional enforcement personnel would be required and the general problem of administering the revenues would have to be adequately addressed. Revenue control has been reported to be a major problem in many cities, and substantial increases in parking fees may add further to theft and other difficulties in collecting and reporting funds. (115,116) It has also been suggested that price increases may not simultaneously achieve reductions in traffic congestion, air pollution, and energy consumption in a typical urban area. (117)

Table 23

Predicted Effects of an Increase in Parking Rates
on VMT and Pollutant Emissions

City	Amount of Rate Increase	Projected Reduc- tion in CBD VMT (%)	Projected Reduc- tion in Pollu- tant Emissions
Pittsburgh	87¢ daily increase.	5.3	NA
Baltimore	From current \$1.83 per day to \$2.50 per day.	7.0	Same as reduc- tion in VMT.
Boston	\$1 per day in- crease.	3.0	Same as reduc- tion in VMT.
Washington	Parking rates doubled.	Minor reduction — not more than 5.0.	Same as reduc- tion in VMT.
	Rates for all spaces tripled or quadrupled.	Motor vehicle traffic might be reduced 20- 25.	

NA = Not available.

Source: Transportation Systems Management, Table 20, p. 64. (18)

Table 24

Estimated Effect on Auto and Transit Trips
of Increasing Parking Charges in Washington, D. C.

<u>Increase in Average Parking Cost (\$)</u>	<u>Percentage Change in</u>	
	<u>Auto Driver Trips</u>	<u>Transit Trips</u>
0.25	- 4	+ 3
0.50	- 8	+ 6
0.75	-12	+10
1.00	-15	+13
1.50	-20	+20
2.00	-23	+26
2.50	-26	+33
3.00	-29	+38
3.50	-31	+42
4.00	-34	+47
4.50	-36	+51
5.00	-37	+55

Source: Transportation System Management, Table 21, p. 64. (18)

Reduced Parking Costs for Priority Vehicles

In addition to reserving parking spaces for car pools and other high-occupancy vehicles, free or low cost parking for priority vehicles can be implemented to further encourage ride sharing. The objectives and methods of implementing this strategy are similar to those of the procedure previously described for reserved parking.

Results of the nationwide survey indicate that this measure has been implemented in only Anniston, Alabama; Dade County, Florida; and Baltimore, Maryland. The strategy has not been programmed for implementation in any city; however, the control is being considered for use in 20 (11%) areas. The reasons cited for reducing parking costs for priority vehicles were to reduce traffic congestion and improve traffic flow. The measure has not been considered for use in 126 (73%) cities and only 2 areas have considered and rejected the control. The majority of respondents indicated they did not consider using the strategy because they did not believe it was applicable to their city's problem and because of public, political, and business opposition to the concept.

Experience with implementing reduced parking fees for priority vehicles has been limited. A significant shift to car pools with three or more occupants was reported at the Prudential Insurance Company office in Boston as a result of a free parking program for car pools.⁽⁸¹⁾ The normal parking fee was \$2.50 per day.

It was estimated that a free car pool parking program where parking costs for other vehicles was increased by \$2.00 per day would reduce automobile trips in the San Francisco Bay area by 11%.⁽¹¹⁸⁾ Also transit ridership was expected to increase by 1% as a result of the measure.

Parking Taxes on Users

Imposing a parking tax on users is one method of increasing the cost of parking to discourage single-occupancy parking in downtown areas. Parking taxes historically have been implemented to raise revenue for the city; however, if the tax substantially increases the cost of parking the auto user may be diverted to more efficient transportation modes. The major issues and problems related to this measure are similar to the ones previously discussed for the strategy of increasing parking rates.

Respondents to the survey indicated that parking taxes are used in five cities; viz., Newark, San Francisco, Washington, Baltimore, and New York. The measure has also been programmed for implementation in Lorain, Ohio, and Salem, Oregon, and is being considered for use in 12 cities. The major reason given for imposing parking taxes was to raise revenue. Parking taxes have not been considered for implementation in 125 (72%) areas and the measure has been considered and rejected in 7 cities. Reasons cited for not using the strategy were local opposition and the inapplicability of the measure to the city's problem.

Experience with parking taxes has been limited. In one evaluation of their effectiveness it was concluded that they have little effect on discouraging automobile use because most drivers do not pay for parking.⁽⁹⁾

In October 1970, San Francisco imposed a two-year 25% tax on all paid parking.⁽¹¹⁹⁾ In 1972 the tax was reduced to 10% at the insistence of the Chamber of Commerce because of decreasing sales. The parking industry estimated a 31% loss of revenue due to the tax. Although the data were inconclusive, only a 2% reduction in vehicle miles of travel was attributed to this strategy. The tax had a negligible effect on congestion, air pollution, and energy consumption.

Other than providing an additional source of revenue, parking taxes appear to have limited benefits for improving transportation related problems in American urban areas.

Tax on Parking Garage Owners

The purpose of this strategy is to impose a tax on each parking stall, with the tax to be paid by the garage owner. The tax is oriented towards employers and commercial facilities who provide free or low cost parking. To cover the cost of the tax the owner may choose to charge long-term users and give preferential treatment to short-term parkers. Unless the tax is passed on to the user, no impacts on vehicle travel will occur.

The results of the nationwide survey revealed that taxes on garage owners have not been imposed in any city, and no cities have programmed the measure for implementation. The strategy is being considered for use in 7 areas. Garage owner taxes have not been considered for implementation in 136 (79%) cities and the strategy has been considered and rejected in 7 communities. The reasons given for not imposing the tax were public, political, and business opposition and the inapplicability of the control to the city's problem. Three respondents noted the tax was prohibited by their city's ordinance.

Documented experiences with parking stall taxes were not found in the literature review.

Parking Management Location Strategies

The major objective of this study was to examine parking control strategies that are implemented in downtown areas; however, parking demands and vehicle traffic in the core area can be reduced by locating parking facilities in peripheral areas. The development of park and ride lots and peripheral parking areas can achieve a relocation of parking. A discussion of these strategies is given below.

Park and Ride Lots

This strategy reallocates the supply of parking from the downtown area to the outlying suburban area. Express bus transportation service is used to replace the automobile for the line hual and downtown distribution portions of the trip. The flexibility of the automobile is used as the primary residential collection or

suburban access mode. Thus, the advantages of the automobile for travel in low density areas are combined with the efficiency of public transportation along high density corridors and highly developed land uses to provide a multimodal alternative that eliminates the need to provide for auto storage in the downtown area. This service has been implemented to serve the work trip in most cases.

The purpose of this strategy is to increase the efficiency of the urban transportation system with two primary changes: (1) increasing the demand for public transit along established travel corridors by extending the service area of transit stations, and (2) reducing the demand for parking in CBD areas by diverting such demand to locations of lower land use density and lower land value.

Express bus-fringe parking operations are generally implemented only where certain conditions exist that have been recognized to support successful experiments with this strategy. These conditions include a deficiency in parking supply in the downtown area, congested roadways, and rather excessive auto trip-making costs. If the area generally supports fringe parking, then high density travel corridors are identified and potential lot sites established. Market areas and the number of potential users of the service are estimated for each alternative lot site. The physical characteristics of each lot site are inventoried. Criteria are established, the alternative lot locations are evaluated, and some are then selected for points of implementation of express bus-fringe parking transit.

The results of the nationwide survey indicate that park and ride lots have been constructed in 33 (19%) cities and the measure is programmed for implementation in 9 areas. The strategy is also being considered for use in 41 (24%) urban areas. Major reasons cited for constructing fringe lots were to increase the use of transit and to reduce energy consumption. The measure has not been considered for use in only 62 (36%) areas and has been considered and rejected in 6 communities. The major reasons given for not providing fringe parking were that the control was not applicable to the city's problem and funds were not available for implementation.

The literature review provided many examples of successful park and ride operations. Because this strategy has received widespread use in the U. S., a number of studies describing related experiences and planning aspects are available. (120,121,122,123,124)

Peripheral Parking Areas

Peripheral parking operations are located at the edge of the downtown area or other major activity centers. The automobile is used for residential collection and the line haul portions of the trip and the trip maker then either walks or takes transit to his destination.

The purpose of this strategy is to reduce the concentration of vehicles within the activity center by intercepting them at the border and requiring the traveler to change modes. The strategy is thus more appropriate for keeping autos from the downtown area than for increasing the use of transit.

The areawide conditions that support express bus-fringe parking operations also support peripheral parking. Additional factors that have been found to support peripheral parking include considerably higher parking fees in the core of the CBD and good downtown shuttle transit service. The peripheral lot should be easily assessed from freeways and minimal travel on local streets should be required.

The results of the questionnaire survey revealed that peripheral parking lots have been constructed in 29 (17%) cities and the measure is programmed for implementation in 2 areas. Plans for using the strategy are being developed in 46 (27%) urban areas. Respondents indicated that they implemented the measure to reduce traffic congestion, improve traffic flow, and increase the use of transit. The measure was being considered for use in 71 (41%) areas but the control was considered and rejected in only 3 cities. The major reason cited for not using the measure was that the control was not applicable to the city's problem. Eight officials noted that funds were not available to provide the lots in their city.

SURVEY OF COMPLEMENTARY STRATEGIES

The effectiveness of most parking management strategies is dependent upon the availability of alternative transportation modes to accommodate the trip-making needs of the single-occupancy automobile user. For the purpose of the study, alternative transportation services which support the implementation of parking measures were identified as complementary strategies. To determine the extent to which complementary strategies were being used a list of 11 of these strategies was included in question 7B of the survey questionnaire. Two of these strategies — park and ride lots and peripheral parking areas — were discussed in the preceding section of this report. The general results of the 9 other support measures shown in Table 25 are given here.

Table 25

Complementary Strategies Included
in the Questionnaire Survey

<u>Category</u>	<u>Strategy</u>
Mass Transit Measures	Improve transit service
	Provide demand-responsive transit
	Provide subscription service
	Promote using transit
	Provide exclusive bus lanes
Other Support Measures	Improve bicycle facilities
	Implement staggered work hours
	Construct auto-free zones
	Provide priority treatment for high-occupancy vehicles

Of the 9 strategies, 5 concerned the use of mass transit. Seventy (40%) of the officials noted that they were promoting the use of transit and 62 (36%) suggested that transit service was being improved in their area. Demand-responsive transit, subscription service, and exclusive bus lanes are being used in less than 10% of the cities. Of the other support strategies, improving bicycle facilities was being implemented in 42 (24%) locations and staggered work hours were implemented in 40 (23%) cities. Auto-free zones and priority treatments for high-occupancy vehicles were in use in less than 8% of the cities. The reasons given for implementing the support strategies are shown in Table 26. Complementary strategies were used primarily to increase the use of transit, to reduce congestion, and to improve traffic flow. The respondents also felt these measures would reduce energy consumption and improve air quality.

An average of 36% of the complementary strategies were not being considered for implementation. As shown in Table 27, the major reasons cited for not using these measures were that the control was not applicable to the city's problem, the public opposed the measure, and funds were not available for implementation. Less than 5% of the respondents indicated they had considered and rejected implementation of the support strategies. As shown in Table 28, the primary reasons the measures were rejected were that funds were not available for implementation and the control was not applicable to the city's problem.

Table 26
Reasons Complementary Strategies Were Implemented

MEASURE	ARGUMENTS FOR MEASURE									Total
	Improve Traffic Flow	Reduce Congestion	Improve Air Quality	Reduce Noise Level	Reduce Energy Consumption	Increase Use of Transit	Increase Auto Occupancy	Reduce Accident Hazards	Other	
Improve Transit Service	22	26	14	7	21	52	5	7	5	159
Provide Demand-Responsive Transit	5	5	4	2	5	16	1	1	3	42
Provide Subscription Service	7	5	4	1	6	9	2	1	1	36
Improve Bicycle Facilities	10	10	13	10	18	6	2	10	9	88
Promote Transit Use	25	23	19	6	22	44	4	5	6	154
Staggered Work Hours	17	23	8	5	4	6	6	7	2	78
Exclusive Bus Lanes	7	4	7	2	2	10	2	1	1	36
Construct Auto-Free Zones	3	5	3	3	2	1	1	2	3	23
Priority Treatment for High-Occupancy Veh.	5	5	5	2	4	6	4	1	1	33
Total	101	106	77	38	84	150	27	35	31	649

Table 27

Reasons Complementary Strategies Not Considered for Implementation

MEASURE ARGUMENTS AGAINST MEASURE	Prohibited by Local Ordinance	Prohibited by State Law	Cannot be Enforced	Control Ineffective	Control Not Applicable to Problem	Public Opposition	Political Opposition	Business Opposition	Funds Not Available	Other	Total
Improve Transit Service	0	0	0	1	11	1	0	0	3	1	17
Provide Demand-Responsive Transit	0	0	0	0	20	3	3	3	13	2	44
Provide Subscription Service	0	0	1	4	36	9	8	7	14	4	83
Improve Bicycle Facilities	0	0	0	1	9	3	2	1	1	1	18
Promote Transit Use	0	0	0	1	11	3	1	1	1	1	19
Staggered Work Hours	0	1	4	5	30	12	9	9	4	4	78
Exclusive Bus Lanes	0	0	1	4	50	11	8	8	12	5	99
Construct Auto-Free Zones	0	0	0	5	47	22	19	22	9	4	128
Priority Treatment for High-Occupancy Veh.	0	0	8	7	47	14	9	7	14	8	114
Total	0	1	14	28	261	78	59	58	71	30	600

Table 28

Reasons Complementary Strategies Considered for Implementation and Rejected

MEASURE	ARGUMENTS AGAINST MEASURE											
	Prohibited by Local Ordinance	Prohibited by State Law	Cannot be Enforced	Control Ineffective	Control Not Applicable to Problem	Public Opposition	Political Opposition	Business Opposition	Parking Enterprise Opposition	Funds Not Available	Other	Total
Improve Transit Service	0	0	0	0	0	1	1	0	0	2	1	5
Provide Demand-Responsive Transit	0	0	0	1	1	1	0	0	0	10	4	17
Provide Subscription Service	0	0	0	0	3	1	1	0	0	8	2	15
Improve Bicycle Facilities	0	0	0	0	1	2	2	0	0	3	1	9
Promote Transit Use	0	0	0	0	0	0	0	1	0	1	0	2
Staggered Work Hours	0	0	0	0	1	0	0	1	0	0	0	2
Exclusive Bus Lanes	0	0	0	1	6	2	1	1	0	2	3	16
Construct Auto-Free Zones	0	1	0	0	4	2	5	9	0	0	0	21
Priority Treatment for High-Occupancy Veh.	0	0	1	1	3	1	1	1	0	0	2	10
Total	0	1	1	3	19	10	11	13	0	26	13	97

It was originally anticipated that identification of support strategies that were implemented in conjunction with parking controls would be useful for determining the elements of a successful parking management policy. Because of the lack of experience with parking control strategies in U. S. cities, this analysis could not be made. Generally, however, the cited support strategies were employed independent of and to a much larger extent than parking management strategies.

While it is generally recognized that implementation of parking management strategies should be coupled with other measures that could lead to improved performance of the urban transportation system, little research has been conducted in this area. Isolated studies such as those done in European cities and San Francisco have provided some insight into the effects parking management strategies can have on an urban area. (4,54,60,119) A recent experience in Madison, Wisconsin, revealed that an increase in parking rates coupled with improvement in bus service led to an increase in bus ridership of approximately 10% a year. (125) An evaluation of demonstration projects such as the Madison experiment is needed before parking strategies and complementary controls can be wisely selected.

GUIDELINES FOR SELECTING AND EVALUATING PARKING MANAGEMENT STRATEGIES

The development of a parking management program for an urban area must incorporate political, institutional, social, environmental, and economic considerations as well as provide a technical assessment of the impact of the plan on transportation related problems. More importantly, the parking policies of a city must be an integral part of the area's comprehensive transportation plan. Because of the unique physical, social, economic, and land use characteristics of American cities, it is not possible to develop a universal parking management plan applicable to all urban areas. Packages of parking management strategies and other transportation management measures must be developed to meet the needs of each metropolitan area.

While it was beyond the scope of this study to design a parking program for specific urban characteristics, the following practical guidelines for selecting and evaluating parking management strategies were developed. The procedure is offered as a guide to local planners, traffic engineers, and others who are responsible for urban transportation planning and project implementation.

Parking management strategies should be considered in the development of the transportation improvement program for an area. A simplified process for selecting and evaluating parking measures is shown in Figure 8.

The first phase of planning a parking management program consists of analyzing existing conditions, developing a list of candidate strategies, and determining the transportation goals and evaluation criteria used to examine the feasibility of each measure.

The following information should be obtained for the purpose of analyzing existing parking conditions.

1. Supply and type of parking facilities
2. Cost of parking at each facility, including curb spaces and time limits
3. Location of parking generators
4. Parking demand
5. Type of parking provided, i.e., short- or long-term
6. Ownership of parking facilities
7. Parking regulations

Procedures for collecting these data are described in the literature. (29,35,126,127) After the data are tabulated, summaries should be prepared for use in evaluating alternative parking policies.

A comprehensive list of parking strategies should be developed for evaluation. The 36 strategies outlined in Table 12 are suggested as a starting point. Along with the parking strategies, a list of complementary, or support, strategies should also be prepared. Several sources for developing a list of support strategies are available. (1,18)

The development of clear, concise goals and objectives is an essential part of any transportation plan. Guidelines for choosing objectives are provided in the literature. (128,129) In addition to transportation factors, the goals should include social, economic, and physical factors.

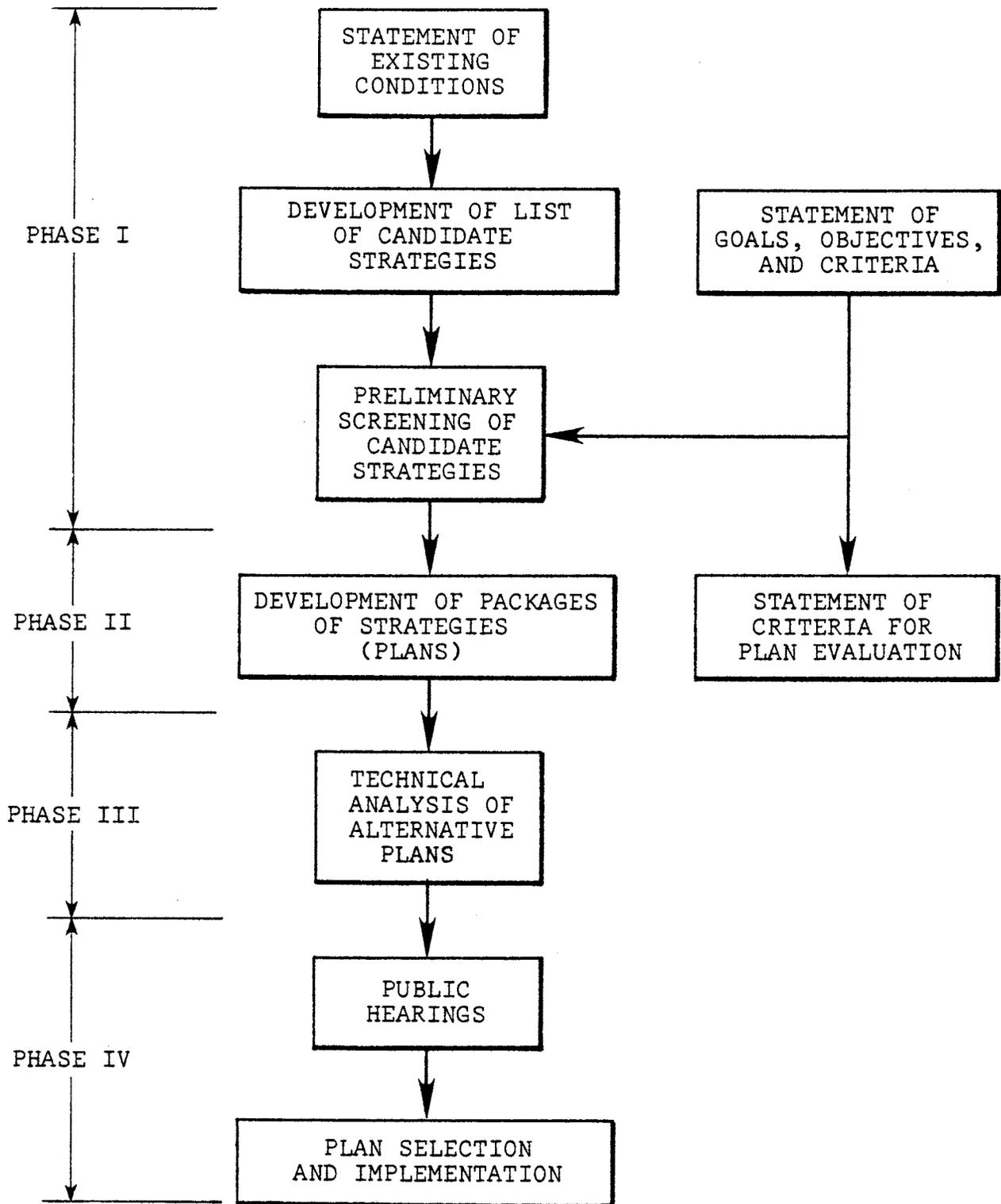


Figure 8. Parking management planning process.

Along with the development of goals, criteria that can be used for a preliminary examination of the feasibility of each candidate strategy should be determined. Based on the literature review and the comments received from transportation officials in the nationwide survey, the criteria given in Table 29 are suggested. A framework for summarizing criteria for parking strategies is given in Figure 9.

Table 29

Criteria for Determining the Feasibility
of Parking Management Strategies

<u>Criteria</u>	<u>Description</u>
Applicability	Does the measure address any of the goals?
Acceptability	Will the groups affected accept the strategy?
Cost	Is the cost of implementing the measure reasonable with respect to the anticipated benefits? Are funds available for the project?
Physicality	Can the control be physically implemented?
Accessibility	How does the control affect the accessibility of the groups affected to other transportation services?
Flexibility	Can the measure be modified to meet the changing needs of the community?
Legality	Do any existing laws or statutes prohibit implementing the strategy?
Simplicity	Is the measure easy to administer and enforce?
Equity	Does the control impose extreme hardships on any disadvantaged groups?

		Strategy Classification										
		Short-Term Supply	Long-Term Supply	Pricing	Preferential Treatment							
		10 AM occupancy restrictions at all commercial facilities	Restrict parking to HOV at large employers	Restrictions on new parking constructions	Parking charge at large employers	Long term rate increase at commercial facilities	Alter rate structure at commercial facilities	Surcharge for all parking	Preferential parking for carpools	Employer based carpool program	Employer based carpool and vanpool programs	
Assessment	Potential Effectiveness	Effective on an areawide basis	•	•								
		Moderately effective on an area-wide basis							•		•	
		Effective within individual market segments	•			•				•	•	
		Not effective					•	•				
	Ease of Implementation	Definitely practicable			•					•	•	•
		Potentially practicable					•	•				
Probably not practicable		•	•		•			•				

Figure 9. Example framework for assessing applicability of parking management strategies.
 Source: Transportation Research Record 722, Figure 2, p. 86.(71)

After the lists of strategies, goals, and evaluation criteria are developed, each control should be examined in accordance with the criteria. It should be noted that the criteria used in the preliminary screening process are non-quantifiable; i.e., most of the criteria shown in Table 29 require subjective answers. Measures which do not pass the preliminary screening test should be eliminated from further consideration.

The second phase of the planning process consists of packaging alternative measures for evaluation and establishing measures of effectiveness that can be used to evaluate the alternative plans. Guidelines for packaging alternative measures are outlined in the literature.⁽⁶²⁾ With regard to parking management, care should be taken to avoid using two or more strategies with incompatible impacts. For example the construction of new parking garages in the downtown area to increase the parking supply should not be combined in the same package as a measure to provide park and ride fringe lots. Also, support measures must be considered in the same package as measures which reduce parking availability, such as a parking ban on long-term users. A minimum of two alternative plans should be developed during this phase.

The purpose of establishing measures of effectiveness is to provide quantitative information on which decisions for selecting a final plan for implementation can be based. Each measure of effectiveness should be related to one or more of the goals developed in phase I. A comprehensive list of measures of effectiveness for multimodal urban traffic management has been developed.^(130,131) Measures of effectiveness which are especially appropriate for most parking management strategies are shown in Table 30. Guidelines for selecting measures of effectiveness are given in Table 31.

The third phase of the planning process consists of conducting the technical analysis. In this phase, each of the alternative plans developed in phase II are evaluated using the measures of effectiveness. There are a wide variety of techniques for conducting evaluations, including manual and computer methods. A comprehensive guide has been developed to aid regional and local planners evaluate alternative transportation plans.⁽¹³²⁾ Procedures for evaluating specific parking strategies and problems with computer models were discussed in a preceding section of this report. Shown in Table 32 is an illustration of the results that can be obtained using these models. The data given in Table 32 were developed for the Denver metropolitan area.

Table 30

Suggested Measures of Effectiveness
for Parking Management Strategies

Traffic volume
Travel time
Travel speed
Number of accidents
Auto occupancy
Parking turnover
Parking violations
Parking accumulation
Transit ridership
Emissions
Noise levels
Energy consumption
Use of high-occupancy vehicles
Revenue from parking charges

The final phase of the planning process consists of conducting a public hearing and selecting a plan for implementation. The need to include public opinion in the transportation planning process has been well documented.^(133,134) Without public support, a transportation strategy may fail to achieve its objectives. Citizen input provides valuable information for selecting alternatives that will be effective in addressing transportation related problems. After considering public input, the final plan is selected for implementation.

Illustrations of the planning process are given in the case studies in a subsequent section of this report.

Table 31

Guidelines for Selecting Measures of Effectiveness

Relevancy to objectives: Each Measure of Effectiveness (MOE) should have a clear and specific relationship to Transportation Systems Management (TSM) objectives in order to ensure the ability to explain changes in the condition of the transportation system.

Simple and understandable: Within the constraints of required precision and accuracy, each MOE should be simple in application and interpretation.

Quantitative: MOEs should be specified in numerical terms whenever possible.

Measurable: Each MOE should be suitable for application in preimplementation simulation and evaluation (i.e., have well-defined mathematical properties and be easily modelled) and in postimplementation monitoring (i.e., require simple field measurement attainable within reasonable time, cost, and manpower budgets).

Broadly applicable: MOEs which are applicable to many different types of strategies should be used wherever possible.

Responsive: Each MOE should be specified to reflect impacts on the various factor groups taking into account, as appropriate, geographic area and time period of application and influence.

Sensitive: Each MOE should have the capacity to discriminate between relatively small changes in the nature of implementation of a control strategy.

Not redundant: Each MOE should avoid measuring an impact that is sufficiently measured by other MOEs.

Appropriately detailed: MOEs should be formulated at the proper level of detail for the analysis (i.e., if conceptual level sketch planning is involved, the appropriate MOE is probably less detailed than one useful for more detailed implementation planning and design).

Source: Proceedings, International Symposium on Traffic Control Systems, Table 1, p. 223.(131)

Table 32

Example Output of Computer Analysis
of Various Transportation Strategies

Strategy	Percentage Change in VKMT ^(a)			
	VKMT of Group Affected	Areawide Work VKMT	Areawide Nonwork VKMT	Areawide Total VKMT
Short-term supply				
10:00 a.m. occupancy restricted at commercial facilities, 50 percent	- 8.7	-1.0	-	-0.5
Employer-provided spaces re- stricted to high-occupancy vehicles (HOVs) at large employers	-15.8	-4.1	-	-1.9
Long-term supply				
New parking construction restricted	-22.7	-6.8	-	-3.2
Pricing				
\$3.00 parking charge at large employer-provided facilities	- 3.2	-0.8	-	-0.4
100 percent price increases for long-term parking at commercial facilities	- 2.4	-0.3	-	-0.13
Rate structure at commercial facilities altered to \$4.00/day and \$0.25/half hour	- 3.7	-0.4	+0.13	-0.05
Parking charge for all parking of daily \$1.00 surcharge/space	- 0.9	-0.9	-1.8	-1.4
Ride-sharing incentives				
Preferential employer-based parking locations for HOVs	- 3.4	-0.9	-	-0.4
Employer-based carpool program for employers of at least 50 employees	- 3.1	-1.4	-	-0.7
For large employers of more than 250 employees	- 3.1	-0.8	-	-0.4
Employer-based carpool-vanpool programs	-14.4	-3.7	-	-1.8

(a) High-occupancy vehicles

Source: Transportation Research Record 722, Table 2, p. 86. (71)

SUMMARY OF MOST PROMISING
PARKING MANAGEMENT STRATEGIES

The objective of Task C, as noted in the project working plan, was to determine the feasibility of implementing various parking management strategies based on the criteria developed in Task B. Because of the unique characteristics of urban areas and the limited knowledge of the impacts of parking controls, it was not considered desirable to conduct this evaluation. In fact, of the 36 parking measures identified in the study, none should be eliminated from consideration by any urban area at this time. There are, however, several strategies which appear to be widely applicable in most American urban areas. A list of these promising strategies is given in Table 33. Most of the strategies are locally acceptable because they are measures which improve transportation service. Also, many of the measures have been in use for a number of years and are familiar to the public.

Table 33

List of Promising Parking Management Strategies

Short-term curb parking	Increases parking turnover for shoppers in retail areas.
On-street parking bans during peak periods	Improves traffic flow.
Parking regulations enforcement patrols	Increases effectiveness of enforcing parking regulations at minimum cost.
Reserved parking for priority vehicles	Encourages car pooling and van pooling and thus reduces parking demand and single-occupancy-vehicle trips.
Residential parking permits	Promotes neighborhood atmosphere and provides curb parking for residents.
Dual uses of facilities	Reduces need to construct parking spaces in the downtown area.
Zoning law limits	Controls the development of parking supply.
Short-term free parking	Encourages stopping in the retail area.
In-lieu parking regulations	Permits reducing future parking spaces for automobiles and provides funds for transit.
Peripheral parking areas and park and ride lots	Reduces peak period congestion and parking demands in the CBDs

CASE STUDIES

Parking management strategies appear to have considerable application and benefits when they are carefully selected and gradually implemented to meet local needs. To demonstrate the potential application of parking measures, two case studies are discussed. In the first study, the integration of parking policies in the comprehensive transportation plan for Palo Alto, California, is outlined. In the second case, the impacts of a city-wide parking control policy and transportation improvement program are summarized for Madison, Wisconsin.

Palo Alto Case Study

Palo Alto, a city of approximately 56,000 persons, is located 35 miles south of San Francisco. On November 29, 1976, after three years of study, the city council adopted the Palo Alto Comprehensive Plan.⁽¹³⁵⁾ Development of the plan followed traditional lines. The development of goals, public hearings, and the selection and evaluation of alternatives were included in the planning process. The transportation element of the plan provides an interesting view of how parking management can be used to achieve the objectives and goals of the city.

The basic transportation objectives as identified by the city were to (1) serve existing and future transportation demands, (2) reduce the growth of traffic, (3) reduce peak hour congestion, (4) serve the captive transit rider, (5) reduce dependence on the automobile, and (6) protect residential neighborhoods from through traffic. The development of a plan to meet these objectives paralleled the planning process previously outlined. First, an inventory of the existing transit, traffic, and parking situation was conducted and traffic demands were projected to the year 1990. In order to meet the objectives of reducing traffic volumes and peak hour congestion and of providing mobility, a goal was set to improve mass transit and to increase its ridership to include 30% of the trips by 1990. The elements of the plan considered essential to accomplish this goal were to discourage auto use by:

1. opposing new highway construction
2. promoting flexible work hours
3. providing free parking for high-occupancy vehicles

4. minimizing the need for additional long-term parking by increasing transit service, modifying zoning ordinance to provide compact car parking, and adopting in-lieu space regulations
5. providing short-term parking in retail areas
6. regulating on-street parking
7. improving transit service
8. promoting bicycle use

To accommodate any changing conditions, the city planning commission is required to make an annual review of the plan and submit modifications to the city council. The elements of the Palo Alto transportation plan are innovative and typify the process for integrating parking management strategies with other transportation control measures to achieve the transportation goals of the city. Although the social, economic, physical, and land use characteristics are unique for every city, the Palo Alto plan can be used as a model by transportation planners in other urban areas.

Madison Case Study

Madison, a city of approximately 205,000 persons, is located in the south central part of Wisconsin in Dane County. Comprehensive planning programs incorporating public opinion have existed for a number of years in the metropolitan area.(136) The major goals of the city are to:

1. minimize auto use and encourage transit use and other forms of transportation such as taxis and bicycles
2. coordinate implementation of transportation improvements with parking policy disincentives to discourage auto use
3. develop non capital programs such as car pooling to reduce peak period congestion
4. discourage auto traffic in the central area
5. discourage the use of low-occupancy-auto traffic in the downtown area.

After an inventory of existing conditions including parking policies was conducted, a long-range transportation plan was developed and is being revised annually to meet changing needs. Among other control measures, the plan includes the following parking strategies.

1. Providing short-term parking through parking space allocation by converting long-term spaces to short-term at the rate of 8% to 10% per year.
2. Discouraging long-term parking by raising parking rates.
3. Eliminating curb parking in the downtown area.
4. Providing park and ride service from fringe lots to the central area.
5. Requiring government employees to pay for parking.

As a result of implementing the plan, bus ridership has increased by 8% to 10% per year. Also, due to improved transit service, employment in the downtown area has increased as well as economic activity. The Madison transportation plan is also an excellent example of implementing parking management strategies along with other measures to achieve community goals.

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2159
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APPENDIX A

QUESTIONNAIRE SURVEY OF CITY TRANSPORTATION OFFICIALS

COMMONWEALTH of VIRGINIA

HIGHWAY & TRANSPORTATION RESEARCH COUNCIL

April 8, 1977

30.2.4

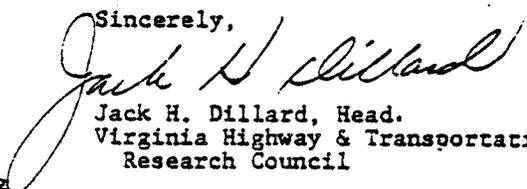
Dear

The Virginia Highway and Transportation Research Council, in cooperation with the Federal Highway Administration, is conducting a study of parking management strategies for metropolitan areas. For the purpose of this research, a parking management strategy is defined to be a measure that attempts to limit the parking supply or increase the parking cost so that auto users are persuaded to shift to other transportation modes or to increase auto occupancy. A more comprehensive description of parking management concepts and strategies is included in Attachment A.

One of the tasks of the study is to examine existing and planned use of parking management strategies in U. S. cities. This task consists of determining the type of parking controls in use, why they were selected, how they were selected, how they are evaluated for effectiveness, and what problems are encountered. To help accomplish this task, the attached questionnaire has been prepared. I would appreciate your cooperation in completing the questionnaire and returning it along with any requested material by May 1, 1977.

Should you not be involved with planning and administering parking management strategies in your community, I would appreciate your forwarding the questionnaire to the proper administrator. If you have any questions or would like more information concerning the study, please contact Martin R. Parker, Jr. of our office, telephone (804) 977-0290.

Sincerely,



Jack H. Dillard, Head.
Virginia Highway & Transportation
Research Council

MRP/cc

Attachments

- A - Description of Parking Management Strategies
- B - Survey Questionnaire

A HIGHWAY IS AS SAFE AS THE USER MAKES IT

ATTACHMENT A

General Concept of Parking Management Planning

Historically, in many U. S. cities, parking management planning has consisted of attempting to provide an adequate supply of spaces to accommodate the parking demands of the auto user. Parking controls have been used on a limited basis to alleviate problems within certain corridors; i.e., controls such as eliminating on-street parking during peak hours have been used to reduce congestion along a major street.

Parking management planning, as related to this survey, is a new concept addressed to the broader issue of managing auto traffic in a city to reduce major transportation related problems. Typical objectives include improving mobility in urban areas and reducing congestion, accidents, environmental problems, etc., through disincentives to reduce single occupant auto work trips, and incentives to encourage the use of alternative modes, e.g., public transit, vanpools, and bicycles. In cities where public transit capacity and service can adequately accommodate additional passengers, parking management planning may consist entirely of implementing parking strategies (providing disincentives for auto use). In cities without adequate transit facilities, the plan may consist of implementing parking strategies and providing support strategies (public transit incentives). For example, increasing the cost of parking in the CBD may not by itself reduce congestion, but when pricing increases are supplemented by providing fringe parking with express bus service, then the auto users may find it more economical to leave their autos in the fringe lot than pay the higher cost of parking downtown.

By definition, a parking management strategy must be directly related either to controlling the cost of parking or limiting the parking supply so that auto drivers are given an incentive to car pool or shift to other modes of transportation. Based on a review of the literature, the following is a descriptive list of some of the parking strategies (auto disincentives) and support strategies (public transit incentives) that have been used in parking management plans.

A. Parking Management Strategies (Auto Disincentives)

1. Charge higher parking rates for single occupancy vehicles.
2. Alter parking rates to provide low cost for short-term parking and high cost for long-term parking.
3. Substantially increase parking rates.
4. Reduce parking costs for priority vehicles, i.e., vanpools, carpools, etc.
5. Provide only short-term parking for on-street spaces.

6. Eliminate on-street parking.
 7. Provide strict police enforcement of parking violations.
 8. Provide reserved parking for priority vehicles, i.e., vanpools, etc.
 9. Restrict parking time for on- and off-street parkers.
 10. Issue parking permits to residents in urban areas near the central business district.
 11. Freeze or limit the number of parking spaces.
 12. Limit new parking garage construction.
 13. Use zoning controls to restrict developers to building a maximum number of parking spaces instead of a minimum number.
 14. Impose a parking tax for each long-term parker.
 15. Impose a parking stall tax on each space for all off-street parking to discourage employers from providing free or low cost parking to their employees.
- B. Support strategies (Public Transportation Incentives)
1. Improve transit service.
 2. Provide demand responsive transit.
 3. Provide subscription service such as vanpools.
 4. Construct park and ride lots.
 5. Improve bicycle facilities.
 6. Promote transit ridership.
 7. Reduce peak transit loads by staggering work hours.
 8. Provide exclusive bus lanes.
 9. Provide peripheral parking near the central business district that would allow walking to destinations.
 10. Construct auto-free zone.
 11. Provide priority treatment for transit and other high occupancy vehicles.

111

RESULTS OF QUESTIONNAIRE SURVEY OF CITY TRANSPORTATION OFFICIALS

Return Completed Questionnaire To:

Martin R. Parker, Jr., P.E.
Research Engineer
Virginia Highway & Transportation Research Council
Box 3817 University Station
Charlottesville, Virginia 22903

ATTACHMENT B

SURVEY QUESTIONNAIRE OF PARKING MANAGEMENT STRATEGIES IN U.S. CITIES

1. City All Responses-173 Cities State United States Date July 1, 1977

2. Population 1970 census Range: 17,000 to 7,968,000

3. In your opinion, how serious are the following transportation related problems in your city?
(Check one for each category)

<u>Categories</u>	<u>No Problem</u>	<u>Minor Problem</u>	<u>Problem</u>	<u>Considerable Problem</u>	<u>Major Problem</u>
a. Traffic congestion	<u>12</u>	<u>53</u>	<u>69</u>	<u>17</u>	<u>15</u>
b. Traffic accidents	<u>3</u>	<u>56</u>	<u>74</u>	<u>23</u>	<u>8</u>
c. Air pollution	<u>43</u>	<u>66</u>	<u>32</u>	<u>16</u>	<u>8</u>
d. Traffic noise	<u>34</u>	<u>90</u>	<u>33</u>	<u>7</u>	<u>1</u>
e. Inefficient use of energy	<u>9</u>	<u>37</u>	<u>70</u>	<u>35</u>	<u>11</u>
f. Other (Please specify)	<u>0</u>	<u>0</u>	<u>1</u>	<u>3</u>	<u>9</u>

Need more roads, more parking facilities, and financing of public transportation.

4. Does your city have a formal parking management plan whose primary objective is to limit the parking supply or increase parking cost so that auto users are persuaded to shift to other transportation modes or increase auto occupancy?

5 Yes. If yes, please attach a copy of the plan.

166 No.

5. Have any studies of parking management strategies been conducted in your city?

27 Yes. (Please furnish a copy of the report or title, date, author, etc., or a summary of findings regardless of how formal or informal).

140 No.

6. Are studies of parking strategies currently being conducted in your city?

38 Yes. Please specify person or agency conducting study.

128 No.

7. For your city, rate the status of each parking management and support strategy listed below.

A. Parking Management Strategies	(1) Not Considered	(2) Under Consideration	(3) Considered and Rejected	(4) Programmed for Implementation	(5) In Use
1. High rates for single occupancy vehicles	134	12	3	1	1
2. Low rates for short-term high rates for long-term parkers	108	23	6	3	12
3. Increase all parking rates	92	31	12	7	10
4. Reduce parking costs for priority vehicles	126	20	2	0	3
5. Allow short-term on street parking only	65	19	5	3	59
6. Eliminate on street parking	79	17	18	7	30
7. Strictly enforce parking violations	33	20	2	12	86
8. Reserved parking for priority vehicles	108	19	4	1	20
9. Restrict parking time at all facilities	112	12	5	0	20
10. Residential parking permits	107	18	14	4	9
11. Freeze limit on number of parking spaces	126	16	5	1	3
12. Limit parking garage construction	130	10	6	1	4
13. Zoning to limit No. of spaces allowed	123	16	2	0	10
14. Parking tax on users	125	12	7	2	5
15. Parking stall tax on parking garage owners	136	7	7	0	0
16. Other (Please specify) <u>Merchant permit</u>	0	0	1	1	1
B. Support strategies (Public Transportation Incentives)					
17. Improve transit service	14	46	5	23	62
18. Provide demand responsive transit	42	57	17	14	21
19. Provide subscription service	80	36	11	5	16
20. Construct park & ride lots	62	41	6	9	33
21. Improve bicycle facilities	18	56	7	30	42
22. Promote using transit	22	38	3	17	70
23. Staggered work hours	75	28	5	2	40
24. Exclusive bus lanes	93	21	16	2	17
25. Provide peripheral parking	71	46	3	2	29
26. Construct auto-free zones	96	20	17	3	14
27. Priority treatment for high occupancy vehicles	102	24	7	5	12
28. Other (Please specify) <u>Bus passes, validation of transit fare by merchants</u>	0	0	0	3	3

8. For each strategy that has not been considered (column 1 of question 7) indicate the reason(s) the measure has not been considered. Use identification numbers of the strategies from question 7.

a. Prohibited by city code or ordinance	48
b. Prohibited by state law	22
c. Cannot be enforced	88
d. Controls are ineffective	132
e. Controls are not applicable to city's transportation problem(s)	1140
f. Public opposition	504
g. Political opposition	381
h. Opposition from businesses	431
i. Funds not available for implementing controls	170
j. Other (Please specify) <u>No paid parking strategy not evaluated, no control of off-street private parking, and alternative travel modes are not available.</u>	127

9. For each strategy that was considered and rejected (column 3 of question 7) indicate the reason(s) the measure was rejected. Use identification numbers of the strategies from question 7.
- a. Prohibited by city code or ordinances 10
 - b. Prohibited by state law 8
 - c. Cannot be enforced 14
 - d. Control is ineffective 9
 - e. Control is not applicable to problem 35
 - f. Public opposition 46
 - g. Political opposition 48
 - h. Opposition from business community 63
 - i. Opposition from parking garages 14
 - j. Funds not available for implementation 29
 - k. Other (Please specify) Not a practical solution, lack of interest, and lack of demand for service. 16

10. For each parking strategy planned or in use, (column 4 and 5 of question 7) indicate the reason(s) it was selected. Use identification numbers of the strategies from question 7.
- a. Improve traffic flow 252
 - b. Reduce congestion 245
 - c. Improve air quality 130
 - d. Reduce noise level 65
 - e. Reduce energy consumption 138
 - f. Increase use of transit 240
 - g. Increase auto occupancy 72
 - h. Reduce accident hazards 93
 - i. Other (Please specify) Benefit business, increase revenue, pressure from businesses and public request. 144

11. Has your city used a parking management strategy and later found it to be ineffective in meeting plan objectives?

9 Yes. (Please describe type of strategy and why you felt it was ineffective)
Ineffective strategies: on-street meters, overnight parking permit, no parking restrictions, and residential parking permits. Reasons: public opposition, demand changed.
137 No. 7 Not applicable.

12. In view of your city's experiences, how do you view the effectiveness of parking management strategies?

44 Not a solution 34 Not applicable
18 Short-term solution 3 Partial solution
33 Long-term solution 8 Other

13. Please list any type(s) of parking strategies that have been particularly successful in your city and give your reason(s) for their success.

Parking Strategy	Reason(s)
<u>Short term on street parking</u>	<u>Best method of serving businesses on the CBD</u>
<u>Residential parking permits</u>	<u>Effective method of providing parking for CBD residents</u>
<u>Enforcement of regulations</u>	<u>Improves traffic flow</u>
<u>Fringe parking</u>	<u>Reduces parking demand and traffic in CBD</u>
<u>Remove on street parking</u>	<u>Increase capacity</u>
<u>Raise parking rates</u>	<u>Discourages long term parking, encourages shoppers</u>

14. How did you measure the effectiveness of any parking strategy that has been implemented?
(Check one or more)

- 32 a. Not measured
- 47 b. Engineering judgement
- 3 c. Measured air pollution level before and after implementation
- 1 d. Measured noise level before and after implementation
- 32 e. Determined if transit ridership has increased
- 12 f. Counted auto occupancy before and after implementation
- 35 g. Measured traffic volumes
- 32 h. Examined enforcement problems
- 23 i. Conducted traffic accident study
- 14 j. Counted the number of all-day (9 to 10 hours per week day) parkers
- 13 k. Other (Please specify) Time and delay studies
- 32 Not applicable

15. What legal problems have you encountered in using parking management strategies in your city?

- 87 No legal problems
- 20 Legal problems (Please describe each strategy and type of problem)
Residential parking permits ruled unconstitutional; obtaining approval of
- 33 Not applicable parking sites.

16. Have changes in the state or city codes been made to permit the implementation of a parking management strategy?

- 27 Yes. (Specify nature of change, state or city code, and type of control)
Ordinances changed to allow on-street parking bans, zoning changes in parking
requirements, changes in parking prices, residential parking permits, and
- 108 No. establishment of parking authorities.

17. Are litigation procedures currently underway or under consideration to allow a parking strategy to be implemented?

- 5 Yes. (Please discuss) Virginia Supreme Court ruled that Residential Parking
Permits were unconstitutional. Case has been appealed to the U. S. Supreme
- 135 No. Court

18. Additional comments or observations.

SEE APPENDIX C

19. Would you like a copy of our final report on this project?

- 140 Yes
- 17 No

Your Name _____
 Title _____
 Mailing Address _____

Phone Number Area Code () _____

Thank you for your cooperation and assistance. The information you have provided will be tabulated along with data from other cities and summarized in the final report. If you have any questions or would like more information concerning the study, please contact: Martin R. Parker, Jr., Virginia Highway and Transportation Research Council, Charlottesville, Virginia, Telephone (804) 977-0290.

APPENDIX B

CITIES RESPONDING TO THE QUESTIONNAIRE

<u>STATE/CITY</u>	1970 POPULATION IN 1000's <u>(Source: U. S. Census Bureau)</u>
<u>ALABAMA</u>	
Anniston	32
Birmingham	301
Gadsden	54
Huntsville	138
Mobile	190
<u>ALASKA</u>	
Anchorage	175
<u>ARIZONA</u>	
Scottsdale	68
Tempe	63
<u>ARKANSAS</u>	
Fort Smith	63
Hot Springs	36
Little Rock	132
<u>CALIFORNIA</u>	
Anaheim	167
Berkeley	117
Beverly Hills	33
Burbank	89
Chula Vista	68
Concord	85
Coronado	21
Hayward	93
Huntington Beach	116
La Mesa	39
Los Angeles	2816
Modesto	62
Norwalk	92
Palo Alto	56
Pasadena	113
Redlands	36
Riverside	140
Sacramento	254
San Bernardino	104
San Francisco	716
Santa Rosa	50
Thousand Oaks	36
Torrance	135
West Covina	68
Whittier	73

COLORADO

Denver	515
Fort Collins	43
Pueblo	97

CONNECTICUT

Bridgeport	157
Hartford	158
New Haven	138

DISTRICT OF COLUMBIA

Washington, D.C.	757
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FLORIDA

Clearwater	52
Dade County	1268
Jacksonville	529
Lakeland	42
Pensacola	60
Sarasota	40

GEORGIA

Atlanta	497
Columbus	154
Macon	122
Savannah	118

HAWAII

Honolulu	325
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IDAHO

Idaho Falls	36
Pocatello	40

ILLINOIS

Elgin	56
Evanston	80
Joliet	80
Moline	46
Park Ridge	42

INDIANA

Evansville	139
Fort Wayne	178
Gary	175
Muncie	69
Terre Haute	70

IOWA

Ames	40
Cedar Rapids	111
Clinton	35

KANSAS

Overland Park	77
Topeka	125
Wichita	277

KENTUCKY

Bowling Green	36
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LOUISIANA

Baton Rouge	166
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MARYLAND

Baltimore	906
Montgomery County	590

MASSACHUSETTS

Cambridge	100
Somerville	89

MICHIGAN

Ann Arbor	100
Battle Creek	39
Grand Rapids	198
Livonia	110
Sterling Heights	61

MINNESOTA

Bloomington	82
Coon Rapids	31
Rochester	54
St. Paul	310

MISSISSIPPI

Jackson	154
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MISSOURI

Independence	112
Kansas City	507
St. Louis	622

MONTANA

Great Falls	60
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NEBRASKA

Fremont	23
Omaha	347

NEVADA

Las Vegas	126
Reno	73

NEW HAMPSHIRE

Nashua	56
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NEW JERSEY

Bayonne	73
Clifton	82
Jersey City	261
Newark	382
Paterson	145
Woodbridge Township	99

NEW MEXICO

Las Cruces	38
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NEW YORK

Albany	116
New York City	7868

NORTH CAROLINA

Burlington	36
Durham	95
Fayetteville	54
Hickory	21
High Point	63
Wilmington	46
Winston-Salem	133

NORTH DAKOTA

Bismark	35
Grand Forks	39
Minot	32

OHIO

Akron	275
Cincinnati	454
Lorain	78
Middletown	49
Parma	100

OKLAHOMA

Lawton	74
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OREGON

Eugene	76
Portland	382
Salem	68

PENNSYLVANIA

Bethlehem	73
Lancaster	58

PUERTO RICO

Caguas	163
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RHODE ISLAND

Pawtucket	77
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SOUTH CAROLINA

North Charleston	54
Rock Hill	34
Spartansburg	45

SOUTH DAKOTA

Sioux Falls	72
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TENNESSEE

Chattanooga	179
Johnson City	34
Knoxville	175

TEXAS

Abilene	90
Arlington	91
Brownsville	53
Fort Worth	393
Galveston	62
Laredo	69
Lubbock	149
San Antonio	654
Tyler	58
Wichita Falls	98

UTAH

Bountiful	28
Provo	53

VERMONT

Burlington	39
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VIRGINIA

Alexandria	110
Arlington	174
Charlottesville	39
Chesapeake	90
Hampton	121
Hopewell	23
Lynchburg	54
Newport News	138
Norfolk	308
Petersburg	36
Richmond	250
Salem	22
Staunton	25
Waynesboro	17

WASHINGTON

Bellevue	61
Bellingham	39
King County	1396
Tacoma	155

WISCONSIN

Appleton	57
Eau Claire	45
Green Bay	88
Milwaukee	717
Racine	95

WYOMING

Cheyenne	41
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APPENDIX C

SELECTED GENERAL COMMENTS FROM
CITY TRANSPORTATION OFFICIALS

One of the tasks of the study was to examine existing and planned use of parking management strategies in U. S. cities. This task was accomplished, in part, by mailing the questionnaire shown in Appendix A to city transportation officials in 458 communities. In addition to the questions included on the form, question 18 allotted space for additional comments or observations. Forty percent of the respondents took advantage of that opportunity and several provided comments on separate sheets or in transmittal letters.

The comments present a wide and interesting cross-sectional view of opinions related to parking management strategies. As the intent of the study was to examine the state of the art of parking management in U. S. cities, selected comments are given below for the interested reader. The comments have been reproduced verbatim from the questionnaires and letters, except direct reference to the respondent's city has been omitted. The city population is given, in parentheses, to assist the reader in interpreting the comments. In some cases an additional word or phrase has been inserted, in parentheses, for clarification.

The responses are grouped into five major categories. The comments are typical of those received for each category. A few of the responses included comments applicable to several categories; however, for the purpose of presenting a respondent's view of parking management, the entire response was given in only one category.

Category 1 comments include those from respondents who felt that parking management strategies were not applicable to their city. Approximately one-third of the general comments received were related to this category. Most of the respondents cited city size (low population center) as the primary reason that parking strategies were not applicable; however, the populations of some of the cities were in excess of 100,000 persons.

A summary of comments from respondents who suggested that parking management strategies are not supported by the community is given in Category 2. Groups opposing, or not supporting, the strategies include the public, politicians, and businesses.

The third category reflects the view of the respondents who felt that more traffic and parking, not less, was needed to save the downtown area. Nineteen percent of the comments received were

related to this category. As suggested by the respondents, there is a need to increase mobility in the CBD's of some American cities to prevent economic collapse of the downtown area. As discussed in the report, this factor should be given major consideration in planning parking management strategies or any other transportation management policy.

Comments in the fourth category are related to the general status of parking management strategies in the respondent's city. The responses are divided into the following three groups: (1) cities where parking strategies are not planned, (2) cities where parking management policies are being or have been planned, and (3) cities where parking management strategies may be used in the future.

Included in the fifth category are comments from two respondents who provided general criticisms of the concepts of the survey that were outlined in Attachment A (see Appendix A). These respondents provide a beneficial overview of the current state of the art of parking management. The concerns expressed by these respondents are generally supported by the findings of the study.

Category 1 Parking Management Strategies Are Not Needed

* * * *

(Our community) is a small city of 50,000. The idea of a parking management strategy does not apply in our area.

* * * *

(Our community - population 60,000) is a rapidly growing city and has not experienced parking problems in context within this inquiry. (Our city size) is 36.8 square miles and approximately 55% (of the area is) developed.

* * * *

Our city (population 50,000) could not use many of the strategies unless massive expansion of the bus system occurred. (The) high ratio of tourist traffic makes many strategies ineffectual for us.

* * * *

Our town (population 180,000), in my opinion, is not a good example, for the proposals discussed. I believe these things would be applicable to a larger city or a regional transportation authority.

* * * *

Since the city (population 110,000) boundaries contain 353 square miles, there are 2.1 acres per person. Most development is low and medium density, so there is plenty of space to provide for adequate parking spaces, and only limited justification for mass transit.

* * * *

All of (our city's - population 90,000) parking generators have adequate parking lots of their own.

* * * *

Congestion (in our city - population 190,000), at present, is not sufficient to support parking strategies as related to this survey.

* * * *

(Our municipality - population 175,000) is not contemplating a Parking Management, as defined in your letter of April 8, 1977.

We are fortunate to be able to provide downtown parking facilities, while at the same time maintaining a high level of ridership in our transit system.

* * * * C-3

Parking management actions were considered in preparation of the TSM (Transportation System Management element of the city's - population 280,000 - transportation plan) and determined to be inappropriate.

Category 2 Parking Management Strategies Are Not Supported

* * * *

Parking management strategy is considered to be politically unfeasible in this area of the country (city population 120,000).

* * * *

We (city population 310,000) have not received council backing for parking strategies.

* * * *

Our (city population 70,000) traffic peaks are of very short duration and not a major problem. The biggest problem is conservation of energy, which I don't think a parking strategy would solve because of public, political, and business opposition.

* * * *

We do not consider the problem great enough in (our city - population 150,000) to restrict the desired mobility of our people.

* * * *

Strong political support by elected officials is an absolute must before any of the strategies can be implemented (city population 380,000).

* * * *

The staff (city population 130,000) is aware of and has discussed the potential of such strategies. There is no evidence that the Council or public would seriously consider such measures. We have a shortage of parking, a public demand for more, while transit goes begging.

* * * *

My recommendation to raise some off-street parking rates was flatly rejected by City Council (city population 50,000). There would be strong opposition from them and the business interest to any strategy to reduce auto use.

* * * *

Parking strategies, as they are defined in Attachment A (of the questionnaire), would appear to pose serious conflicts with

constitutional guarantees . . . and until this nation is governed by authoritarian rule . . . they seem, for the most part, to be destined to legal challenges in our courts (city population 250,000).

* * * *

Category 3 More Parking and Traffic Needed to Save Downtown

* * * *

A large regional shopping mall has recently opened in (our city - population 100,000). Downtown businessmen feel that free CBD parking is their only hope for economic survival.

* * * *

The city's (population 80,000) CBD is on the brink of economic collapse, (and) has been declining for the last ten years. Parking strategies developed have sought to relate parking supply to perceived need. Limiting the availability or convenience of parking would adversely impact the few businesses still remaining. It is anticipated that, as a result of redevelopment efforts under way, management strategies may be necessary in the next five years.

* * * *

Over the past 10 years the downtown (city population 30,000) area has declined greatly. Much of the decline has been attributed to the lack of parking and easy access. Though we are just starting a transit system and will be encouraging people to use the transit line, we project there will still be a need for additional parking to fully realize a successful redevelopment of the downtown area.

* * * *

We have strong doubts that this is a viable objective for a city such as (our community - population 280,000). If we make access of parking more difficult, people will go elsewhere, particularly to nearby shopping centers and other outlying businesses, or to (a large nearby city - population 751,000).

* * * *

(Our city's - population 60,000) major CBD problem is lack of sufficient parking lots to maintain commercial competition with peripheral shopping malls. Any attempts to discourage auto access to CBD will result in downtown commercial income loss. Commuter access and circulation is presently no significant problem and city size is still not large enough or of high enough density to justify significant efforts at vehicle (auto) reduction.

* * * *

The biggest conflict inherent in a parking management approach is the avoidance of negative impacts on downtown offices and stores in a situation where they are already at a competitive disadvantage vis-a-vis suburban locations. (City population 910,000.)

* * * *

The current policy of this city (population 150,000) is to attract people into the downtown area through connections to state and federal highways. Therefore, the concept of parking management strategy would hinder this stated policy.

* * * *

We (city population 50,000) are trying to compete with a new shopping mall outside the city limits and are doing everything possible to encourage cars, shoppers, and people to come downtown.

* * * *

Restrictive parking controls, beyond those necessary to guarantee traffic flow and turnover, would tend to run counter to present efforts to save downtown (city population 40,000). Focus is on bringing more traffic downtown and competing with outlying shopping centers which have free parking. Artificial restrictions would be strongly resisted.

* * * *

Category 4 Parking Management Policies

Strategies Are Not Planned

* * * *

We have no parking strategy as defined herein. Although we have a population of approximately 50,000 we still have a small town atmosphere.

* * * *

I'm sorry but (our city) has not conducted a survey or study of this nature.

(Our city) has a population of approximately 120,000 which mostly work in (a larger city - population 510,000), a distance of 15 miles. The (transit system of the larger city) does provide service to our City for this purpose and a small number of bus routes from residential (areas) to shopping centers.

* * * *

The city (population 50,000) was incorporated in 1972 and nothing along the lines of planning for parking strategies has been addressed.

* * * *

Current Parking Strategy Planning

* * * *

(Our city - population 50,000) does not have high concentrations of vehicular traffic in the CBD--most of our congestion

is of a short term duration, less than 30 minutes, and is at isolated intersections. I attempt to utilize parking strategies as but one of the techniques in my overall transportation systems program.

* * * *

Our (city population 40,000) experiences in these areas have been in "spot" locations and not as an overall policy.

* * * *

We (city population 310,000) have just prepared a rough draft for a residential permit parking ordinance.

* * * *

(Our city - population 90,000) is included in a regional parking management study which is being done by the Metropolitan Transportation Commission.

* * * *

(Our city - population 175,000) is concentrating on support strategies to reduce CBD demand for long term parking and provision of additional supply for short term. Three to four garages (are) planned on periphery of CBD for short term (parking) and long term as well.

* * * *

I am enclosing a parking Management Study report prepared by the regional planning council of (our - population 622,000) metropolitan area. This study was done in connection with other plans propped for the reduction of air pollution and energy consumption. The other such studies were inspection and maintenance of automobile emission control equipment, car pooling and reserve bus lanes. The regional planning agency has continued to encourage car pools and (our city) has established reserve bus lanes on one surface street. These are the only things that have been done to this date to help improve the reduction of emission levels and energy conservation. Perhaps the upcoming Federal Energy Program may cause all or some of these to be reconsidered and implemented in the future.

* * * *

We (city population 50,000) are completing work on a Transit Service Improvement Plan and a Downtown Parking Feasibility and Policy Plan which will be available within the next month. (We are) preparing to let a marketing study for (our) transit system.

* * * *

Future Planning

* * * *

We (city population 30,000) are hoping to develop a parking management strategy in the near future to complement our new transit system, which should begin operation in January 1978.

* * * *

We (city population 40,000) are just reaching a stage in our City's development where traffic problems are evolving which might lend themselves to solutions through parking management strategies.

* * * *

At this time parking is not a problem in (our city - population 70,000) and no parking management strategy has been exercised. However, I do foresee a need for such a plan in the future. Therefore, a copy of your findings will be helpful to me in future assessments of parking.

* * * *

Your work and results (are) of great interest to (our city - population 60,000) and we would appreciate anything you could send us in terms of results and conclusions.

* * * *

Category 5 Survey Criticisms

* * * *

In response to your April 8, 1977 request, please find enclosed a completed parking management strategies questionnaire. (County population 1,270,000).

Certain of our staff have expressed deep concern with inferred measures of effectiveness and goals of your April 8, 1977 letter, attachments, and questionnaire, and--thus--the approach to this study. We disagree with your statements that parking management planning is a new concept, and that where public transit capacity and service can accommodate additional passengers only auto use disincentives should be planned. An increase in auto occupancy or shift to other transportation modes may only be modest indicators of performance of a transportation goal. We disagree with the slant of your study toward limiting parking supplies or increasing parking costs as the preferred means for increasing auto occupancy and transit use.

In general, we have usually found it more worthy to pursue those transportation system management strategies which are oriented toward mobility improvements resulting in overall reductions in cost, delays, accidents, and energy consumption, with associated increases in comfort and convenience. Cost increases or other disincentives in one area of individual modal selection with no

incentives or service improvements in another has not been our general philosophy, although such programs can be instituted and measured in such a manner as to characterize artificial mobility improvements.

While we do have these expressed disagreements with your study, I assure you that we have completed the attached questionnaire to the best of our abilities.

We would appreciate receiving two copies of your final report when completed.

* * * *

I have received the Parking Management Survey from your Research Council. I have several questions about the basic premise and terms set forth within the survey text.

I do not think I can agree that Parking Management is "a new concept", nor that by definition, a parking management strategy must be directly related either to controlling the cost of parking or limiting the supply. . . etc., etc." - underlines mine.

We have utilized parking management in (our city - population 140,000), via our local Parking Authority since the early 1950's, and the original and continuing thrust has been the stimulation of economic development, a goal of increasing importance to us. Many other cities do likewise. Recently, we see parking management as a tool to assist in achieving other objectives, such as air quality improvement, improvement to the general traffic system and the general public transit system. Clearly, "parking management" is one tool within a repertoire of tools available to be used toward a central purpose. The central purpose may, or may not, be consonant with the definition set forth in your Virginia survey.

I am a member of the Parking and Terminals Committee of the Transportation Research Board, and while I do not speak for the Committee, I can tell you that the subject of parking management is of keen interest to it. At the January meeting of the TRB, Anne Rappaport presented a paper on parking management. I do not have a copy of this paper any longer, but by carbon of this letter to Anne, perhaps she can send you a spare copy of it. I am attaching a copy of a note I sent to Anne subsequent to the January meeting in which I attempted to indicate my view of the interactions potential to parking management and determined objectives.

In dealing with social and economic goals we often find contradictions within the process. Parking management to obtain socioeconomical development is one thing, and parking management to secure (for instance) an "auto-free zone" is quite another endeavor! I feel that transportation technicians must use caution in presentations of transportation management concepts. These presentations should set forth these sort of interactions as a "caveat" of sorts.

I trust the foregoing comments are useful and constructive, and I mean no personal criticism to anyone involved with the survey.

1972