MANHATTAN BIKEWAY SYSTEM EVALUATION PROCEDURES

by

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Introduction

In the fall of 1976 the Manhattan Bikeway Plan II, Phase I Grant Application was approved by the Federal Highway Administration as a bikeway demonstration project. The Manhattan demonstration project will consist of a combination of the following three types of bikeways:

Class I

A completely separated right-of-way designated for the exclusive use of bicycles. Crossflows by pedestrians and motorists are minimized.

Class II

A restricted right-of-way designated for the exclusive or semi-exclusive use of bicycles. Through travel by motor vehicles or pedestrians is not allowed. However, vehicle parking may be allowed. Crossflows by motorists to gain access to driveways or parking facilities, is allowed; pedestrian crossflows, to gain access to parked vehicles, bus stops or associated land use, is allowed.

Class III

A shared right-of-way designated as such by signs placed on vertical posts or stenciled on the pavement. Any bikeway which shares its through-traffic right-of-way with either moving motor vehicles or pedestrians is considered a Class III bikeway.[1]

The latest plans for the bikeway facility as developed by the Manhattan City Engineer's Office is shown in Figure 1.

As required by the Federal Regulations (Federal-Aid Highway Program Manual Volume 6, Chapter 9, Section 14) an evaluation

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[1]Smith, D. T. Jr., Safety and Locational Criteria For Bicycle Facilities User Manual Volume II: Design and Safety Criteria. Department of Transportation, Federal Highway Administration, February, 1976, p. 3.

THIS BOOK CONTAINS NUMEROUS PAGES WITH DIAGRAMS THAT ARE CROOKED COMPARED TO THE REST OF THE INFORMATION ON THE PAGE.

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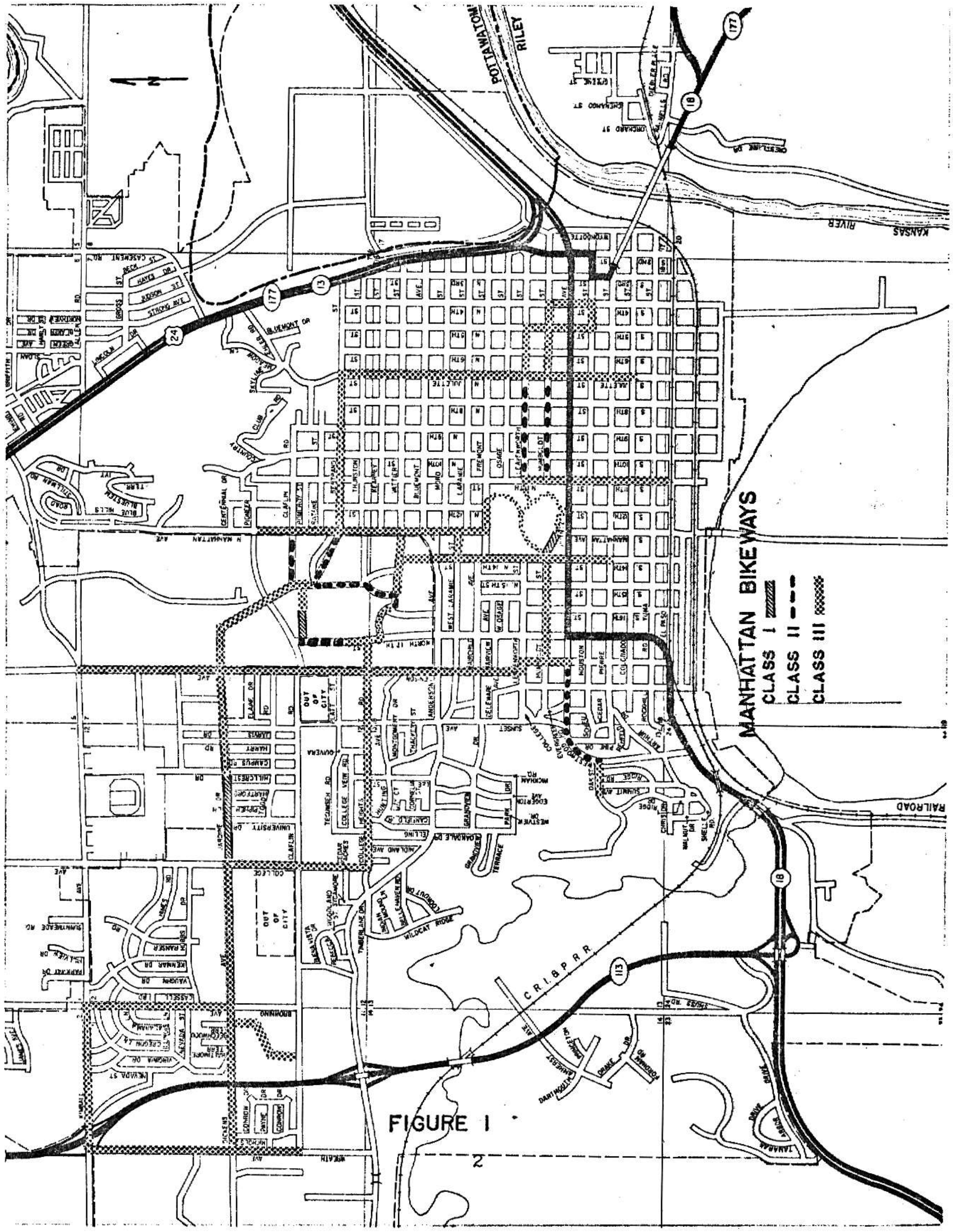
MANHATTAN BIKEWAYS
CLASS I
CLASS II
CLASS III
KANSAS RIVER
RAILROAD
POTTAWATOMIE
RILEY

FIGURE I

plan for measuring the success in achieving the project objectives was described on pages 17 through 22 of the application (See Appendix A). The application presented a general evaluation plan by describing several methods which might be used to evaluate a completed bikeway, but the actual details of a method for evaluating the Manhattan demonstration project were left for development at a later date. Since the city of Manhattan is now preparing to implement the bikeway demonstration project, the details of an evaluation method should be designed to measure the effect of the new system upon ridership and safety and as a tool to be used in the continuing bikeway planning process. As part of the preliminary research for developing a detailed method for evaluating the Manhattan project, the author wrote a paper in the fall of 1976 titled "Bicycle Planning Projection and Evaluation Techniques - A State of the Art." This paper which is included in Appendix B indicates how important the evaluation of bikeways is to an adequate planning process. In the following report a detailed evaluation procedure is described which should meet the Federal requirements for measuring the success in achieving the project objectives and at the same time fulfill the needs of an adequate continuing planning process as described in the bicycle planning paper in Appendix B.

A review of the Federal requirements, the Grant Proposal, and the planning needs reveals that the evaluation must be able to indicate the following:

1. The effect of the bikeway system upon bicycle usage in Manhattan.

2. The effect of the system upon bicycle safety.

3. The effect of the system upon other modes of transportation.

4. What might be done to better meet citizen's needs and desires.

5. Where modifications in the bikeway system are needed.

In order to fulfill these needs the evaluation process will require the following surveys:

1. A combination origin-destination (O.D.) and attitude survey designed to be compatible with an earlier 1974 survey.

2. Bicycle safety evaluation using before and after bicycle accident data along with direct observation of selected sections of the completed system.

3. A minimum of before and after bicycle volume counts at selected locations.

Origin-Destination and Attitude Study/Design

In the spring of 1974 a combination origin-destination (O.D.) and attitude survey was conducted in Manhattan to determine the actual bicycle usage as well as the potential users of an adequate bikeway system. The results of this study were included in the "Manhattan Bikeway Plan II" grant proposal as an indication of the bikeway demand. A description of the survey procedures and methods of processing the 1974 data as presented in the report "Manhattan Bikeway Plan" is included in Appendix C of this report. The 1974 survey was a well designed study and should function as an adequate before study as long as the after study is designed and conducted so that it is compatible with the 1974 study. In

order to eliminate as many unwanted factors such as weather conditions and status of classes at Kansas State University the follow-up study should be conducted at a time when such conditions are as close to the original conditions as possible. Interviews of those responsible for the 1974 survey revealed that the study was conducted during the spring of 1974 while classes were in progress at Kansas State University. There had been several weeks of favorable spring weather prior to the survey and the weather continued to be pleasant during the actual survey. This would indicate that our follow-up survey should be conducted in the spring of 1978. As with the original survey Kansas State University classes should be in progress and spring weather should exist several weeks prior to and during the survey.

Besides making sure the data is collected under similar conditions it needs to be collected in a manner which will facilitate comparison of the two studies. In the 1974 survey the study area was divided into 53 zones as indicated by Figure 1C on page C-2 of Appendix C. With only minor updating to reflect development or changes since 1974 these same zones could be used for the after study, thereby enhancing the ability to compare the two studies.

As in the 1974 study a 5% sample of the dwelling units in the residential zones would be randomly selected and interviewed by telephone.

Questionnaire Design

The questionnaire for the after study must also be

designed so that it will furnish data compatible with the 1974 survey. The proposed questionnaire (See Figure 2) has been designed to provide the needed data compatibility. For purposes of comparison the 1974 questionnaire and a discussion of it can be found in Appendix C.

The proposed questionnaire (See Figure 2) will be used for each dwelling unit interview. It is designed for one form per dwelling unit but if additional space is needed the interview can be continued on another form. Just prior to the interview the interviewer will enter at the top of the questionnaire the date of the trips being surveyed and the weather conditions for that day. The date will consist of the month, day, year and day of week. The weather will consist of a conditional statement such as light-rain afternoon, and the low and high temperatures for the day. If there are any significant variations in the data, the date and weather information will allow the data to be analyzed to determine if the variation can be attributed to either the date or weather. The date and weather conditions would also be very important to anyone who might desire to use the data from this survey at a later date or in another study.

The Origin-Destination and Attitude Survey

During the interview for a particular dwelling unit the following four types of information will be collected:

1. Demographic information about the household and each member.

ILLEGIBLE DOCUMENT

THE FOLLOWING DOCUMENT(S) IS OF POOR LEGIBILITY IN THE ORIGINAL

THIS IS THE BEST COPY AVAILABLE

Date of Trips_____ Weather_____ Manhattan, Kansas

Household Member	Bicycle owner																	
	Occupation																	
	Age-Group/sex																	
	Income-Range																	
Trip Ends	Origin																	
	Destination																	
Modes bike	On System																	
	Off System																	
Modes auto	Driver																	
	Passenger																	
Modes other	Transit																	
	Walking																	
Trip Purpose	Work																	
	School																	
	Shopping																	
	Recreation																	
Attitude Questions	#1																	
	#2																	
	#3																	
	#4																	
	#5																	
	#6																	
	#7																	

Age Groups

1: 0-5
2: 6-10
3: 11-15
4: 16-19
5: 19-24
6: 25-49
7: 40-UP

Income Range

1: Less than $2,000
2: $2,000 to $4,999
3: $5,000 to $7,999
4: $8,000 to $10,999
5: $11,000 to $13,999
6: $14,000 to $19,999
7: $20,000 and UP

Questions

1. Do you feel the Manhattan bikeway system is an asset to the community?
2. What are the reasons you don't use a bicycle now or use your present bicycle more?
3. When does weather prevent you from riding a bike?
4. How far out of your way in blocks will you go in order to use a bikeway?
5. Why do you ride a bicycle?
6. What effect do you feel the bikeway system has upon auto travel?
7. Has the bikeway system made bicycling safer?

Suggestions:

Figure 2

2. The origins and destinations, mode used, and purpose of all trips taken by members of the household on the day prior to the interview.

3. Attitudinal information concerning bicycling, the bikeway system and the effects of these upon the community.

4. Suggested changes or improvements for the Manhattan bikeway system.

Under the demographic information the interviewer will obtain the following information for each household member: 1) number of bicycles owned, 2) occupation, 3) sex, and 4) age, according to the groups indicated on the form. The total household income will be indicated only once for each household using the income ranges shown on the form.

After recording the demographic information for a particular household member, the interviewer will record the information about all trips made by that member on the day prior to the interview. Using the same zones as the 1974 survey the numbers of the zones corresponding to the origin and destination of each trip will be recorded. Next the mode used for that trip will be indicated. For bicycles an "on system" indication would indicate that one of the bicycle routes was used for at least part of the trip while an "off system" indication would mean the trip did not follow any of the bikeways. If the mode is private auto, the interviewer will indicate whether the person was the driver or a passenger. Other modes are divided into transit (taxi and bus) and walking. Finally the trip purpose will be entered as one of the following: work, school, shopping or recreation.

When all of the trips for a particular individual have been recorded, the interviewer will record that individual's response to the seven attitude questions indicated on the form. The interviewer will interview at least one adult member of each household and any other household members older than 15 that are available at the time of the interview. Attitude responses will not be entered for anyone under 16 years of age or unavailable for the interview. However, the demographic and trip data may be obtained from an adult member of the household for children under sixteen years old and other household members not available for interview.

Each person interviewed will also be given the opportunity to suggest any needed changes in the Manhattan bikeway system or bicycling program. These suggestions or comments will be entered at the bottom of the questionnaire.

Origin-Destination and Attitude Survey Evaluation

By comparing the results of this survey with the 1974 O.D./attitude survey many aspects of the bikeway system could be evaluated. In order to aid in this comparison the data should be processed into a form compatible with the 1974 survey. Therefore, as in the 1974 survey, data expansion should be on a zone by zone basis using an expansion factor equal to the zone population divided by the number of persons included in the survey. In the 1974 survey the following three types of two-way trips were developed for each pair of zones: 1) Present (1974) bicycle trips, 2) Potential bicycle trips assuming an

adequate bikeway system, and 3) Auto driver trips. The 1974 bicycle trips were developed from the origin-destination data and the potential bicycle trips were based on the attitude survey. A listing of these three types of zone to zone trips for the 1974 study can be found on pages C20 - C27 of Appendix C. Since the proposed survey will be using the same zones the two-way zone to zone bicycle and auto driver trips can be developed and compared to the 1974 bicycle trips, potential bicycle trips and auto driver trips. The comparison of the total actual bicycle trips in this survey with the total actual 1974 bicycle trips should indicate any change in bicycle use in the Manhattan area. A comparison of each of the zone to zone volumes for the two studies should indicate if the relative change was different for zones being served by the bikeway system. A substantial overall increase in bike usage and/or a higher rate of increase in zone to zone movements served by the bikeway system would be an indication that the bikeway demonstration project was successful in increasing bicycle usage. A comparison of the actual bicycle trips for this survey and the 1974 potential bicycle trips would give an indication of how realistic the 1974 potential values were and how well the bicycle system developed that potential. A comparison of the bicycle usage in those zones served by the bikeway system with bicycle usage in other zones, along with an analysis of the attitude responses would aid in determining if the potential values were too high or if the bikeway system was inadequate. A comparison of the area auto driver

trips for this and the 1974 survey along with a comparison of relative changes for each mode bicycle and auto could also be used to analyze the effect of the bikeway system upon the travel habits of the area. Again not only total volumes and changes should be compared, but also zone to zone movement served by bikeways should be compared to those not served by bikeways.

The answers to the proposed attitude question, "Is the Manhattan bikeway system an asset to the community?", will be compared to the 1974 attitude question, "Would you like Manhattan to construct a bikeway system?", to determine how well the actual system satisfied the people's desires.

The attitude question, "What are the reasons you don't use a bicycle now or use your present bicycle more?", was included in the 1974 survey and is proposed for this study. The two results for this question would be compared to see if attitudes had changed since construction of the bikeway system.

Both a present and potential user age distribution was developed in the 1974 study and a similar distribution should again be developed to determine if there has been any change. An analysis of the changes in this distribution could indicate what ages are being attracted by the system and possibly how realistic the 1974 potential data actually was.

A distribution of bicycle trips by trip purpose should also be developed for comparison with the "present", and "present plus potential" distributions by trip purpose

developed in the 1974 study. This comparison could indicate what types of trips by purpose are attracted by the bikeway system. This comparison might also indicate how realistic the 1974 potential values were.

The median and average trip length for bicycles could also be developed and compared to the values in the 1974 study. An estimate of the number of bicycles in Manhattan should be developed from the survey and compared to the 1974 value and bicycle registrations for Manhattan. The attitude question, "When does weather prevent you from riding?", is included in this survey as an attempt to better understand the effect of weather upon bicycle usage. The question, "How far out of your way will you go to use the bikeway system", should give an indication of the ability of the routeways to attract bicycle traffic from the surrounding area. Hopefully the question, "What effect does the bikeway system have upon auto travel?", will give an indication of the perceived as well as actual effect of bicycling and bicycles upon auto travel. The last attitude question is part of the safety evaluation which will be discussed next.

Bikeway Safety Evaluation

The perceived effect upon safety will be measured by the attitude question, "Has the bikeway system made bicycling safer?". This perceived effect upon safety should later be compared to an analysis of reported accidents before and after the implementation of bikeway system. Using the previous year's

records as a base the number of accidents after the implementation of the bikeway system should be statistically analyzed to see if there has been a significant increase or decrease in accidents. Accident experience along with different classes of bikeways should be compared to each other in an attempt to determine which type of facility is the safest.

Along with this accident analysis the safety evaluation should include direct observation of several potential problem areas. This observation could be accomplished by video tape. General operating features and conflicts between bicycles and other vehicles should be observed. Special notice should be made of erratic movements by bicycles or autos, near misses for bicycles or autos, and violations of traffic laws or controls. The following locations which possess some unique operational requirements and possible conflicts, are recommended for such direct observation (See Figure 3):

1. The intersection of Dickens Avenue and College Avenue.

   At this location a Class I bikeway will proceed east from the intersection but auto traffic will be restricted to the other three directions.

2. The intersection of Eleventh Street and Leavenworth Street.

   At this location a Class II bikeway is proposed for Leavenworth Street east of the intersection, a Class III on Eleventh Street south of the intersection and a Class III along the city park entrance. No bikeway facility is proposed for the north leg.

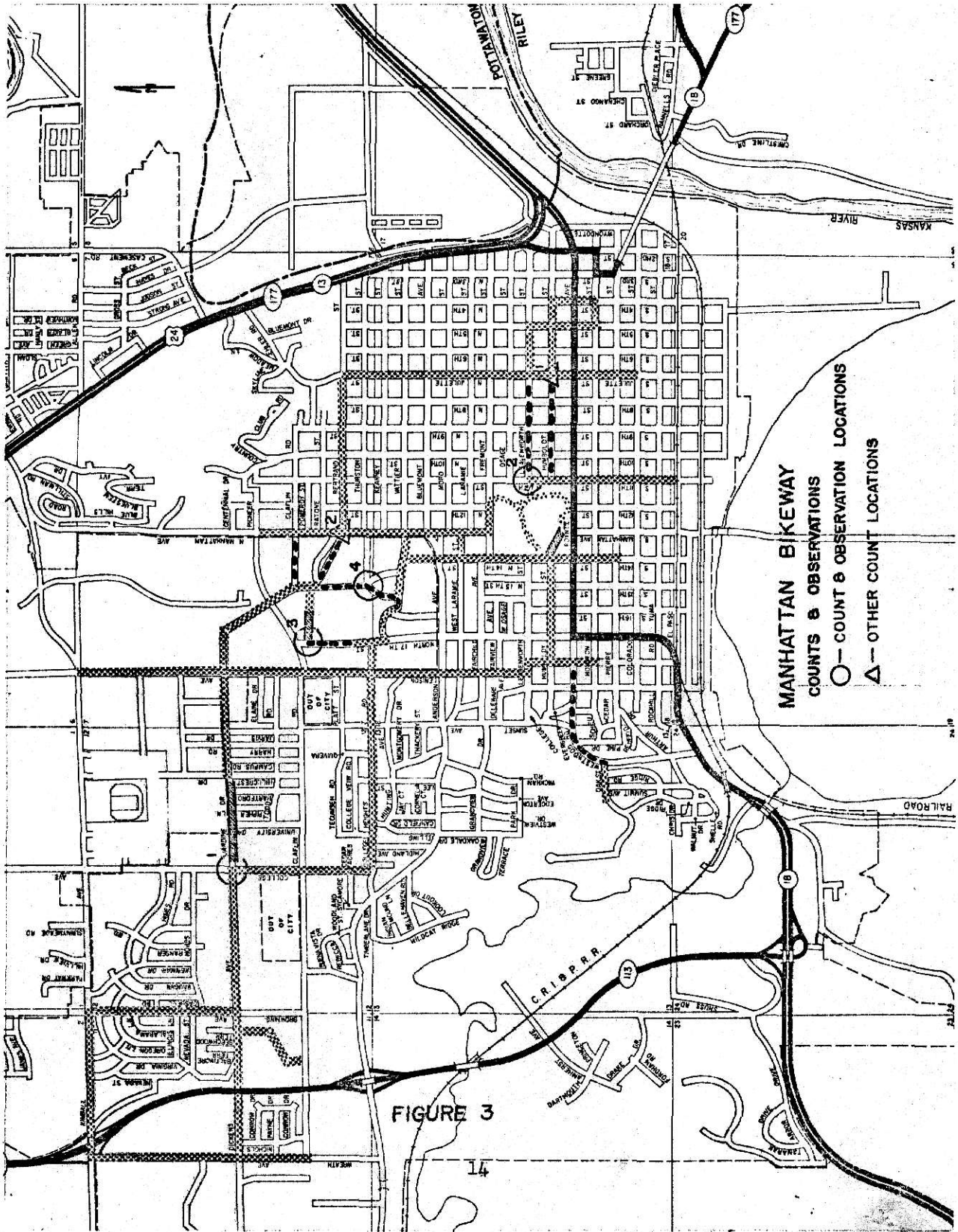
MANHATTAN BIKEWAY
COUNTS & OBSERVATIONS
○— COUNT & OBSERVATION LOCATIONS
△— OTHER COUNT LOCATIONS
POTTAWATOMIE
RILEY
KANSAS RIVER
RAILROAD
CRISPR
MANHATTAN AVE
WEST LARAMIE AVE
COLLEGE HILL
OUT OF CITY
MILDCAT BRIDGE
177
18
113
24
13

FIGURE 3

3. The intersection of the Class I Bikeway and Seventeenth Street just south of Claflin Road.

   At this location a Class I Bikeway is to be constructed east of Seventeenth and a Class II Bikeway will follow Seventeenth south of the Class I Bikeway. A bikeway does not follow Seventeenth north of the Class I facility.

4. The Class II bikeway in front of Anderson Hall.

   At this location a two way bikeway will occupy part of a street designated for one way auto traffic. The bike lanes will be on the left side of the auto traffic.

These locations are areas where it is anticipated that direct observation may be desirable; however, other locations warranting observation may develop. Observation should also be combined with other functions such as traffic counts when possible.

For the last aspect of the safety evaluation Police reports of crime and vandalism along the bikeways should be reviewed hopefully to detect any cause and effect relationship between the bikeways and crimes or vandalism.

Bicycle Volume Counts

A minimum number of manual before and after volume counts is being recommended as an additional tool for evaluating the bikeway system. These counts will be used to supplement the O.D./Attitude survey evaluation. The before counts should be taken in the summer of 1977 prior to implementing the bikeway system and the after counts in the summer of 1978. The time of the counts, location, weather conditions and status of

classes at Kansas State University should all be considered when planning the before and after volume counts, in order to eliminate as much effect from unwanted factors as possible.

The bicycle volume data should be collected for a sufficient portion of the day to include the peak volume period.[2] Turning movements should also be collected during the volume counts. The direct observations and volume counts could be combined on the "after" volume counts; therefore, the four locations recommended for observation (See Figure 3) are also being recommended as volume count locations. Two additional locations recommended for volume counts are (See Figure 3):

1. The intersection of Juliette Avenue and Humboldt Street.
2. The intersection of Bertrand Street and Manhattan Avenue.

Since the volume counts are proposed for the summer of 1977 and 1978 and the O.D./Attitude surveys the springs of 1974 and 1978, an analysis of the difference in the results of these two methods may indicate how much effect other variables such as the fuel situation have had upon bicycle usage. It should be realized that without an extensive area wide bicycle volume study it will not be possible to differentiate between increased bicycle usage and bicycles attracted to the system from other streets. This is the reasoning behind making the O.D./Attitude survey the primary part of the evaluation procedure with the volume counts being used to supplement it.

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[2]Civil Engineering Projects Class (585), Manhattan Bikeway Plan II Phase I, Kansas State University. Manhattan, Kansas, May, 1976, p. 18.

Summary

The evaluation procedure proposed in this report contains three basic procedures:

1. An origin-destination and attitude survey in the spring of 1978 which would be compared to a similar survey conducted in the spring of 1974.

2. Bicycle safety evaluation using before and after accident data and observation of selected locations.

3. A minimum of before and after bicycle volume counts.

The major portion of the evaluation will be based upon the origin-destination and attitude survey. The accident data and direct observations are necessary for an adequate analysis of the effect upon safety. The bicycle volume counts are being included not as a primary evaluation tool but as a supplement to the other evaluation tools.

This three-process approach has been designed primarily to satisfy the need for evaluating the success of the demonstration project. The O.D./Attitude survey was expanded slightly in order to fulfill some additional planning needs. These additions to the survey would include the provision for citizen input by obtaining suggestions and the attitude question concerning the effect of weather upon bicycle riding. The rest of the survey and process is interwoven into the entire proposed evaluation procedure. Considering the available data, i.e., the 1974 study, it was felt that this procedure would facilitate adequate evaluation with a minimum of expense.

APPENDIX A

MANHATTAN BIKEWAY PLAN II

PHASE I

Grant Application

"Bikeway Evaluation"

Civil Engineering Projects Class (585)

May, 1976

BIKEWAY EVALUATION

After the bikeway system has been implemented, an evaluation of the system's effectiveness needs to be made by the community to determine the utilization of a bikeway system and a system evaluation survey should be made not only to justify the expenses, but also to determine aspects of the facility that should be changed.

A completed bikeway facility will represent a substantial investment of community time and effort. Costs will have resulted from gathering data and developing alternative design solutions for review by the public and the decision makers. Dollars will have been spent to build the bikeway. An evaluation of the effectiveness of the new facility needs to be compared with its costs in order to judge the worth of the community's investment.

The following describes some methods for evaluating a completed bikeway. Some data will require a period of time in which to accumulate a sufficient base before being usable. Other information can be gathered and used immediately after construction. However, it should be kept in mind that weather causes seasonal variation in bicycling and, therefore, any direct comparison of a period before bikeway construction and a period after should contain the same months of the year.

The following methods provide a full range of information to aid in an evaluation of a bikeway:

1. Bicycle Volume on Bikeway - Bicycle volume counts taken at several locations along the

bikeway route after construction can measure the change in ridership resulting from the facility.

2. Bicycle Volume Within Area - Bicycle volume counts at selected locations within the bikeway service area before and after construction help to evaluate how well the facility has attracted riders from streets within the corridor.

3. Accident Data - All records of accidents within the corridor, before and after construction, give an indication of the effect on safety resulting from the bikeway.

4. Roadway User Survey - A survey of users of all transportation modes along the route is a measure of the impact resulting from the bikeway.

5. Direct Observation - Observation of the ability of roadway users to adopt to the changed traffic conditions.

6. Citizen Response - Solicited response of individuals and businesses along the bikeway route are a good source of information about the facility's effect on the community.

Bicycle Volume on Bikeway

Bicycle volume counts should be taken at significant locations along the bikeway route after construction. The frequency and location of each count station will be dependent on the amount of information desired and the complexity of the roadway arrangement where the bikeway is being installed. Data should include the commuter/recreational orientation of the bicycle operator being counted and the day of the week of the operation. The sex and and estimated age of the persons passing the counting stations on the two occasions can indicate a shift in user characteristics caused by the facility.

The bicycle volume data should be collected for a

sufficient portion of the day to include the peak volume period. The information should be tabulated at fifteen minute intervals to clearly define the peak period. In addition to total bicycle volumes entering an intersection, all turning movements should be recorded.

A study of the bicycle use information developed in the above fashion allows answers to be given to the following questions:

1. Did the bikeway have an effect on bicycle volumes?
2. Are there volume changes along the entire route, or only at some locations?
3. Are the volumes and peak time period in accord with the estimates?
4. Do turning movements indicate an attraction to the bikeway?
5. Does the sex and age of the users conform with the expected client? (Did a commuter facility generate a strong recreational use or visa versa?)

An analysis of the answers to these questions is one step toward the final bikeway evaluation.

Bicycle Volume Within The Area

A similar operation to that of the preceding section should be conducted within the serviced area adjacent to the bikeway. The counting station locations should be coincidental with often used bicycle routes identified by surveys or counting techniques. When no information is available, direct observation in the effected area may assist in deciding the locations. The enumerators at the stations should direct their attention toward counting the

Bicycles that appear headed in a direction serviced by the bicycle route. Counts of all other bicycle movements should be taken at each station, but may have little value in assessing the attraction of the bikeway facility.

As in the case of comparing tabulations of bicycle movement on the bikeway route, a series of questions can be framed to aid in the evaluation of the bikeway's impact throughout the adjoining neighborhood. However, the more remote the counting station location is to the bikeway, the greater the probability of error in assessing the influence of the facility.

Accidents

Accident records can be used to indicate the effect on the safety of the roadway users resulting from the bikeway. Accident records involving bicycles and motor vehicles as well as all other motor vehicle accidents should be assembled and analyzed. Direct comparisons can be made between accident frequencies along the bikeway path before and after construction. Inferences can be drawn from the accident data in the surrounding area when used in conjunction with the before and after bicycle volumes.

Although many months will probably be required to build a sufficient data base for comparative purposes, constant surveillance of accidents occurring on the bikeway must be maintained, and corrective action taken as soon as a problem becomes apparent.

Roadway Users Survey

A survey of the users of the roadway and the bikeway

can be a valuable aid in evaluating the success of the facility. A bikeway which appears to have created problems for the motorists or the bicyclists should either be corrected or relocated. Surveys can highlight needed improvements before irrevocable harm has resulted. The information obtained through roadway surveys can document support and opposition to the facility and will be a better gauge than that received from a biased vocal group. Some survey answers can be compared to observed practices along the bikeway route to judge the effectiveness of specific design details. Additionally, data gathered from surveys will indicate the amount of bicycle trips generated by the bikeway, the purposes of the trips, and the feelings of the safety of the bicycle operators.

The following information should be obtained from the appropriate people:

Motorists

1. The extent of understanding of the operational features of the bikeway.
2. The perceived impact of the facility on travel time and safety.
3. The amount of previous use of the route.
4. If and how much respondent bicycles.

Bicyclists

1. Trip purpose (Recreational, Work, Shopping, Exercise, School, other).
2. The perceived impact of the facility on travel time and safety.
3. The amount of previous use of the route.
4. Opinions on specific bikeway design features.

In addition the interviewer should note the sex and approximate age of the motorist or bicyclist and record the time of day and the direction of travel. It is also helpful to gather information on the years of bicycling experience.

Direct Observation

In the case of specific features, evaluation is best done by observing how bicyclist, automobile drivers, trucks, buses, and pedestrians react. The use of a particular design feature can be filmed or video taped and reviewed several times. Where the equipment is available the video taped activity can be played back at increased speed so that several hours of observation can be viewed quickly. Observers should pay particular attention to how well all users obey regulatory signing, signals, channelization and other traffic control devices.

Motor Vehicle Volume and Parking Impacts

In addition to the observation of motorist's behavior changes resulting from the bikeway, comparisons should be made of the facility's impact on traffic volume and speed. This can be done immediately after the bikeway is operational but will be more indicative of the true influence of the facility if a period of adjustment is allowed.

If on-street parking was allowed to remain along the bikeway, studies should be made to assess the bikeways effect. Where parking was removed to provide space for bicycle operation, the impact on the adjacent area should be

reviewed and an evaluation made of the total influence.

Citizen Response

Persons who live or own businesses along the bikeway are another source of information necessary to evaluate the effect of the facility on the surrounding community.

Notification should be made to these individuals prior to construction to minimize negative reaction to the change. Letters can be hand delivered directly to the properties along the route. Newspapers, including smaller community or neighborhood newspapers, along with radio and television can also be used to inform the neighborhood that the bikeway will be built.

Some of the questions which should be anticipated and for which answers and corrective strategies developed are:

1. Will the bikeway have an effect on on-street parking?
2. Will access to the abutting properties be affected?
3. Will an on-street bikeway cause traffic congestion?
4. Will large numbers of bicyclist riding through a neighborhood increase crime and vandalism?
5. Will the necessary bikeway traffic control devices degrade the attractiveness of the neighborhood?

By soliciting comment to the proposed improvement and reaction to the completed facility, valuable information can be obtained. Not only is the community given an outlet for expressing its concerns, but specific details will be uncovered for corrective action.

The information presented in this Chapter has been

structured toward the evaluation of a single bikeway from within a total network. It could be relevant to decision makers to also consider the effectiveness of bikeway expenditures in terms of the entire system. As each bikeway is implemented, it will probably enhance the bikeway system in serving urban bicycle travel. Indicators of this improvement may take the form of:

1. Increased bicycle usage.
2. Longer bicycle trips.
3. Lower bicycle/motor vehicle accident rate.
4. Increased bicycle accessibility throughout the community.
5. Improvements in urban recreation, health and environmental values.

Bicycle Registration

In addition to the above method of evaluation, one more method should be used for Manhattan. A very good measure of increased bicycle usage is the increase in bicycle registration. A bicycle registration count needs to be taken before the bikeway facility is constructed. Hopefully, this can be in advance of any public announcement of the bikeway system. This way, no bicycle registrations can be attributed to the bikeway. After the implementation of the bikeway, periodic registration counts should be made. Under normal conditions, the increase in this count can be attributed to the bikeway.

Conclusion

Certain areas need special observation, such as,

where a transition occurs from a Class II to a Class III bikeway. Perhaps some of the changes are too abrupt. It was also indicated previously that ideally, all parking of cars along the routes should be removed; however, at this time, some opposition by the city was encountered as to doing this. So, this removal of parking was not included in the proposal. This area should be examined after construction of the bikeway to determine if this change should still be made; particularly on Juliette Street.

Results received from the techniques described in the previous pages should be indicative of the facility's effectiveness. Of course, for any surveys to result in accuracy, good survey techniques should be researched and used. And in conclusion, good judgment should be exercised in evaluating the results.

APPENDIX B

BICYCLE PLANNING, PROJECTION AND EVALUATION TECHNIQUES - A STATE OF THE ART

C. Gerald Jasper

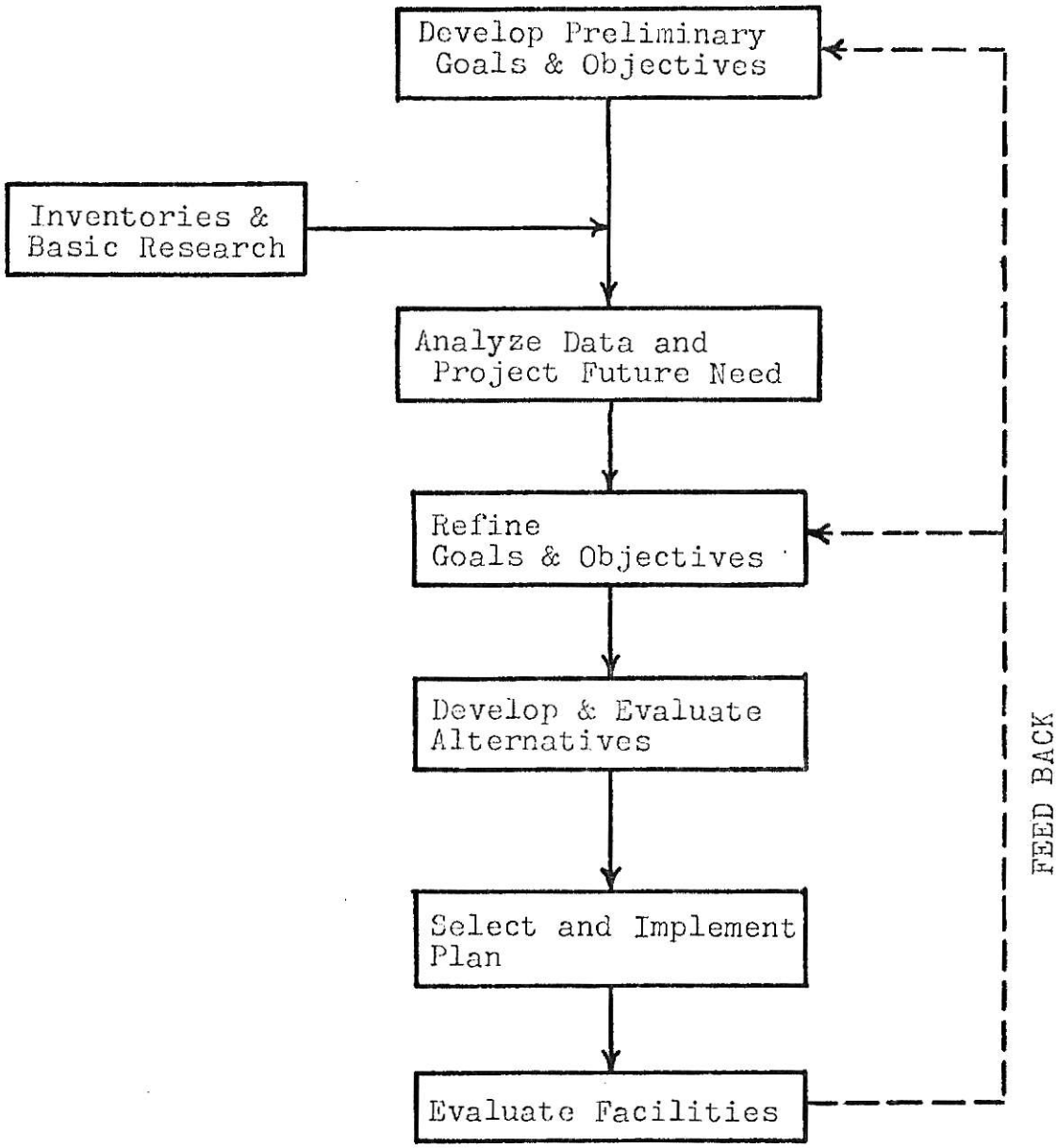
November, 1976

Bicycle Planning, Projection and Evaluation Techniques

Our ever present need to reduce traffic congestion, air pollution, and energy consumption makes it imperative that we develop the full potential of bicycle transportation. In order to accomplish this the bicycle mode must be developed through a comprehensive planning process. Although we lack past experience in bicycle planning, we can adequately plan for the bike facilities by following a systematic process similar to the one diagrammed in Figure 1B. This basic process can be used for planning all modes of the transportation system, however, our lack of past experience with bicycle facilities makes it more difficult to project needs and evaluate alternatives for the bicycle mode. In the following pages each phase of the planning process presented in Figure 1B will be discussed and it will be shown that adequate techniques can be employed to project future bicycle needs and evaluate bicycle alternatives.

Goals and Objectives

In bicycle planning as well as other areas of planning there seems to be a tendency to not place enough time and consideration on the development of the goals and objectives. The importance of the goals and objectives is emphasized by the fact that two phases of the proposed planning process is devoted to their development. The preliminary goals and objectives should reflect the desires of the community and should be liberal ones since we do not want to eliminate any possible alternatives at this early state. After the



Bicycle Planning Process

Figure 1B

community surveys have been analyzed and the future bicycle needs projected, then the goals and objectives can be refined to assure that they are feasible and realistic. It is usually helpful to think of this phase as identifying and solving problems. Making sure that the process is not being influenced by preconceived solutions the problems should be identified first and then their causes. The goals might be thought of as eliminating the problems and the objectives as the steps needed to correct the causes.

Inventories and Basic Research

The amount of data needed for bicycle planning depends upon several factors including the amount and type of previous bicycle work in the community, the size and complexity of the community and the scope of the planning effort. Since these inventories and basic research will be used to project future need and alternatives, the data collected must adequately meet these requirements. The actual data requirement will be discussed later under these two phases of the planning process. The basic underlying requirement of all data is that it be useful. To assure usefulness the surveys must be properly designed and good survey procedures used. The actual design of a survey and its collection procedures will depend upon the required realibility of the data, the population to be surveyed, and the availability of time and resources. It is beyond the scope of this paper to discuss the details of good survey design and data collection but the reader is encouraged to give this area plenty of consideration before beginning the planning effort.

Future Needs

Assuming that our plan does include bikeways and related facilities, we must be able to adequately predict the future travel demand for such facilities. The lack of sufficient past experience with bikeways makes this the most difficult task of the bicycle planning process; however, the following techniques should prove adequate. Some of the data required by the proposed techniques for projecting future needs may be available from other sources while the rest must be obtained from surveys. It would be advisable to design a few good multi-purpose surveys instead of one for each data requirement. One of the first data requirements would be origin-destination information by trip purpose for the present bicycle users and information enabling us to identify the major routes presently being used by these bicyclists. The origin-destination information and the route identification both could be obtained by use of any acceptable origin-destination procedure. (Cordon line bicycle volumes will also be needed in order to expand the above O-D Study.) Origin-destination information by trip purpose will also be needed for the other modes of transportation. This information might be available from other studies, but if it is not then it could be included in the bicycle O-D study. In order to project the future bicycle travel demand predictions must be made of the future trips by other modes that will be diverted to the bikeways. Presently, the best method for determining this is through an analysis of attitude surveys. The attitude survey should be designed to determine which of the trips the interviewee feels could be diverted to

a new or improved bicycle facility. The attitude survey should also record demographic information about the interviewee and determine what factors or weather conditions do or would prevent him from riding a bicycle. This information is then analyzed and a prediction of the trips to be diverted from other modes is made. In this analysis our limited experience with bikeways in the U. S. as well as European experience should be utilized. This process is rather subjective; however, later in the discussion of the continuing planning process it will be shown why the procedure is considered acceptable.

Alternatives

This stage of the bicycle planning process requires the greatest amount of familiarity with the community. Through the basic research the planner must now be familiar with the communities environment, existing transportation facilities, and the needs and desires of the residents. This familiarity is necessary in order to evaluate how well each alternative fits into the environment, how compatable it is with other modes of transportation, and how well it satisfies the communities needs and desires.

For detailed discussion of various evaluation criteria the reader is referred to the Department of Tansportation's (DOT) User Manual Volume I Bicycle Facility Location Criteria. The evaluation criteria presented in the DOT Manual can be divided into the three following categories:

1) Suggested Primary-User related criteria and potential use; basic width; continuity, directness and destination service; safety; grades; and barriers.

2) Secondary User related criteria include imaginability; attractiveness; pavement surface quality; trucks and air quality.

3) Non-User criteria include cost and funding; competing use, social status and privacy security.[1]

Selection and Implementation

The alternatives and their evaluation is presented to the community for selection of a plan. After the decision makers have selected the bicycle plan, the implementation process will begin. Since most communities will not be able to implement an entire bicycle system at once, each facility in the selected plan should be given a priority ranking. This ranking should be based on a cost effective analysis so that as funds become available the most cost effective projects will be undertaken first.

Facility Evaluation

The facility evaluation phase enables the establishment of an adequate process of continuing planning. At this point we are also able to justify the earlier rather subjective techniques for predicting the potential of bikeways to attract trips from other modes. Properly designed travel surveys will make it possible to determine how realistic our previous forecast actually was. If needed we can now adjust our forecast and revise the plan. Since we have been using a priority ranking for implementation, these adjustments should be possible before any questionable projects are undertaken. User attitude surveys are also recommended at this time in order to have

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[1]Smith, O. T. Jr., Safety and Locational Criteria for Bicycle Facilities, User Manual Volume 1, Bicycle Facility Location Criteria. Department of Transportation, Federal Highway Administration, p. 34.

citizen input into continuing planning process. With time we may also find that the demographic information that we should routinely collect in the attitude and O-D studies may enable us to develop better and easier methods of projecting future need.

An essential element of the bicycle planning process which has not been directly addressed in this paper is citizens participation. Although it has not been addressed directly, it should be apparent that the proposed process includes adequate means for citizens input. Through the various attitude surveys the public is informed of the bikeway program and citizens input can be obtained. In addition to the surveys it is advisable to solicit input from various groups interested in bicycling and as many communities have done, create a citizens advisory group for bicycle planning. Bruce L. Balshone in his book Bicycle Transit, Its Planning and Design advocates a model of participatory planning at the neighborhood level where the participation has reached the level of citizens control. Mr. Balshone's model would present each interested citizen with a bicycle planning packet and allow the neighborhood residents to prepare their own plans. A close review of this model reveals that the co-ordination of such a process would be practically impossible. The citizen participation method proposed in this paper is adequate and will not be difficult to accomplish.

The bicycle planning process proposed in this paper is a process that will give adequate results and is compatible with available techniques. The process presented includes the better points of the works reviewed, but since none of the works

were without need of modification, the process also includes some original ideas. None of the works reviewed adequately addressed the effect of weather conditions on bicycle usage, since they usually addressed this point in an arbitrary manner. The possibility of transit trips being differed to bikeways is another area where all previous work has been extremely arbitrary. In both cases it is felt that a better approach would be to use attitude surveys as a basis for determining estimates of these factors. A third and most important addition is in the continuing planning process. Others have not addressed this phase of the planning process as thoroughly as it should have been. The proposed continuing process will eliminate some of the shortcomings in the projection techniques and will aid in the evolution of new and improved bicycle planning techniques.

APPENDIX C

Manhattan Bikeway Plan
(Demand Study Section)

A Master's Report
by
David Albert Lacey

Kansas State University
1974

Survey

A survey was conducted to gather information on the residents of Manhattan. Two types of information were gathered: General opinion type information and origin-destination information for design purposes.

The city was first dividied into 53 zones (See Figure 1C). These zones were selected on the basis of land use. Land use types considered were: residential, commercial, industrial, school and public. The residential zones were coordinated with the public school zones so that the expanded grade school population for each school zone could be compared with actual school enrollment.

A 1973 land use study which was conducted by a class in the Planning Department at K.S.U. provided an in-depth study of land use in Manhattan. This study was invaluable in helping select zones for our study.

The zones were classified according to land use as follows: commercial, industrial, public-recreational, school and residential. The commercial zones are areas of concentrated retail and wholesale activities. These zones--25, 32 and 47 were isolated as it was anticipated that these would be major traffic generators. There is only one industrial zone in Manhattan--Zone 24. Lt is largely vacant land for future industrial expansion and some commercial activities are conducted in this area. The city parks and recreational areas--zones 5, 8, 21, 33 and 41, were isolated in separate zones as it was anticipated that these might be major attractions to bicycle users.

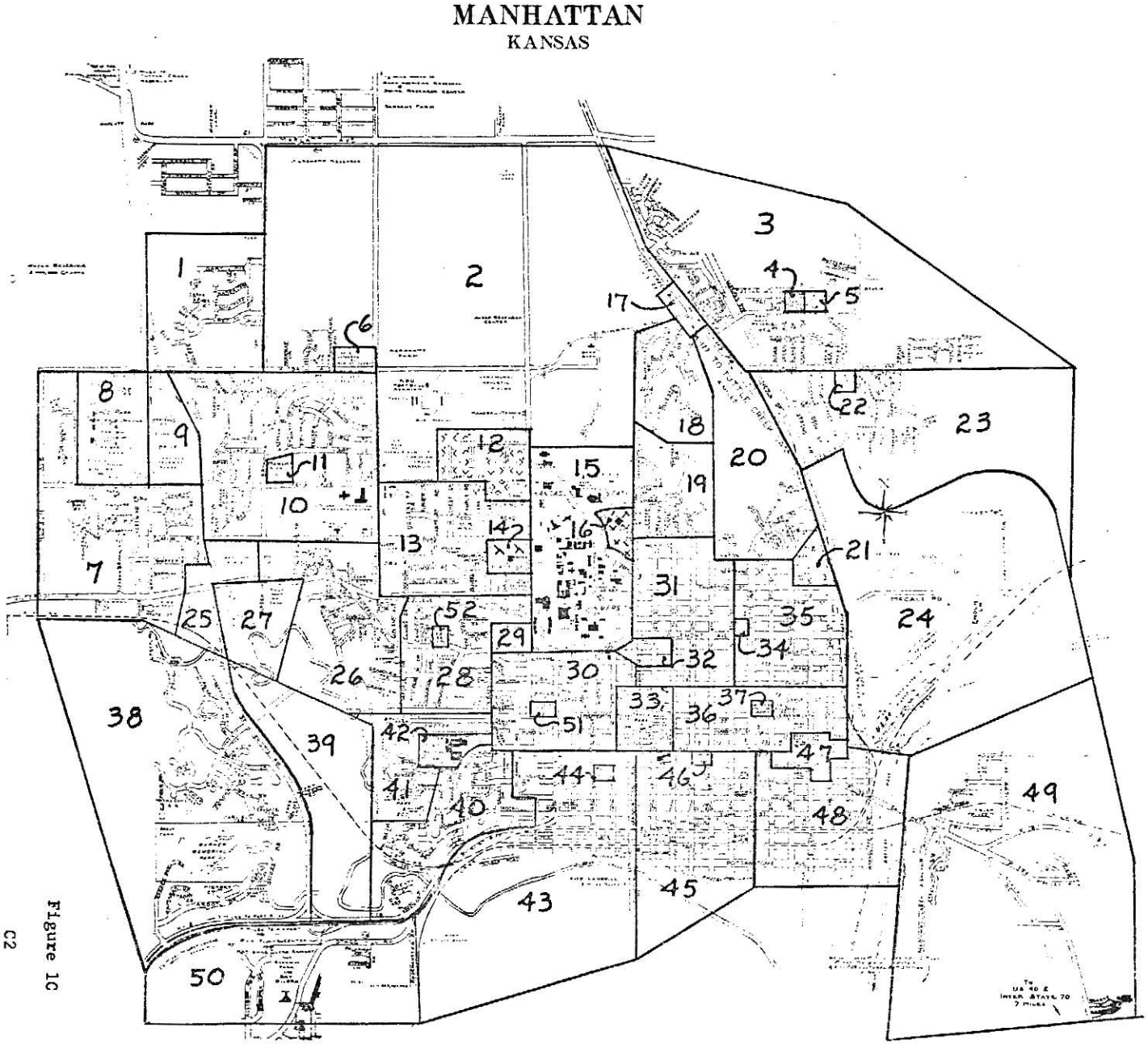
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Figure 1C

C2

The zones which are classified as residential zones--1, 3, 7, 10, 13, 14, 16, 18, 19, 20, 23, 25, 26, 27, 28, 30, 31, 35, 36, 38, 40, 43, 45, and 48, contain all of the residences within the city limits and some outside the city limits (Zones 1, 49 and 50). The 1970 Federal Census was used to determine the number of dwelling units (D.U.) and the population in each zone. Five percent of the D.U.s in each zone were selected at random. These residences were selected from a map furnished by the City of Manhattan, which showed all the lots throughout the city. Telephone numbers were then obtained for the selected lots from the Manhattan Cross Directory, which gives telephone numbers by address. In all 353 D.U. were sampled.

"The Emerging Needs of Bicycle Users" and other articles indicate that bicycle ridership increases with the installation of bikeways. This increase is due to the fact that most cities have a considerable number of residents who would ride bicycles if an adequate system were available to them. This, effect which is called "latent demand", indicates that a study of present users would yield trip values which would be less than the number we could expect to use the facility. We decided, therefore, to predict the number of potential bicycles which would be produced by the latent demand.

The city part of the survey (all zones except 14 and 16) was conducted by volunteers from several service and social organizations. The American Association of University Women was of special service in that they contacted other organizations to obtain volunteer interviewers. Some wives of the

class members and some members of The American Association of University Women, The University for Man - Bicycle Touring Group, The league of Women Voters, and Girl Scout Troop 312, participated in the survey. The forty volunteers each committed themselves for two hours of work. This provided the eighty man-hours which were necessary to conduct the survey. These interviewers met in groups to receive materials and to be instructed on how to conduct the interview and how to fill out the questionnaire. The interviews were conducted by telephone using the telephone numbers which were obtained by the method outlined above. Completed questionnaires were returned to the University for coding.

The students who live in the University dorms (zone 14 and 16) were interviewed in person by members of the class. A five percent sample was taken from each dorm. The students were interviewed in the various dorm lobbies during regular school hours.

Zones 13, 19, 28, 30, and 31 were considered special zones as they contain the various fraternity and sorority houses associated with the University. The population of each of these zones was reduced by the number of residents of houses in these zones. A five percent sample of each house was interviewed. This data was recorded as coming from zones 60, 61, 62, 63, or 64 representing houses in zones 13, 19, 28, 30, or 31 respectively. The data collected for ten zones mentioned above was expanded separately.

The Questionnaire

The questionnaire (See Figure 20), is basically a one-page

How many bicycles are owned by people living in your home? ___

How many people are living in your home? ___

Family Income: Less than $2,000 ___ $ 8,000 to $10,999 ___
$2,000 to $4,999 ___ $11,000 to $13,999 ___
$5,000 to $7,999 ___ $14,000 and up ___

Yes No (Don't care--check both)

___ ___ Would you like Manhattan to construct a bikeway system?

___ ___ Would you like Manhattan to keep its bus system?

___ ___ Would you like Manhattan to increase its bus system?

What would you consider a reasonable annual bicycle fee to finance and maintain bicycle lanes? (Check one)

$0___ $1___ $3___ $5___ $7___ More than $7___

What are the reasons you don't use a bicycle now or use your present bicycle more?

Safety___ Physical effort___ Social pressure___ Time___ Theft___
Cannot carry packages___ No bicycle racks___ Other___

Age Occupation

___ 0-5
___ 6-10
___ 11-15
___ 16-18
___ 19-24
___ 25-49
___ 50 up

Purpose				Orig.	Dest.	# Trips	Mode						
Work	Shopping	School	Recreation	(zone)	(zone)		Auto Driver	Auto Pass.	Bicycle	Walk	Taxi	Bus	

Which of these trips would you have made by bicycle if there was an adequate bicycle system?

Which of these trips would you have made by bus if there was an adequate bus system?

Age Occupation

___ 0-5
___ 6-10
___ 11-15
___ 16-18
___ 19-24
___ 25-49
___ 50 up

Purpose				Orig.	Dest.	# Trips	Mode						
Work	Shopping	School	Recreation	(zone)	(zone)		Auto Driver	Auto Pass.	Bicycle	Walk	Taxi	Bus	

Which of these trips would you have made by bicycle if there was an adequate bicycle system?

Which of these trips would you have made by bus if there was an adequate bus system?

Questionnarie

Figure 20

questionnaire. Figure 3C shows an optional page which could be added to the questionnaire if needed.

One questionnaire was used per dwelling unit (D.U.). The top portion of the questionnaire is a group of general questions which were answered by any adult in the D.U. The lower portion of the questionnaire contains information for each individual who lived in the D.U. As can be seen in Figure 2C the questionnaire contains spaces for information for only two persons. The optional sheets (See Figure 3C) were added if more than two people lived in the D.U. If there were nine people in the family, the first page and three optional pages were used. If the spaces provided for trip information were inadequate for one individual, his trips were continued on the next section down. A large X was drawn through the age-occupation area to indicate that these trips were made by the person in the preceding section. The trips listed represent all the trips made by the individual on the day preceding the interview. After all trips for that day were recorded, the individual was asked which of the trips he would have made by bicycle or bus if there were adequate facilities. A check in the appropriate box indicated the trips he would have made by these modes.

The questionnaire was designed to serve two purposes: First, to provide general information on attitudes of the residents about bicycles and second, to provide origin-destination information on bicycles which would aid in planning and designing bikeways. Normally, these two types of surveys are not conducted simultaneously. Separate surveys would allow one to investigate both areas more thoroughly, however, time

Age **Occupation**

___ 0-5
___ 6-10
___ 11-15
___ 16-18
___ 19-24
___ 25-49
___ 50 up

Purpose				Orig.	Dest.	# Trips	Mode							
Work	Shopping	School	Recreation	(zone)	(zone)		Auto Driver	Auto Pass.	Bicycle	Walk	Taxi	Bus		

Which of these trips would you have made by bicycle if there was an adequate bicycle system?

Which of these trips would you have made by bus if there was an adequate bus system?

Age **Occupation**

___ 0-5
___ 6-10
___ 11-15
___ 16-18
___ 19-24
___ 25-49
___ 50 up

Purpose				Orig.	Dest.	# Trips	Mode							
Work	Shopping	School	Recreation	(zone)	(zone)		Auto Driver	Auto Pass.	Bicycle	Walk	Taxi	Bus		

Which of these trips would you have made by bicycle if there was an adequate bicycle system?

Which of these trips would you have made by bus if there was an adequate bus system?

Age **Occupation**

___ 0-5
___ 6-10
___ 11-15
___ 16-18
___ 19-24
___ 25-49
___ 50 up

Purpose				Orig.	Dest.	# Trips	Mode							
Work	Shopping	School	Recreation	(zone)	(zone)		Auto Driver	Auto Pass.	Bicycle	Walk	Taxi	Bus		

Which of these trips would you have made by bicycle if there was an adequate bicycle system?

Which of these trips would you have made by bus if there was an adequate bus system?

OPTIONAL QUESTIONNAIRE SHEET

Figure 3C

considerations did not allow us this luxury. The time allowed for writing and executing the survey was one month.

The following questions we wanted the survey to answer are a combination of questions we felt must be answered, questions raised at the time we presented our proposal, and questions asked by city government officials when they were interviewed. Interviews of city officials were conducted by members of the "Community Organization and Leadership" class, a sociology class at K.S.U. These students conducted interviews with the mayor, some members of the City Commission and the City Planner, as part of a semester project for their class.

1. Do the citizens want a bikeway system and are they willing to support it?
2. What type of facility is desired, recreational or functional, who would it be for--children, commuters, etc.?
3. What characteristics of the present street system limit or prohibit the use of bicycles?
4. What would be the effect of a bicycle system on the main arterial system of the city?
5. How many bicycles are there in the city?
6. Where are the present cyclists going and where would they go if there was a system?
7. What will the system cost and what will be the benefits of the system?

The questionnaire, shown in Figure 2C, asks these questions, some directly, some indirectly. Questions 1, 3 and 5 are asked directly. Question 2 and 6 are asked indirectly in the O.D. portion of the questionnaire. Questions 4 and 7 are answered more with a combination of results of the O.D. portion and the proposed bikeway design.

A typical O.D. study contains enough specific trip information to predict vehicle movements throughout an area. The area is divided into zones which are homogeneous. This allows one to sample some residents of each zone and say that these people are representative of all who live in that zone. The sample trip data is then expanded and taken to represent the activities of everyone who lives in that zone. This method has proven effective not only for showing current movements of traffic, but also for predicting traffic several years in the future.

In the case of bicycles, if the people were using them principally for recreational purposes, say an evening ride around the neighborhood, few zone-to-zone trips would be indicated and few trips for purposes other than recreation would be indicated. Other studies have indicated that some of the most important reasons people ride bicycles is for recreation and exercise. It is our belief, however, that they are fulfilling these desires while taking a trip they must make anyway. That is, they must go to work and shopping, but the correct mode choice can fulfill their desire for recreation and exercise.

The bus information collected in our survey (See survey, page C5) is not included in this report. It was gathered for the A.A.U.W. who assisted us in conducting the survey. They were studying the bus situation in Manhattan, as well as bicycles.

Data Processing

The usable data received was processed by computer. The

program, which will be discussed presently, printed two types of information: tabulations based on sample data and tabulations based on expanded data. Data expansion was done on a zone-by zone basis, using an expansion factor which was the zone population divided by the number of persons sampled. The program to accomplish this was written in PL/1 language by Mr. Joel Mason, a graduate student in the Planning Department at K.S.U. The data printout is shown on pages C20 through C27.

Results

The following is a summary of the data printed out by the computer. The expansion of this data and the conclusions we have drawn from it can be found in the next section, Conclusions.

1. The ratio of bicycles per person was 0.41 bicycles per person.

2. The percent of people who would like to see bikeways constructed in Manhattan.

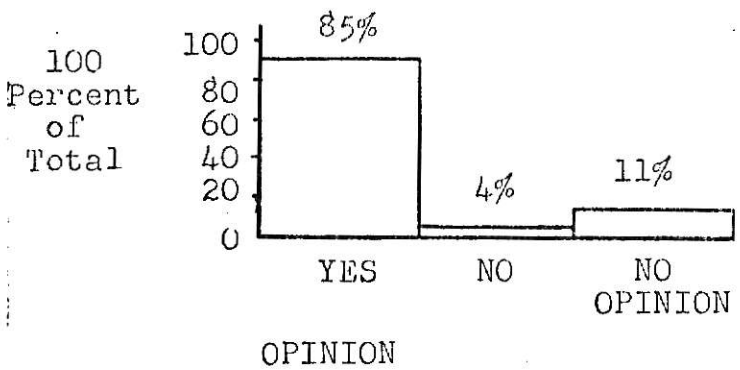


Figure 4C

3. A reasonable fee to construct and maintain bicycle lanes.

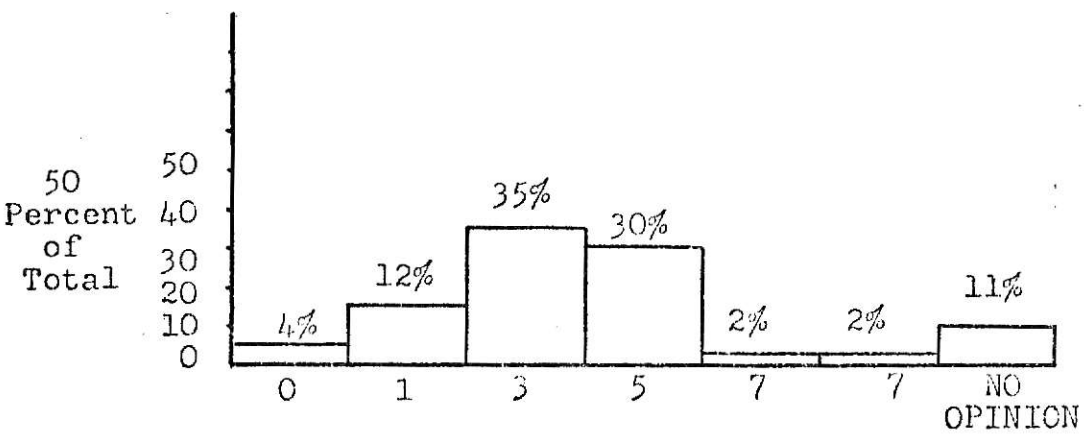
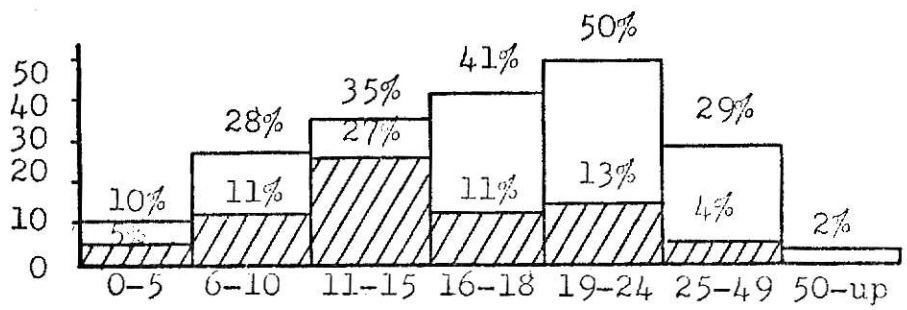


Figure 5C

4. The reasons people don't use bicycles or don't use their present bicycle more are shown below. The percentages shown are based on the number who answered, divided by the number of people questioned.

Safety	19%
Physical Effort	15%
Social Pressure	1%
Time	20%
Theft	5%
Cannot Carry Packages . . .	11%
No Bicycle Racks	3%
Weather	20%
No Bike	21%

5. Bike User Age Distribution



Potential Users

Present Users

AGE DISTRIBUTION

Figure 6C

6. The distribution of bicycle trips by trip purpose

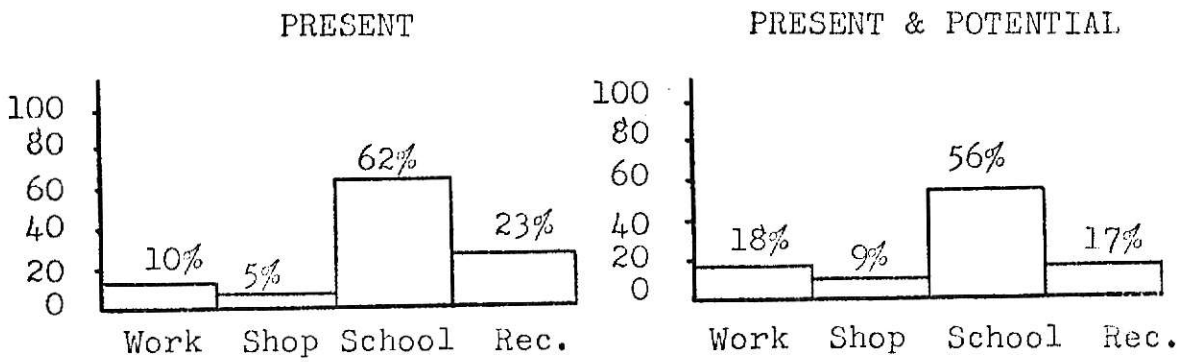


Figure 7C

7. Trip Length Frequency Diagram

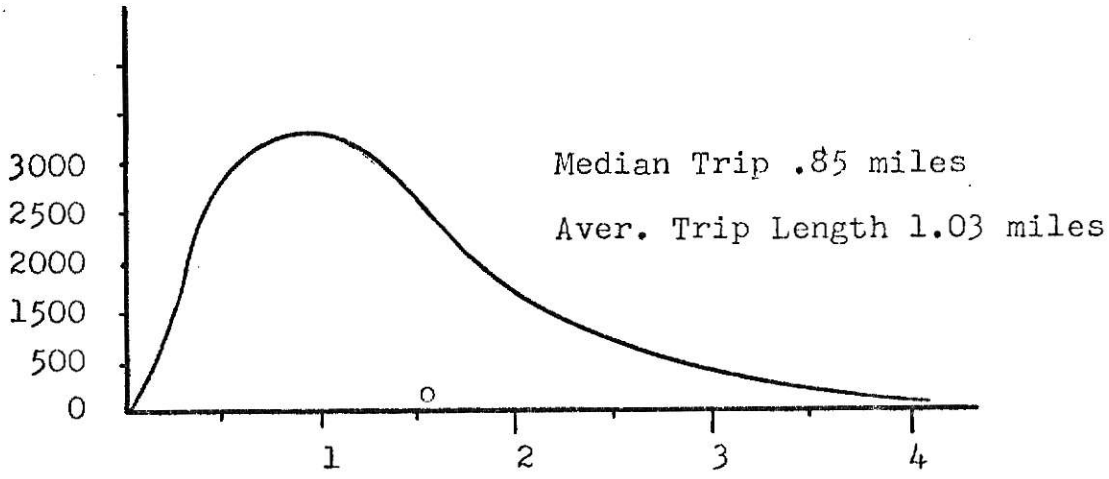


Figure 8C

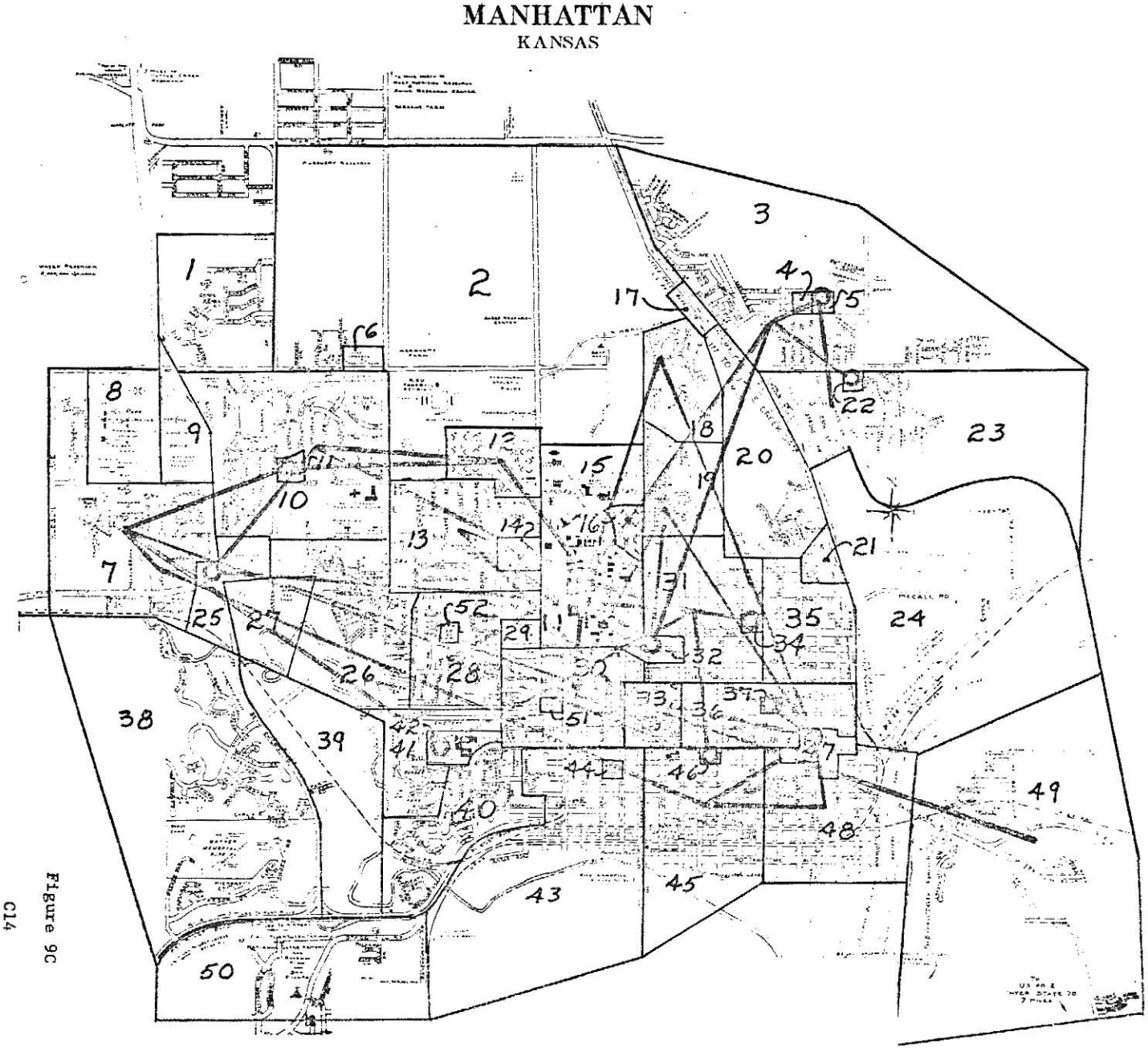

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Figure 9C

Conclusions

The number of dwelling units sampled represent approximately 3% of the D.U.'s in the city of Manhattan proper. These D.U.'s are distributed evenly throughout the community and represent a good cross section of the community. This sample represents 2,582 people.

The automobile is clearly the main choice as a mode of transportation in this city. The number of bicycle trips represents about 12% of the combined bicycle-auto driver trips in the city. This number, however, represents some 7,300 bicycle trips per day at present.

How do the citizens feel about bikeways? The "Bicycle Questionnaire Project," conducted in the fall of 1973, indicated that the citizens wanted bikeways and that the desire for bikeways was shared equally by auto drivers and bicyclists. Our questionnaire, based on a larger sample, indicated that 84% of the people questioned wanted Manhattan to construct bikeways. Clearly, this represents approval for the idea of constructing bikeways in Manhattan.

Often times the public wants some type of facility, but is unwilling to provide the funds necessary to construct it. This is not the case with bicycles. The "Bicycle Questionnaire Project" indicates that the bicyclists are willing to pay a reasonable fee to help build and maintain bicycle facilities. We would assert that if they are willing to pay for a facility, then they must really want it and they will use it. We tried to tie down more closely what a reasonable fee might be. Our questionnaire asked what the people felt was a reasonable fee, and allowed a choice of $0.00, $1.00, $3.00, $5.00, $7.00, and

no opinion (See Figure 5C). The largest number of people, 35% indicated that $3.00 would be a reasonable fee. Those above $3.00 represent 34%, while those below represent 16%. If one assumes that those who indicated an amount greater than $3.00 would be willing to pay $3.00 per year, there results a combined group of 69% of the people willing to pay $3.00 per year to build and maintain bikeways. Our estimate of the number of bicycles in the city proper, is 11,610. With the additional 1,200 bicycles on campus, a $3.00 fee would provide about $35,000 to $40,000 per year for bikeways.

Who is the average bicycle rider? Is he a person on his way to work, or is he a person exercising in his spare time? Is he a young person or an older person? The actions of the bicycle riders speak for themselves. Only 23% of the bicycle trips are made for recreation while 77% of the trips are made for some specific purpose. Further, 96% of the bicycle trips are interzonal trips with a definite destination while only 4% of the bicycle trips are intrazonal trips. This means that the bicycle in our community is not functioning as a toy for use in off-hours. Rather, it is a means of transportation.

At the present the bicyclists are operating on the streets with the automobiles since the streets are the only place they can ride to get easily from one area to another. If the number of bicycles increases at its present rate we can expect to see more bicycles operating on the streets. The university at present is planning to demotorize the campus. Many streets on campus are scheduled for closing. This will make it much less desireable to use an automobile around campus, and will probably result in an increase in bicycle usage. The resulting

increase in bicycles in the streets will cause increased conflict which will probably result in an increase in the number of automobile-bicycle accidents in 1974 over the 13 reported accidents for 1973.

Bicycle users are of all ages (See Figure 6C). For the young people, 15 and under, it is their only independent mode of transportation other than walking. As a child grows older his interests expand and he is allowed to go further from home. The further he goes the more attractive is a bicycle as compared to walking. This probably accounts for the increase in bicycle usage from 0 to 15 years of age. The sharp drop in bicycle usage at 16 is probably the result of being able to use an automobile. At the college level there seems to be increased interest. This is probably due to the fact that the bicycle is an ideal vehicle for getting around the campus. From college age on up there is a decrease in bicycle usage. This will probably continue as people show less interest in activities which require physical effort as they grow older.

All age groups show an interest in bicycle facilities by the number of trips they say they would make by bicycle if there were adequate facilities. In numbers this would represent a 380% increase in bicycle trips. The commensurate drop in automobile trips would be 50%. This level of usage is rare in the United States, but not unheard of. One college town of 24,000 people has developed into a bicycle community with this level of usage. With enough time Manhattan might develop into a community of this type, but for the present one should discount these values. The values do, however, illustrate the

principal of latent bicycle demand. Upon completion of a bicycle system we can expect an increase in bicycle usage. The increase, however, will probably be more on the order of 50% of the present bicycle usage. This amount of increased bicycle usage would correspond to approximately a 5% reduction in auto driver trips. The 50% latent demand mentioned above is in keeping with values determined in other cities.

While the number of potential bicycle trips may be too large there is nothing to indicate that their relative proportions are incorrect. If they are correct then we can expect work trips and shopping trips to increase faster than school trips and recreation trips.

The trip length frequency diagram (See Figure 8C) is derived from the expanded zone to zone trips (See Figure 9C). The curve which has been drawn fits all of the data quite well except for the trips of 1.5 mile in length. The curve is indicative of a normal trip length distribution curve. The place where our data differs from a normal shaped curve is probably due to inadequate zone data. The average zone sample size was 49, which is a small number, statistically speaking. In spite of the discrepancy the remainder of the data seems normal. The median trip length is .85 miles only slightly less than the 1.03 mile average trip length. There are few trips shown to be longer than 2 miles which is normally accepted as the upper limit for bicycle trips. The two points made above justify the use of this data for design purposes even though the sample size was less than desired.

The data collected in the survey certainly represents significantly better information than was available prior to

the survey. This information will serve as a guide for the selection of the initial bikeway routes of a Manhattan bikeway system. Knowledge gained through experience with the first phases of the system will help improve the quality and workability of later phases.

Recommendations for Future Surveys

An O.D. survey is a relatively complex and expensive survey to conduct. Due to this complexity only well trained interviewers should conduct the survey. The expense involved in a more thorough survey might be prohibitive unless the survey is combined with a survey for another mode of transportation. It makes a great amount of sense to gather bicycle data at the same time an automobile O.D. study is conducted.

If funds are not available to conduct an extensive O.D. survey, then a user survey of the type outlined in the proposal should be considered. A user survey is limited in that it will supply information on the activities of present bicycle users only. It would, however, be less expensive and this type of survey has been quite successful in other cities.

BICYCLES	1082
PEOPLE	2582
BICYCLES PER PERSON. .	0.41

YES	NO	DON'T CARE
84	4	10
68	7	24
42	25	32

REASONS	PERCENT
SAFETY	19
EFFORT	15
PRESSURE	1
TIME	20
THEFT	5
PACKAGES	11
RACKS	3
OTHER	47

FEE	PERCENT
. . . . .	11
0	4
1	12
3	35
5	30
7	2
>7	2

INCOME	PRECENT
. . . . .	37
LESS THAN $2,000 . . .	3
$2,000 to $4,999 . . .	9
$5,000 to $7,999 . . .	10
$8,000 to $10,999 . . .	9
$11,000 to $13,999 . .	6
$14,000 AND UP	23

AGE	USERS	POTENTIAL USERS
0-5	5	10
6-10	11	28
11-15	27	35
16-18	11	41
19-24	13	50
25-49	4	29
50-UP	0	2

PURPOSE	TRIPS	POTENTIAL TRIPS
WORK	24	192
SHOP	12	91
SCHOOL	157	516
RECREATION	57	151

BICYCLE TRIPS

Zone	Zone	Trips
3	4	156
3	15	52
3	22	156
3	32	52
7	11	62
7	33	62
7	42	62
7	45	124
7	49	62
7	55	62
10	10	46
10	12	46
10	15	138
10	25	46
12	11	42
12	12	84
12	15	378
13	15	250
13	32	100
14	15	235
15	13	50
16	15	260
16	32	130
16	46	130
16	47	130
18	15	48
18	48	48
19	30	48
23	4	62
27	15	198
28	28	16
28	46	64
30	15	54
30	30	81
30	33	162
30	47	54
31	15	200

BICYCLE TRIPS

Zone	Zone	Trips
31	25	58
31	34	142
31	41	116
31	42	116
31	46	232
33	60	22
36	37	84
36	47	84
40	15	64
40	46	64
45	47	280
45	48	80
48	48	45
60	15	132
60	47	22
61	15	280
61	32	40
61	47	40
62	15	546
63	15	700
63	32	100
64	15	4

POTENTIAL BICYCLE TRIPS

Zone	Zone	Trips
2	19	24
2	32	24
2	63	25
3	4	104
3	11	52
3	15	306
3	22	156
3	24	104
3	25	104
3	32	52
3	42	250
3	46	104
3	47	156
3	49	52
7	46	62
7	47	124
7	48	62
7	55	62
10	10	138
10	11	92
10	12	46
10	15	713
10	17	46
10	25	280
10	26	46
10	30	46
10	39	46
10	42	322
10	46	92
12	11	42
12	12	21
12	15	1764
12	16	42
12	25	168
12	26	42
12	42	84
12	44	42
12	46	84
12	49	84
12	50	84
12	51	42
12	55	42
13	15	300
13	30	100
13	32	300
13	45	100

POTENTIAL BICYCLE TRIPS

Zone	Zone	Trips
14	2	94
14	15	2773
14	16	94
14	25	188
14	32	94
14	47	141
15	3	26
15	13	50
15	28	16
15	31	29
15	32	27
15	45	42
15	47	78
15	51	32
15	55	31
16	2	260
16	13	130
16	15	8320
16	24	130
16	31	130
16	32	780
16	33	130
16	47	325
18	15	72
18	36	24
18	48	24
19	2	48
19	15	144
19	30	48
19	32	48
19	40	24
19	42	96
19	47	96
19	55	48
20	41	84
23	19	2
23	32	93
23	36	62
23	42	124
23	48	31
24	14	47
25	13	50
25	16	65
25	32	16
26	15	370
26	42	160

POTENTIAL BICYCLE TRIPS

Zone	Zone	Trips
26	52	40
27	11	66
27	13	132
27	15	66
28	6	32
28	11	32
28	15	96
28	24	32
28	25	48
28	28	16
28	33	64
28	42	80
28	46	96
28	47	64
28	51	32
28	52	32
30	15	351
30	25	108
30	28	54
30	30	54
30	31	54
30	32	54
30	46	270
30	47	54
30	51	189
30	55	54
31	15	1399
31	20	147
31	28	16
31	32	116
31	34	58
31	35	58
31	42	58
31	47	174
32	2	25
32	19	24
32	30	27
32	31	16
32	55	31
35	19	24
35	24	88
35	36	88
35	46	44
35	48	88
36	15	84
36	28	16
36	47	31
36	48	24

POTENTIAL BICYCLE TRIPS

Zone	Zone	Trips
40	15	64
40	35	24
40	36	64
40	46	32
40	51	32
40	52	64
42	28	16
43	42	196
43	46	196
45	15	2800
45	31	42
45	42	280
45	47	591
46	26	48
46	35	44
46	40	32
46	45	64
47	24	47
47	25	65
47	45	31
47	48	76
48	35	24
48	36	31
48	47	90
48	49	31
48	55	90
49	23	31
51	15	32
51	28	27
51	40	32
52	28	16
52	36	16
55	23	31
60	15	396
60	25	44
60	32	176
61	15	200
61	32	40
61	35	40
61	55	40
62	15	210
62	24	42
62	47	42
63	15	800
63	25	50
63	32	25
63	47	50
64	15	128

AUTO DRIVER TRIPS

Zone	Zone	Trips
1	55	24
2	30	27
2	32	24
2	63	25
3	4	104
3	10	52
3	15	728
3	17	208
3	22	208
3	24	104
3	25	260
3	26	104
3	30	52
3	32	52
3	42	312
3	43	104
3	45	260
3	46	182
3	47	544
3	55	156
5	40	32
6	40	32
7	13	62
7	15	91
7	25	62
7	31	29
7	32	62
7	39	62
7	42	62
7	47	124
7	48	62
7	55	124
10	6	46
10	7	115
10	10	207
10	11	138
10	13	92
10	15	805
10	17	115
10	19	24
10	24	115
10	25	648
10	26	115
10	30	46
10	31	46
10	32	46
10	35	46
10	36	45
10	37	46
10	39	46
10	40	23
10	41	46
10	42	391
10	45	92

AUTO DRIVER TRIPS

Zone	Zone	Trips
10	46	92
10	47	532
10	48	184
10	49	46
10	51	46
10	52	46
10	55	368
11	47	16
12	11	42
12	15	672
12	17	42
12	25	441
12	26	126
12	30	42
12	35	84
12	42	84
12	46	84
12	47	42
12	49	84
12	50	84
12	51	126
12	52	42
12	55	294
13	3	150
13	10	50
13	15	500
13	17	100
13	24	100
13	25	200
13	26	50
13	30	100
13	35	100
13	36	150
13	42	200
13	45	100
13	47	100
13	55	200
14	2	94
14	10	94
14	15	188
14	24	94
14	25	210
14	28	16
14	32	188
14	47	235
15	3	26
15	13	50
15	25	76
15	28	16
15	30	81
15	31	29
15	32	54
15	38	16
15	40	32

AUTO DRIVER TRIPS

Zone	Zone	Trips
15	45	74
15	47	172
15	48	27
15	51	32
15	55	101
15	60	22
16	2	130
16	24	390
16	31	130
16	32	455
16	33	130
16	47	455
16	55	195
17	2	27
17	12	21
17	16	65
17	19	24
17	35	44
18	3	48
18	15	72
18	20	48
18	25	72
18	36	48
18	37	96
18	45	24
18	47	120
18	48	48
18	55	96
19	1	24
19	2	24
19	10	48
19	15	48
19	25	72
19	26	24
19	30	48
19	32	72
19	40	24
19	42	48
19	47	216
19	55	72
20	15	42
20	25	42
20	30	27
20	32	42
20	38	84
20	41	42
20	42	21
20	47	42
23	10	62
23	15	248
23	18	124
23	19	2
23	25	93
23	27	62

AUTO DRIVER TRIPS

Zone	Zone	Trips
23	32	124
23	33	31
23	35	15
23	36	124
23	42	186
23	47	372
23	48	31
23	55	341
24	10	23
24	14	47
24	28	32
25	7	29
25	10	23
25	13	50
25	14	16
25	15	78
25	16	65
25	17	45
25	19	24
25	23	31
25	24	16
25	28	64
25	30	54
25	32	31
25	35	48
25	45	24
25	60	22
26	10	80
26	13	80
26	15	410
26	24	40
26	25	263
26	26	100
26	28	80
26	30	40
26	32	40
26	42	80
26	46	80
26	47	404
26	52	40
26	55	200
27	11	66
27	13	132
27	25	66
27	30	66
27	32	66
27	55	132
28	2	64
28	10	32
28	15	336
28	24	32
28	25	155
28	28	64

AUTO DRIVER TRIPS

Zone	Zone	Trips
28	30	64
28	31	32
28	33	32
28	36	176
28	38	31
28	42	16
28	44	16
28	46	16
28	47	256
28	55	96
30	10	54
30	15	486
30	17	27
30	18	24
30	25	108
30	26	54
30	28	135
30	30	162
30	31	54
30	32	378
30	35	31
30	38	15
30	46	162
30	47	324
30	48	108
30	55	540
31	3	58
31	7	29
31	15	938
31	18	58
31	20	142
31	22	116
31	23	31
31	25	174
31	26	58
31	28	16
31	30	58
31	31	58
31	32	116
31	36	232
31	42	116
31	46	58
31	47	406
31	55	812
32	2	25
32	19	48
32	20	21
32	28	16
32	30	27
32	31	16
32	40	32
32	46	15
32	47	173

AUTO DRIVER TRIPS

Zone	Zone	Trips
32	50	22
33	28	16
33	30	31
35	15	88
35	17	88
35	19	24
35	21	88
35	23	81
35	24	264
35	25	88
35	32	32
35	35	44
35	36	156
35	38	30
35	42	88
35	44	88
35	45	88
35	47	352
35	48	220
35	55	176
36	14	47
36	15	588
36	17	212
36	18	72
36	24	84
36	35	76
36	36	58
36	40	56
36	45	30
36	46	58
36	47	292
36	48	24
36	55	84
38	11	16
38	15	90
38	19	30
38	20	30
38	23	15
38	25	15
38	28	16
38	30	45
38	31	30
38	40	30
38	43	15
38	45	15
38	46	30
38	48	15
38	55	45
40	5	32
40	6	32
40	8	64
40	10	64
40	15	320

AUTO DRIVER TRIPS

Zone	Zone	Trips
40	18	48
40	24	64
40	25	64
40	35	24
40	36	96
40	40	64
40	46	32
40	47	56
40	51	32
40	55	64
41	15	22
41	25	16
41	38	15
41	55	42
42	28	16
42	32	21
42	47	66
43	13	196
43	15	196
43	25	196
43	26	392
43	30	196
43	31	196
43	36	243
43	41	15
43	43	196
43	45	196
43	46	392
43	47	196
43	51	196
43	55	392
44	25	29
44	38	58
44	41	16
45	3	142
45	15	3080
45	18	48
45	19	24
45	28	81
45	31	71
45	36	32
45	38	114
45	42	422
45	45	32
45	46	280
45	47	871
45	48	45
45	55	39
46	26	16
46	36	15
46	40	32
46	45	64
47	2	50
47	10	24

AUTO DRIVER TRIPS

Zone	Zone	Trips
47	13	100
47	15	27
47	16	65
47	18	48
47	19	72
47	20	27
47	24	63
47	25	92
47	30	24
47	32	88
47	33	16
47	40	48
47	42	16
47	45	71
47	48	124
47	55	54
48	10	45
48	15	32
48	20	90
48	28	16
48	30	27
48	35	24
48	36	99
48	45	84
48	47	114
48	48	90
48	49	31
48	55	360
49	23	31
50	36	24
50	60	22
51	15	32
51	40	32
52	24	23
55	17	65
55	19	24
55	20	42
55	23	31
55	31	31
55	32	62
55	36	15
55	38	15
55	45	45
55	47	58
55	48	24
55	50	24
60	14	22
60	15	38
60	25	132
60	30	44
60	32	176
60	41	22
60	55	132
61	3	120

AUTO DRIVER TRIPS

Zone	Zone	Trips
61	15	120
61	22	40
61	25	40
61	32	120
61	47	40
61	55	80
62	3	42
62	14	84
62	15	168
62	24	84
62	25	42
62	32	84
62	47	168
62	50	42
62	55	252
62	62	42
63	10	50
63	15	100
63	24	50
63	25	50
63	32	175
63	36	50
63	47	200
63	55	350
64	15	32
64	32	32

APPENDIX D

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MANHATTAN BIKEWAY SYSTEM EVALUATION PROCEDURES

by

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AN ABSTRACT OF A MASTER'S REPORT

submitted in partial fulfillment of the

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MASTER OF SCIENCE

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1977

Construction of a basic bikeway system for Manhattan, Kansas consisting of a combination of trails, bicycle lanes and streets designated for bicycle usage has been approved by the Federal Highway Administration as a bikeway demonstration project. Recipients of Federal Highway Administration Grants for bikeway demonstration projects must evaluate the success of the project in achieving its objectives. The projects objectives and a general plan for evaluation were presented in the May 1976 Grant Application. From this general evaluation plan the author has developed a detail evaluation scheme which satisfies the Federal Highway Administration requirements and the planning needs for future bikeways. The proposed scheme is designed so that a 1974 origin-destination and attitude survey can be used as the before study. Another origin-destination and attitude survey would be conducted in the spring of 1978 after the bikeway system is in full operation. This second or after study is to be compared to the 1974 before study to determine the effect of the demonstration project upon bicycling in Manhattan. A minimum amount of manual volume counts are proposed to supplement the basic before and after studies.

Other methods of supplementing the evaluation include: 1. The analysis of before and after accident records, 2. The analysis of before and after bicycle registrations in Manhattan, and 3. Direct observation of selected parts of the bikeway system. A detailed questionnaire for the 1978 origin-destination and attitude survey which is compatable with the 1974 survey has been developed.

The appropriate time and method of conducting this after survey is also presented.

The author also discusses how each part of the origin-destination and attitude survey and the supplemental data will be used to evaluate the bikeway demonstration project.