Analysis of Societal Issues in an ITS Operational Field Test

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Barbara C. Richardson
Walter A. Albers
Owen W. Ward

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Office for the Study of Automotive Transportation
The University of Michigan Transportation Research Institute
2901 Baxter Road
Ann Arbor, Michigan 48109-2150
Phone: (734) 764-5592
Fax: (734) 936-1081

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16. Abstract

The objective of the study reported was to demonstrate the use of analytical methods in addressing societal issues attendant to implementation of intelligent transportation system (ITS) technology. The objective has been met by identifying the societal issues of relevance in an operational field test in Michigan, preparing an ordered inventory of such societal issues, identifying analytical methods that can be used in addressing the societal issues, and demonstrating the use of such analytical methods in addressing selected societal issues. The operational field test studied in this report is the ITS Faster and Safer Travel through Traffic Routing and Advanced Controls (FAST-TRAC) program in Oakland County, Michigan. Methods by which the application of analytical methods in addressing societal issues could have improved the deployment of ITS technology are illustrated. The societal issues analyzed are equity and access for assisted-living-facility residents who are transportation disadvantaged. Two focus groups were conducted with (1) eight residents of assisted-living facilities; and (2) nine FAST-TRAC participants. The data collected in the focus groups were analyzed in several ways including analytical hierarchy process and cluster analysis.

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I. INTRODUCTION

This paper reports on a project entitled "Analysis of Societal Issues in a Michigan Intelligent Transportation System Operational Field Test," funded by the U.S. Department of Transportation, Federal Highway Administration through the University of Michigan Intelligent Transportation Systems Research Center of Excellence and conducted by the University of Michigan Transportation Research Institute. It was conducted between October 1995 and December 1997. The research team includes Barbara C. Richardson, Ph.D., of the University of Michigan Transportation Research Institute, project director, Walter A. Albers, Ph.D., President Albers Systems, Inc., consultant, and Owen W. Ward, a University of Michigan student. Michelle A. Barnes, M.P.A., of the University of Michigan participated in the early stages of the project.

The objective of the study was to demonstrate the use of analytical methods in addressing societal issues attendant to the implementation of intelligent transportation system technology. This was done by identifying a range of societal issues that are relevant to an ITS deployment, identifying those that were addressed or analyzed in the Faster and Safer Travel through Traffic Routing and Advanced Controls (FAST-TRAC) operational field test in Michigan, and demonstrating analytical techniques that could be used to include such issues in the planning of future ITS deployments.

This paper first establishes the problem involving societal issues in ITS planning. Next is the identification of societal issues addressed in FAST-TRAC. Following are the data collected and a discussion of the analytical methods used. The findings and conclusions are then presented, while implications for policy are included in a recommendations section.

II. BACKGROUND

Transportation plays a pivotal role in society by providing access to nearly all of a person's activities outside the home. Most of us do not use transportation for the sake of transportation itself, but rather to gain access to our jobs, education, medical care, shopping, recreation, and so on. Transportation is a necessity for almost every member of society. Corresponding to society's increased demand for access, the transportation industry accounted for 3.8% of the national gross domestic product in 1993, up from 3.2% in 1980 (U.S. Department of Commerce 1996, Table No. 686). Intelligent transportation system (ITS) technology is an increasingly important part of the transportation system, resulting, in part, from the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA), which proposed that $659 million be spent on ITS between fiscal years 1992 and 1997 (U.S. Department of Transportation 1991).

Considering the importance of transportation in society and the level of funding for ITS technology research and development, adequately and equitably addressing societal issues is pivotal in the planning, funding, and deployment of ITS. Addressing such issues has at least three major advantages. First, the risk of nondeployment of a technology because of citizen opposition to ITS implementation may be minimized. Examples of such cases span the country, ranging from objections to Long Island Expressway route diversions to a lawsuit in California over traffic speed increases in neighborhoods (due to signal timing improvements) possibly resulting in higher vehicle crash rates. A second advantage is the collection of benefits accrued from maximizing the potential benefits to society from the technology. Society

benefits, for example, when all potential members of the workforce can get to places of employment and consequently contribute to the economy. The lost benefits are traditionally difficult to measure quantitatively, but including societal issues analytically ensures that ITS technologies' impacts on society will not be ignored. Third, inclusion of societal issues also identifies new potential markets for manufacturers and vendors of different transportation system components. This yields benefits for both public and private sectors. For instance, if transportation systems do not provide access to education, jobs, and health care to some members of society, then they are clearly at a disadvantage in attending necessary daily activities.

While large sums of money are dedicated to ITS from ISTEA, the funds are spent primarily on the development of technology. Little, if any, money is spent on addressing societal issues related to the deployment of that technology. The paucity of research devoted to societal issues is illustrated by the low percentage (less than 10%) of papers on this subject presented at the 1995 ITS America meeting (ITS America 1995).

Several ITS technologies have been experimentally implemented in areas across the country. To assess their performances, operational field tests (OFT) have been conducted and evaluated by the U.S. Department of Transportation's (DOT) Intelligent Transportation Systems Institutional and Legal Issues Program. They are: ADVANCE, Advantage I-75, HELP/Crescent, TRANSCOM/TRANSMIT, TravTek, Westchester Commuter Central, FAST-TRAC, Travlink & Genesis, SmarTraveler, Travelaid, Houston Smart Commuter, and Safires. Among the goals of each OFT evaluation was to recognize the institutional issues (defined as "non-technical impediments or constraints") affecting ITS deployment and decide how to respond to them. Institutional issues were identified from materials from the U.S. DOT, the ITS America Institutional Issues Committee, other government agencies, universities, and other private groups (Science Applications International Corporation 1994, a-g; DeBlasio et al. 1994; DeBlasio and Haines 1994; DeBlasio and Borg 1994; Morissey and DeBlasio 1995; Jackson and DeBlasio 1995; LaFrance-Linden et al. 1995).

The institutional-issues studies focused on the effect of ITS implementation on the individual driver, marketing techniques, and technological requirements. No parallel studies have been conducted that focus on societal issues such as safety, transportation user cost, personal mobility, reducing environmental and energy costs, and promoting economic growth and enhanced productivity for individuals, organizations, or the economy as a whole. These are the goals of the program as stated in *IVHS Institutional Issues and Case Studies, Analysis and Lessons Learned* by the Science Applications International Corporation (1994c). While some societal issues such as regulation, organizational issues, management, and driver preferences are mentioned in OFT evaluations, they are not analyzed. One such instance is the report *Overview of the FAST-TRAC IVHS Program: Early Results and Future Plans*, where mobility was mentioned as a societal issue but was never addressed analytically (Bair et al. 1995). Other societal issues were analyzed in the OFT evaluations, but there is no documentation that shows whether they were included in a planning process. For example, FAST-TRAC participants were surveyed on issues relating to intellectual property rights (DeBlasio et al. 1994). All information, however, was collected subsequent to the operational field tests.

III. STATEMENT OF THE PROBLEM

The ITS technology OFTs in the early 1990s were undertaken to demonstrate the efficacy of ITS technologies in real-world settings. OFTs were evaluated after the implementations of the technologies. Because of this sequence, measurements of attendant variables were as impacts, not as causal factors. In this process, ITS technology was implemented without being part of a traditional transportation planning process, which includes the following four steps:

- Identify the transportation problem
- Specify the alternatives
- Analyze the alternative solutions
- Choose a solution

These are then followed by:

- Implement the solution
- Evaluate the solution

As ITS Technologies become more readily available and reliable, they will evolve into being viable components of alternative solutions to transportation problems, and then included in the transportation planning process. This may not, however, be true for those ITS technologies that fall entirely within the realm of private-sector production and consumption. The inclusion of ITS technologies in the transportation planning process has been illustrated by Richardson and Rodriguez (1997) and is shown here as figure 1. Those interested in the implementation of ITS technologies in public-sector projects will need to address the considerations listed in the first column of figure 1. These include raising the awareness of ITS technology as a viable solution to transportation problems; finding out how it can best serve the entire transportation system while being consistent with the ITS system architecture; and determining the costs and benefits of the technology. The considerations noted in the chart can be worked into the steps of the transportation planning process.

To ensure that societal issues are most effectively included in the planning process prior to the implementation of ITS technologies, analytical methods should be used. Several such methods are demonstrated in this paper.

Societal issues, whose importance in transportation and particularly in ITS implementation is noted above, can then be included in these steps of the transportation planning process: identifying problems, specifying alternatives, and analyzing the alternatives. As such, their role in influencing ITS implementations and being impacted by them will become ascendant. The application of analytical methods in the decision-making process regarding an ITS development was demonstrated by Richardson et al. (1997). The present paper illustrates a variety of analytical methods that can be used in the planning process to address societal issues prior to ITS implementation.

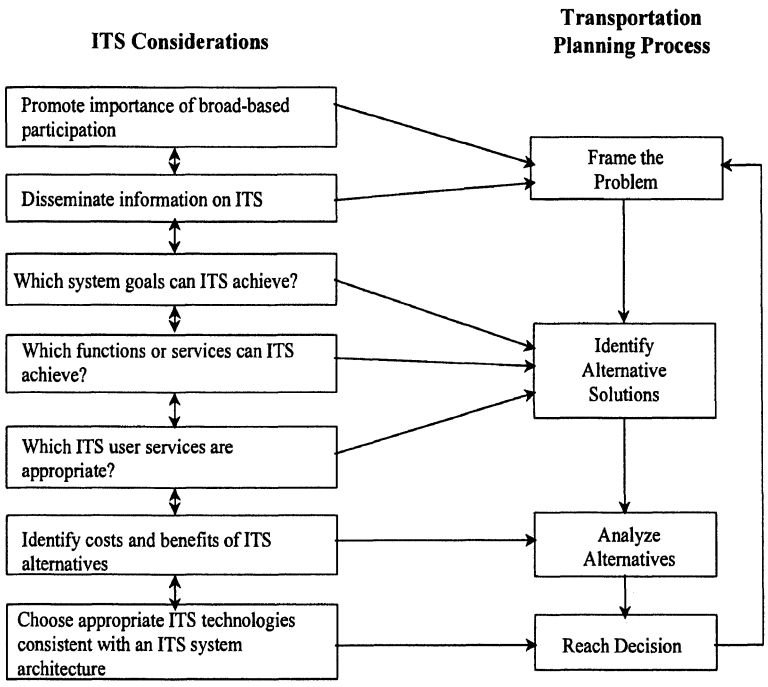

FIGURE 1
INCLUDING ITS IN THE TRANSPORTATION PLANNING PROCESS

IV. APPROACH AND METHOD

A. Overview

After developing the statement of the problem, a method for collecting and analyzing data was followed. First, societal issues attendant to the implementation of intelligent transportation system technologies were identified. Then, societal issues addressed in the FAST-TRAC deployment documents were identified. Among those identified, societal issues for analysis in this study were selected. Data related to the societal issues being analyzed were collected through a set of focus groups. Methods for analyzing data were demonstrated, and conclusions were drawn.

B. Description of Methods

1. Identify societal issues related to ITS

In order to ascertain the extent to which different societal issues were analyzed in the OFT examined, FAST-TRAC, it was first necessary to identify what the societal issues relevant to an ITS deployment are. In a paper entitled "Socioeconomic Issues and Intelligent Transportation Systems," Richardson (1994) reported sixty such issues. They were divided into two sets of societal issues relating to transportation: societal issues that are affected by transportation systems and societal issues affecting transportation systems. The societal issues affected by transportation were further categorized as access, equity, economic factors, organizational issues, traffic effects, transportation issues, and users or nonusers of systems. The issues affecting transportation systems were divided into demographic factors, economic factors,

organizational factors, and transportation factors. For each category, several societal issues were identified and are reported here in tables 1 and 2.

2. Identify societal issues addressed in FAST-TRAC

To systematically identify the societal issues mentioned and analyzed in any FAST-TRAC documents, a set of matrices was prepared. In appendix A separate matrices for societal issues mentioned and analyzed are presented. They separate the societal issues addressed by category and by the FAST-TRAC technology (en-route information, route guidance, traffic control, or incident management) to which each is applied. In addition, for each societal issue, a document reference and page number are provided where discussion of the FAST-TRAC societal issue can be found. In the case of societal issues analyzed, the analysis method is also shown. Societal issues that were mentioned in any of the several FAST-TRAC documents include access, economic factors, traffic effects, transportation issues, and organizational factors. Of these, analytical methods were used to evaluate issues related to access, traffic effects, transportation issues, and economic factors. In addition, analyses were performed on issues related to users and nonusers of FAST-TRAC. In all situations, evaluative analyses, rather than analyses for planning, were conducted.

Of the many FAST-TRAC-related documents reviewed, only four addressed societal issues (DeBlasio et al. 1994; Gruber 1995; Mitchell 1995; Levine and Underwood 1995). These were all evaluative. The specific analytical methods used in the FAST-TRAC OFT reviews were survey instruments, analytical hierarchy process, analysis of variance, clustering techniques, cross-impact matrices, and step-wise regression. In addition, examples of analytical methods applied in the non-ITS transportation field include the use of survey research combined with linear programming to determine how to most effectively serve the elderly in suburban areas with public transportation (Nwokolo 1990); cost-effectiveness analysis to recommend mobile source pollution abatement strategies for California (Austin et al. 1994); and Bayesian statistics and multivariate step regression analysis to estimate the societal impact of the 55 mph speed limit (Braddock et al. 1974). In sum, in none of these studies were analytical methods used to address societal issues prior to an ITS technology implementation.

3. Select societal issues for analysis

In order to demonstrate the inclusion of societal issues analytically in the planning process prior to ITS technology implementation, specific societal issues were chosen as examples. Recognizing that physical limitations on mobility restrict a person's access to alternative means of transportation, the elderly were chosen as a target population for the study. Many members of this demographic group can no longer drive and are forced to rely on relatives or public transportation services to access activities as essential as health care. Although they may still pay taxes, their needs are rarely considered adequately in the planning process. The common practice of focusing on the needs of employed people, therefore, gives rise to an equity problem in the ITS deployment process. It was decided to demonstrate how to include the transportation needs of assisted-living-facility residents in ITS planning. This would address the societal issue of equity in addition to the related issue of access for the elderly. Thus, equity and access were the societal issues chosen for analysis, where they would be applied to the assisted-living-facility transportation disadvantaged. Of interest was whether this population can benefit from a FAST-TRAC implementation. Structured methods were then used to collect

TABLE 1
Societal Issues Affected by Transportation Systems

ACCESS	ECONOMIC FACTORS	TRANSPORTATION ISSUES
Access of disadvantaged groups such as the poor, the young, the aged, and the geographically and physically disadvantaged	Affordability	Modal choice
Access to day care	Competing social goals	Movement of goods
Access to employment/ job training	Economic growth	Transit availability
Access to education	Employment availability	
Access to health care	Income	**USERS/NONUSERS OF SYSTEMS**
Access to housing	**ORGANIZATIONAL ISSUES**	Bus riders
Access to recreation	Legal issues	Cyclists
Access to shopping	Jurisdictional issues	Intermodal transfers
Participation in society	Regulation	Isolation of population
EQUITY	**TRAFFIC EFFECTS**	Joggers
Availability of energy	Air pollution	Land use
Crime / security	Congestion	Neighborhood viability
Who pays / who benefits	Energy conservation	Nonusers of system
	Noise pollution	Pedestrians
	Safety	Privacy
	Water pollution	Quality of life
		Sustainability
		Transit users
		Truckers

TABLE 2
Societal Issues Affecting Transportation Systems

DEMOGRAPHIC FACTORS	ECONOMIC FACTORS	ORGANIZATIONAL FACTORS
Age	Affordability	Cross-organizational cooperation
Education	Availability of energy	Jurisdictional issues
English as a second language	Defense industry refocus	Legal issues
Ergonomics	Economic growth	Product and tort liability
Family structure	Employment availability	Regulation
Gender	Intellectual property	
Immigration	Land use	**TRANSPORTATION FACTORS**
Minorities	Private funding	Telecommunication
Societal attitudes	Public funding	Teleconferencing
Vehicle ownership	Market forces	
	Transportation system costs	

and analyze data on these issues. Such methods could be used as part of a future planning process to address these issues prior to ITS technology implementation.

4. Collect data

Guidance was obtained from FAST-TRAC staff, and the study team decided to collect information on transportation needs and ITS user services from both actual users of the FAST-TRAC system and assisted-living-facility residents. To do so, two separate focus groups were conducted. Each group was designed to share, as closely as possible, like demographic attributes. With assistance from an Oakland County assisted-living facility and a University of Michigan FAST-TRAC study team, participants for each of the focus groups were identified. One focus group consisted entirely of assisted-living facility residents located within the FAST-TRAC field test region of Oakland County, Michigan. The focus group was conducted at the assisted-living facility and had eight participants: seven women and one man. They ranged in age from 78 to 93 and no longer drove. The second group of nine people, ranging in age from 67 to 81, with four women and five men, was selected from a set of drivers who participated in the FAST-TRAC field trial. On the whole, they were younger than the previous focus group members, and all lived independently and still drove.

The participants in the second focus group were asked to provide additional information based on their predictions of their transportation needs and ITS preferences in the future, when they would be less independent. In other words, they were asked to imagine themselves as assisted-living-facility residents. The resulting data were used as a forecast of future transportation needs.

All participants in the first focus group had been drivers in the past, with two participants having relinquished their licenses as recently as one year prior to the focus group. While the second focus group participants, all presently drivers, were familiar with FAST-TRAC, participants in the first focus group indicated just a vague awareness of FAST-TRAC at the beginning of the focus group. However, a video and other background information led a majority of them to recall an awareness of it and recognize that the implementation of advanced technologies such as those used in FAST-TRAC could be beneficial to society.

Data were collected from the two focus groups separately. The sessions, which lasted for several hours, consisted of a tutorial on ITS technologies, a group discussion, and administration of a questionnaire. Each session was facilitated by a member of the study team and commenced with summary information on the project and background information on ITS. The facilitators collected data through both group discussions and individual written responses.

Following the tutorial, group members discussed their transportation needs, the usefulness of different ITS technologies, including the FAST-TRAC project, and whether their transportation needs were being met. The group discussions were recorded on audiotape and in written form by project personnel.

At the conclusion of the discussion portion of each meeting, participants were asked to complete a questionnaire. In addition to providing relevant demographic information, each focus group member also filled out forms to rate the importance of their transportation access needs and rank all their transportation needs in order of importance. A paired comparison

format was utilized to determine each participant's ranking of ITS user services. Reduced copies of the forms used in the focus groups are included in appendix B.

Five ITS services were described to the focus group participants. Of these, route guidance and traffic-signal optimization are part of the FAST-TRAC operational field test. The others were added to enrich the variety of ITS services in the analysis that might be of benefit to assisted-living-facility residents. The five services described are:

- Route Guidance - Provides travelers with simple instructions on how to reach their destination. Displays on dashboards or hand-held units can provide route guidance to drivers, pedestrians, or bicyclists.
- Pretrip Planning Information - Provides a directory via, for example, TV, which includes quick access to traveler-related services and facilities. Information provided might include location, hours, parking, police, and hospital facilities.
- Traffic-Signal Optimization - Manages the movement of traffic on streets and highways by gathering traffic data and organizing the information on a computer so that the optimum flow of traffic, with preference for public safety, is achieved for vehicles as well as pedestrians.
- Personal Public Transit - Small publicly or privately owned vehicles pick up passengers who have requested service and deliver them to their destinations. This service can provide almost door-to-door services, expanding transit coverage to lesser populated locations and neighborhoods.
- Safety Readiness - Provides warnings about the condition of the driver, the vehicle, and the roadway. This service provides a warning if the driver is becoming drowsy or otherwise impaired. Equipment within the vehicle could also detect unsafe road conditions, such as ice or standing water on the roadway.

5. Analyze data

The following methods were used to analyze the data collected: averaging, analytical hierarchy process, scatter plots, regression, and cluster analysis. They were applied to both the ratings and rankings of transportation needs and the paired comparison data on the ITS user services. The project team understood that, because of limited project resources, the quantity of data was not adequate for all methods. However, the techniques were applied to illustrate how they could be used if more data were collected. Given adequate data collection, other techniques such as psychometric scaling or cognitive mapping might be applied to indicate what ITS technologies potential users consider to be most and least useful.

V. ANALYSIS OF DATA COLLECTED

A. Introduction

All the data collected represented either the transportation needs or the preferences for ITS user services of the participants. Two separate data-collection methods were employed: focus group discussions and individual questionnaires administered during the focus groups. The focus group discussions yielded qualitative data, some of which were structured by ranking them. The quantitative data collected through the questionnaires lent themselves to more analytical techniques. The group discussions yielded comments on existing transportation services, an unranked list of the transportation access needs, and a group ranking of

usefulness of the ITS user services. In addition, during the group discussions, the participants commented on, for example, how the ITS user services would best serve their specific needs. These opinions were recorded during the focus groups, and many are reported in the following section. The questionnaires provided three items that were analyzed separately: (1) individual ratings of the transportation access needs, which were averaged; (2) individual rankings of the transportation access needs, which were analyzed through averaging, scatter plots, regression, and clusters; and (3) paired comparison responses on the ITS user services, which were analyzed using the analytical hierarchy process. The data collected, data-collection methods, data format, and analysis performed are summarized in table 3.

Table 3
Data Collection and Analysis Summary

Data collected	Data collection method	Data Format	Analysis performed
Existing transportation services	1) Focus group discussion →	Unstructured →	Recorded
Transportation access needs	1) Focus group Discussion →	Listed →	Recorded
	2) Questionnaire →	Rated →	Averaged
		Ranked →	Averaged, scatter plots, regression, cluster
ITS user services	2) Focus group discussion →	Ranked →	Recorded
	3) Questionnaire →	Paired comparison →	Analytical hierarchy process

B. Existing Transportation Services

Part of the discussion in the focus groups centered on the accessibility and convenience of existing transportation services. Dependence on family members for transportation allows some assisted-living facility residents to travel when necessary, but participants clearly desired a more comprehensive system that serves the physical needs of the users and does not require advanced notification for usage. The assisted-living facility participants did not express any interest in using public transportation because it requires money they do not have, and the existing service is not properly suited for their use. Basic paratransit service is provided to them, but they considered it too inconvenient. The participants expressed clear views on the existing services and were concerned about the availability of usable services in the future.

Focus group participants generally felt that the current levels of transportation services were not meeting their transportation needs. Comments of the assisted-living facility participants included:

- There are no regular bus routes serving their residences.

- The paratransit service in their area is inconvenient and required two days' notice for service.
- Bus steps were too high.
- Taxis are not a viable transportation alternative because of the high cost and the lack of available cash to assisted-living facility residents.
- Access to cash for public transportation is inconvenient because assisted-living facility residents need transportation to get to the bank to get the cash for transportation.
- Those who are wheelchair bound are virtually precluded from travelling; if they have no family nearby, they likely do not have any transportation available.
- Passenger vehicles, particularly vans and trucks, are difficult to get into and out of. This is a problem because of the preponderance of vans among relatives who are primary sources of transportation.

The FAST-TRAC participants stressed that they wanted to preserve their independence as long as possible and do not wish to be dependent upon friends and family for their transportation needs. They indicated that:

- The cost of taxis is too high.
- There is a need for more shared living and shared public vans.
- Bus service is not frequent enough.
- Bus service is inconvenient because of the need to wait outside.
- It would be ideal to have private drivers for the elderly.

C. Transportation access needs

1. Focus group discussion

During the discussion section of each focus group, the participants were asked to list what activities they rely upon transportation (either personal automobile or public transportation) to gain access to. The participants in the focus group at the assisted-living facility indicated the following activities and destinations:

- Restaurants
- Shopping
- Health services – local and long distance
- Recreation
- Religious activities
- Volunteering
- Education
- Vacations by automobile and air
- Socializing – seeing friends and family

The FAST–TRAC focus group participants listed all of the same transportation needs plus the following:

- Groceries
- Library
- Work

- Personal care – beauty shop and barber
- Personal business – banks, credit unions, errands
- Caregiving – helping friends and family, transporting grandchildren to school

When asked about their future transportation needs, they stressed the desire to be able to go everywhere they go now and maintain independence. However, they noted that existing services would not meet their future transportation needs.

Meeting transportation needs for access to health-service facilities was a major concern of the members of both focus groups, primarily for the assisted-living-facility residents. Through the course of the discussions, several participants suggested a need for more shared-ride services such as public vans and call-for-ride operations.

2. Questionnaire

a) Ratings

The ratings section of the questionnaire, administered to the participants following the discussion period, asked the participants, who were aged 65 through 96, to rate the importance of their transportation needs on a scale of 1 to 10 (where 10 is the most important). The average ratings for each transportation need for each of the three sets of focus-group participants and the total of all participants are presented in table 4 in decreasing order of importance. The overall average is for subjects aged 65 through 96.

Table 4
Averaged Rating of Transportation Needs *

Transportation Need	Overall Average (n = 26)	Assisted – Living Facility Residents (n = 8)	FAST-TRAC Participants (n = 9)	FAST-TRAC Forecasts (n = 9)
Health care	9.7	10	9.1	10
Socializing	8.2	8.6	8.0	8
Personal business	6.8	5.0	8.0	7.1
Religious activities	6.5	5.3	7.2	6.9
Shopping	6.4	7.3	7.4	4.6
Recreation	6.3	5.9	7.3	5.7
Education	3.4	3.1	4.3	3.0
Employment or job training	3.3	2.1	5.6	2.2

* A score of 10 is most important, and 1 is least important

Table 4 shows that health care is a highly important access need for the elderly, especially when living in an assisted-living facility. Destinations for socializing are also a strongly supported transportation access need for the assisted-living facility residents. A comparison of the assisted-living facility residents' responses with the forecasts provided by the FAST-TRAC

participants shows that the major differences in the two sets are driven by the different ratings of the importance of access to shopping. The assisted-living facility participants scored this access need at 7.5, while the forecasted rating was 4.5, as seen in table 4. Other ratings across the groups are remarkably similar.

b) Rankings

Averaging

The questionnaire also asked the respondents to provide a rank order of their transportation needs. Several analysis techniques were applied to these data. Data from both focus groups including the FAST-TRAC participants' forecast rankings were combined to do additional analysis. The first and simplest approach to analyzing the ranked transportation-needs data was to average the rankings for each of the eight destinations the participants had to choose from. In effect, the output for the overall average was an estimated ranking for individuals between the ages of 65 and 96. The results are shown in table 5 in descending importance with scores included, where the lowest score indicates the most important transportation need.

Table 5
Averaged Ranking of Transportation Needs *

Transportation Need	Overall Average (n = 26)	Assisted – Living Facility Residents (n = 8)	FAST-TRAC Participants (n = 9)	FAST-TRAC Participants Forecasts (n = 9)
Health care	2.1	1.5	2.9	1.9
Shopping	3.0	3.0	3.0	3.1
Recreation	4.2	4.5	3.7	4.3
Socializing	4.2	3.8	5.3	3.6
Religion	4.6	5.3	4.9	3.8
Personal business	4.9	4.8	4.6	4.8
Employment or job training	6.3	7.5	5.1	6.6
Education	6.7	7.1	6.2	6.6

* A score of 1 is most important, and 8 is least important

The orders of the averaged rankings and ratings are not identical. Tables 4 and 5 both indicate that health care access is the most important transportation need of persons of 65 years and greater. In addition, both ranking and rating results show that education, employment, and job training are substantially less important transportation-access needs for that age group. However, the ranking results show that shopping is the second most important transportation-access need for the elderly. For the most part, the FAST-TRAC forecasts are consistent with the assisted-living facility rankings, except for their different views of the importance of access to religious activities.

Of the participants in this study, relatively few were at the younger end of the age range, so the overall average results are biased toward the transportation needs of persons of 80 years and greater. To gain further insight into the transportation needs by age groups, the data were separated into three sets: ages 65 to 74, 75 to 84, and 85 to 96. Table 6 shows the average ranking for each destination by age group, where lower scores indicate more important transportation needs.

Table 6
Average Ranking of Transportation Needs by Age Group *

65-74 (n=5)		75-84 (n=9)		85-96 (n=12)	
Transportation Need	**Ranking Score**	**Transportation Need**	**Ranking Score**	**Transportation Need**	**Ranking Score**
Shopping	2.6	Health care	2.1	Health care	1.5
Recreation	3.4	Shopping	3.1	Shopping	3.2
Health care	3.6	Recreation	3.7	Socializing	3.2
Religion	3.8	Personal business	5.0	Religion	4.3
Personal business	4.8	Socializing	5.2	Recreation	4.8
Socializing	5.0	Religion	5.4	Personal business	4.9
Employ/ job training	5.6	Employ/ job training	6.1	Employ/ job training	6.8
Education	6.6	Education	6.4	Education	6.8

* A score of 1 is most important, and 8 is least important

The data show that for those just over the retirement age, shopping is the most important transportation-access need. As age increases, health care becomes the most important. It is interesting to note that socializing also becomes increasingly important with age, while recreation decreases in importance.

(2) *Scatter Plots*

Scatter plots were generated with the responses of all participants (including the FAST-TRAC group predictions), showing transportation-access needs as a function of age. No other demographic variable was analyzed because there was not enough variation for the gender, education, nor license variables. It was evident from examination of the plots that there are some trends in the data. For example, figure 2, where 1 is important, and 8 is unimportant, is a sample scatter plot that shows that recreation access is clearly of less importance to the older participants.

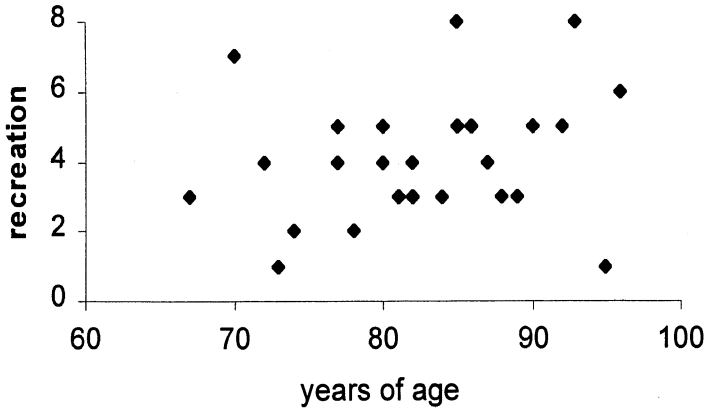

Figure 2
Age vs. Recreation Ranking

(3) Regression

Using the scatter plots generated, each transportation-access need was regressed against participant age. The results from these regressions were inconclusive because the correlations were not strong enough to yield statistically significant results.

(4) Cluster Analysis

The third analysis technique used was cluster analysis, where trends were estimated visually from the scatter plots, and circles were drawn around data that grouped together. Examination of the scatter plots for the transportation-access rankings as a function of age shows that the participants' preferences changed substantially at certain ages (not necessarily the same for each destination). Furthermore, the trends are more evident if outlying data points are omitted from the analysis. Thus, each data point was not necessarily included in a cluster. The clusters are shown and identified in figure 3. The number of observations in each cluster set is twenty-six, which is the sum of all participants' rankings in the focus groups including the forecasts by the FAST-TRAC participants. Cluster analysis was not performed on the subsets of data by focus group because they were too small.

The clusters shown in figure 3 were subjectively defined, so for each scatter graph several alternative clusters or cluster sizes could be chosen for analysis. In fact, cluster 1 for the personal business ranking could have been chosen to include only the three points in the upper-left portion of the graph and, thus, would have produced different analysis results. More objective methods of identifying the clusters have been employed, for example, those used in cognitive mapping (Kintsch, Miller, and Polson 1984). These more cumbersome methods could not be justified in this study because of the limited quantity of the data. Thus, the subjective method was used here to demonstrate what might be accomplished using more quantitative approaches in a more comprehensive study.

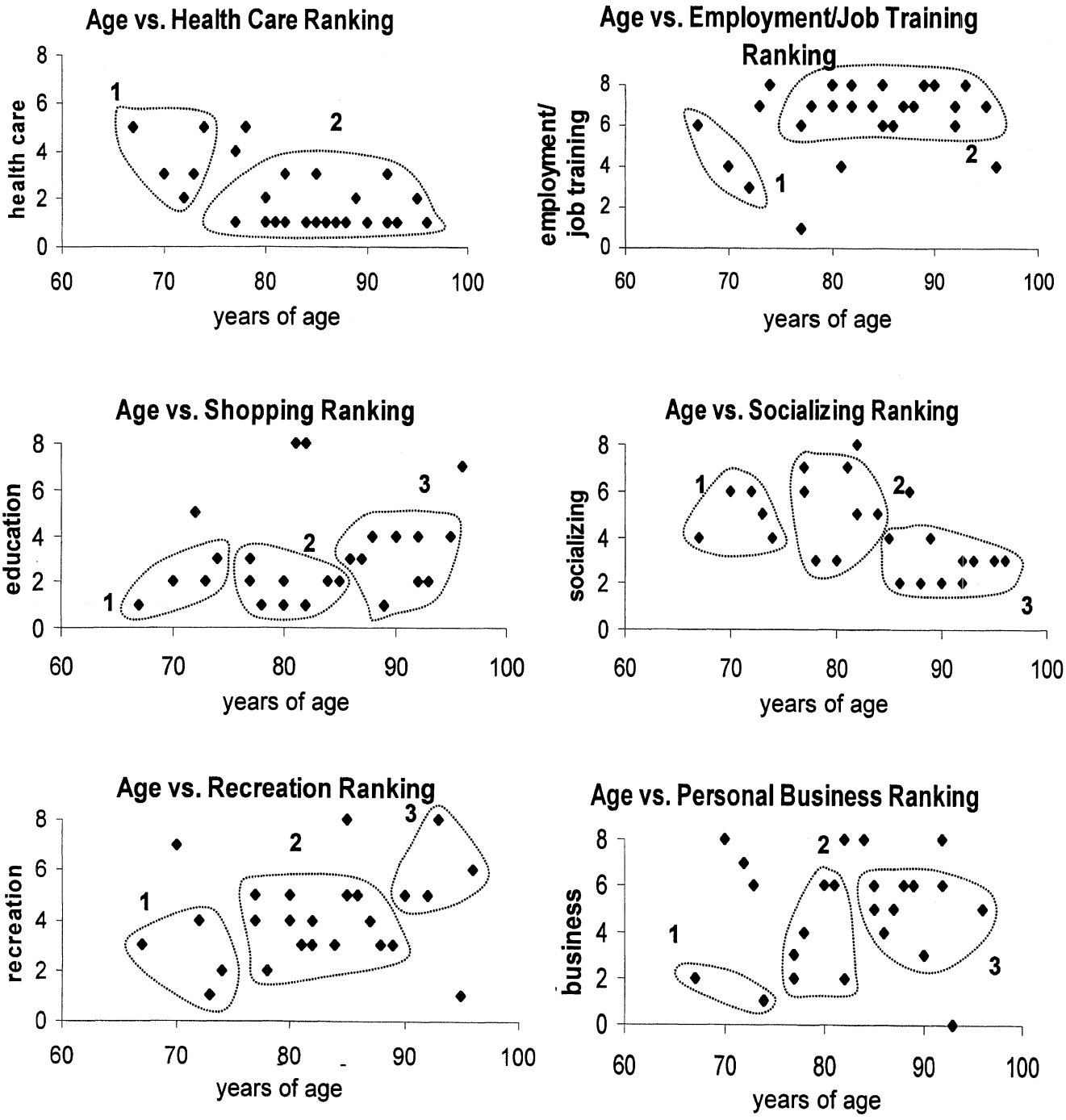

Figure 3
Cluster Analysis of Age vs. Transportation Access Need

(1 is important; 8 is unimportant)

To demonstrate how this subjective analysis can reveal information about transportation needs, consider the Age vs. Recreation Ranking graph of figure 3. There are three subjective clusters

identified, and, if we accept these clusters, they reveal several characteristics. The younger people in the groups highly value access to recreation. The clusters show that as their age increases, the importance of access to recreation decreases. Further, the age breaks among the clusters for importance of recreation access are at about 76 and 90. Similarly, the Age vs. Employment / Job Training clusters show a decrease in the importance of those activities as people age. The opposite trend is observable in the Age vs. Socializing Ranking. Here as people age, the importance of access to social opportunities increases. The increasing importance of access to health care with increasing age is also seen in clusters. At about the age of 77, there is a marked increase in importance of access to health care.

D. ITS user services

1. Focus group discussion

Following the discussion of transportation needs in the focus groups, the discussion moved to usefulness of ITS services. During each focus group, the participants were asked to come to a consensus as a group on a preference order of the usefulness to them of five ITS user services. In the assisted-living facility focus group, discussion of FAST-TRAC was based primarily on the videos and information presented at the focus group by the facilitators because none of the participants had actually experienced the technology. This was to be expected since all of the participants no longer drove.

The assisted-living facility group noted in general discussion that safety readiness and pretrip planning services would be useful. They were interested in pretrip planning because it is occasionally difficult for them to find their destination, but personal public transit was their strongest preference. Existing public transit was felt to be inconvenient and does not adequately meet the needs of the elderly. They felt that a personalized system would better respond to each individual's specific needs and limitations.

The FAST-TRAC participants were most enthusiastic about the safety readiness service. They suggested that drowsiness detection, black-ice detection, reduction of glare and disparate light height effects, and notification of accident-upon-impact systems would all be useful to drivers. Traffic-signal optimization was also of concern to them because of the importance of keeping traffic moving. They felt route guidance would be most useful for drivers in unfamiliar areas, such as car renters.

The facilitators asked the FAST-TRAC participants to discuss what services would be most useful if they resided in an assisted-living facility in the future. Their response was overwhelmingly in favor of personal public transit. They also felt that pretrip planning would become more useful as they grew older. The group preferences based on the discussions and votes in both focus groups are shown in descending order in table 7. Concerning funding for such services, they felt that users should expect to pay a modest fee for ITS services, but that such services should be heavily subsidized for the elderly.

Table 7
ITS User Service Group Preferences

	Assisted-Living-Facility Residents	FAST-TRAC Participants (now)	FAST-TRAC Participants (forecasts)
1	Personal public transit	Safety readiness	Personal public transit
2	Safety readiness	Traffic signal optimization	Pretrip planning
3	Traffic signal optimization	Route guidance	Safety readiness
4	Pretrip planning	Personal public transit	Traffic signal optimization
5	Route guidance	Pretrip planning	Route guidance

2. Questionnaire

As a part of the questionnaire, the participants were asked to choose preferred ITS user services for several paired choices. By applying the analytical hierarchy process (AHP), a preference order may also be formulated from the individual paired comparison responses recorded in the questionnaire administered to the participants in both focus groups. The AHP method, often used in decision-making scenarios such as consumer choice models, is useful in deriving a quantitative order of importance from qualitative information. The method used in the following analysis is a simple form of AHP.

The questionnaire shown in appendix B asked the participants to state preferences in twelve ITS-user service-pair groupings. Two groupings were included twice in order to test for consistency. For the twelve questions, a matrix was formed with subject number and user-service pair as dimensions. Responses from the FAST-TRAC participants' predictions of preferences fifteen years in the future were also included. Each field shows one subject's preference between two different ITS services. The resulting individual preference matrix shows all the individuals' responses and is included in appendix C. Some data inconsistencies occurred where the participant reported, for instance, traffic-signal optimization was preferred to route guidance in one question and route guidance preferred to traffic-signal optimization in another. This was to be expected. Analysis showed that including these responses had no effect on the preferred order. A resulting individual response preference order was generated as shown in table 8.

Table 8
ITS User Service Individual Preferences

	Assisted-Living-Facility Residents	FAST-TRAC Participants (now)	FAST-TRAC Participants (forecast)
1	Safety readiness	Safety readiness	Personal public transit
2	Personal public transit	Traffic-signal optimization	Safety readiness
3	Traffic-signal optimization	Pretrip planning	Route guidance
4	Route guidance	Route guidance	Pretrip planning
5	Pretrip planning	Personal public transit	Traffic-signal optimization

Comparison of the individual preferences from the questionnaire (table 8) with the group response from the discussion (table 7) shows that there were some differences. For instance, for the assisted-living facility residents, switches occurred between safety readiness and personal public transit as well as between route guidance and pretrip planning. This was not unexpected behavior for a focus group, thus, the paired comparison data indicate that safety readiness and personal public transit services are the ITS services most valued by the assisted-living facility residents. The FAST-TRAC participants also highly value these two services in the future. It is interesting to note that neither of these two services was included in the FAST-TRAC study.

A final comparison is that of the FAST-TRAC participants' predictions of their transportation needs in the future with the needs expressed by the assisted-living facility group. Tables 7 and 8 show that FAST-TRAC participants were somewhat inconsistent in predicting the assisted-living facility residents' needs, probably because they perceive the future as biased toward their own independent living style. However, there is some evidence that at least the FAST-TRAC group does have a good sense that transportation needs will change substantially as people age, and that transportation needs priorities will reorder as one becomes less and less independent. This aspect of anticipating the needs of special societal groups is extremely important, and the incorporation of societal issues into the planning and implementation phases of ITS depends on the ability to recognize these sets of needs. A systematic, analytical approach, including quantitative methods, provides an effective way to address societal issues prior to ITS implementation.

VI. FINDINGS

By collecting qualitative and quantitative data in open, rated, and ranked formats through discussions and questionnaires, it was possible to analyze a range of issues dealing with transportation-access needs of the elderly. Averaging, scatter plots, regression, cluster analysis, and the analytical hierarchy process were used to analyze the data collected and develop the findings presented here.

In the focus groups conducted in this study, it was found through discussion, that the elderly participants, many of them articulate spokespersons of their needs and preferences, had definite views on their current and anticipated transportation needs and on the level of transportation service currently available to them.

Although there are publicly and family-provided transportation services, all focus group participants felt that the current levels of transportation services are inadequate in meeting the transportation needs of assisted-living facility residents. These needs are almost the same as those of younger people. Access to health services was almost unanimously recognized as the most important transportation need for the elderly, especially assisted-living facility residents. This result was also evident from quantitative analysis based on data from individual questionnaires.

The analytical methods applied to the questionnaire data provided further insight into the transportation needs of the elderly. Both the averaged rankings and ratings analysis showed trends and changing needs by age. The elderly do not highly value access to education, employment, or job training for themselves. Furthermore, these destinations are increasingly

unimportant with age. The analysis by age groups also showed that as the elderly get older, they want transportation access to social events more and recreation activities less. The cluster analysis identified ages where the transportation needs of the elderly change most significantly. Health care was found to be overwhelmingly important after the age of 77, while personal business access loses importance after the age of 74. The increase in importance of socializing occurs around the age of 85.

Concerning the ITS user services, the participants showed a strong preference for safety readiness and personal public transit. In fact, during the group discussions, the participants expressed an interest in reintroducing jitney-type transit service because of its flexibility and convenience. They noted that it would be desirable to include these characteristics in the planning process for services such as personal public transit. In addition, for ITS services to be most useful, they suggested it would be necessary for the elderly to be able to travel outside of their hometown. It was felt that transportation services, including ITS, should be heavily subsidized with public funds, but that the users should be responsible for part of the cost of the service. This is an important equity issue that addresses who should pay and who should benefit from these services. Further, the participants felt that the biggest problem with technology is that there are too many choices. It was felt that there should be a focus on simplicity and reliability of basic operations.

FAST-TRAC participants were asked to state their transportation needs and ITS preferences for the present and for a time fifteen years in the future, where the latter was intended to represent the future needs of elderly citizens. The present needs of the assisted-living facility residents and the forecasts of the FAST-TRAC participants were compared. They were remarkably similar, with the major differences in transportation-access need in the areas of shopping and religious activity. Both groups identified personal public transit as their most preferred ITS user service and, of the five ITS options presented, route guidance as the least desired.

A comparison of the assisted-living facility residents' responses with the forecasts provided by the FAST-TRAC participants shows that the major differences in the two sets are driven by the different ratings of the importance of access to shopping. The assisted-living facility participants scored this access need at 7.5, while the forecasted rating was 4.5, as seen in table 4. Other ratings across the groups, on the other hand, are remarkably similar. Based on this finding, some confidence can be put on the quality of the forecasts by the younger elderly of their future transportation needs. Clearly, additional research needs to be done to confirm this finding.

The transportation needs, ITS-user-service preferences, and trends by age identified in this study provide guidance for planning studies prior to ITS technology implementation.

VII. SUMMARY AND CONCLUSIONS

In summary, the purpose of this study was to illustrate methods of analyzing societal issues that are attendant to ITS deployments. To meet this purpose, an ITS deployment in which societal issues apparently had not been addressed in the planning process was identified. This deployment was FAST-TRAC in Oakland County, Michigan. The transportation needs and ITS preferences of the elderly, particularly those in assisted-living facilities, presented themselves

as ideal subjects for study, especially with regard to access and equity. The importance of the findings in this study is highlighted by the nation's changing demographics, one characteristic of which is that 47 million Americans will be over the age of 64 in the year 2015. This compares with 33 million in 1995, an increase of almost 42%, as opposed to a growth of just 16% for adults aged 25 through 64 (U.S. Department of Commerce 1994).

Using a discussion format and questionnaires in a focus group, qualitative and quantitative data were collected from assisted-living facility residents and a group of slightly younger people who had participated in FAST-TRAC demonstrations. Both types of data were used in structured analyses of transportation needs and ITS preferences. These data were collected as rated or ranked transportation needs and as paired comparisons of ITS-user-service preferences. Of the many analytical methods available [see, for example, Richardson, Albers, and Waller (1995)], five different methods were demonstrated in this study for data analysis: averaging, scatter plots, regression, cluster analysis, and the analytical hierarchy process.

Several conclusions can be drawn from this study. As ITS technologies become more available and reliable, they will be considered as alternative solutions to transportation problems in the transportation-planning process. As such, they will be subject to the same types of analyses that other alternative solutions are. In performing these analyses, care will need to be taken in collecting accurate data and properly applying a selected set of the many methods available.

Because the purpose of the study was to demonstrate that analytical methods could be used in addressing societal issues prior to ITS implementation, not to perform definitive analyses, project resources precluded collecting enough data to ensure that the results are statistically significant. Thus, data collected from focus-group discussions and questionnaires were used in performing analyses in which more comprehensive data sets are generally used. However, confidence can be placed in the types of methods used if adequate data are available and the methods properly applied. It is important to note that qualitative results on transportation needs and ITS-user-service preferences will vary depending on the characteristics of the population being studied. Each location will have its own needs that will need to be considered in planning and implementing an ITS technology.

Several benefits will arise from analyzing societal issues early in the planning process for an ITS implementation. The first is that early consideration of societal issues presents opportunities not only to identify and meet the transportation needs of the transportation disadvantaged, but also to identify new markets for the technology. Secondly, the early consideration of societal issues allows for the identification of potential problems further down the road. Addressing these problems early increases the likelihood of a smoother ITS technology implementation due to user acceptance. A third benefit is the increased ability to identify what technologies would be most appealing to the target user population. This allows changes in technology choice early in the implementation process. In this study, it was found that the transportation needs of the elderly population would have been better served by ITS technologies that were not part of the FAST-TRAC demonstration project.

As ITS technology comes into the mainstream of ways to solve transportation problems, addressing user needs will become more desirable because of the potentially expanding market for ITS technologies and the increased likelihood of unobstructed implementation. Furthermore, requirements in many areas will call for the inclusion in the transportation-planning process of technologies that might solve transportation problems. As that happens,

the public-sector portion of ITS will enter the transportation-planning process, and analytical methods to address the societal issues will be necessary. This study has illustrated ways of meeting these requirements in the future.

VIII. RECOMMENDATIONS

The recommendations from this study relate to four time periods relevant to the transportation-planning process. They are at the initiation of planning, during data collection, during analysis, and after analysis has occurred.

Societal issues both influence the implementation of ITS technologies and are impacted by them. To name a few, societal issues include equity, access, pollution, congestion, and transportation for those who do not have access to private vehicles whether for reasons of age, health, or financial status. It is recommended that they be analyzed in a structured way as early in the planning process as possible in order to benefit from the opportunities that understanding them offers. Early consideration of societal issues will increase the likelihood of a successful implementation by eliminating some of the conflicts that may ultimately occur. For example, instances of citizen and legal opposition could be minimized by addressing societal issues prior to implementation of ITS technologies.

Some portions of ITS implementations are dependent upon public-sector investment. With that investment come the requirements to address the needs of the public and include that portion of the ITS implementation in the local or regional transportation-planning process. As ITS technologies become more available, their inclusion as alternatives in the transportation-planning process will become imperative.

Including societal issues in the planning process will help in meeting society's transportation needs, which can then initiate a virtuous circle. As transportation is provided to the transportation disadvantaged, they become more able to participate in life's productive activities. This has two positive results: their contribution to the economy and the creation of an expanded market for ITS technologies.

Once it has been decided to include societal issues in the planning for ITS technology deployment, it is important to set up a study design that will accommodate the various issues to be addressed in the best manner possible. Such a study design would include selecting issues for analysis, developing a hypothesis to be tested, and applying analytical methods to test the hypothesis. The constraints of this study, including its limited resources and retrospective nature, precluded operating within such a study design. In the transportation-planning process, the study design will be applicable in the stages of identifying the problem, specifying the alternatives, and analyzing the alternatives. An illustration of how analytical techniques can be included in these steps in an ITS decision is provided by Richardson et al. (1997).

Collection of data pertaining to societal issues can present challenges that are unique to dealing with people who are elderly, youthful, or disabled. Sometimes their ability to understand instructions or respond to questions is impaired. This does not mean that these people should not be included in data-collection activities (for example, focus groups), but rather that great care must be taken to deal with their constraints so that the views of the participants can be most accurately recorded. As with all types of participants, but very importantly the elderly, in

the focus group setting, it is critical to follow procedures that will improve the likelihood of getting reliable results. Such procedures include delivering clear messages in a voice that can be easily heard; using visual aids as necessary; providing breaks as necessary; providing forms that are user friendly; and providing personal assistance to complete forms. Other guidelines may apply depending on the ability levels of the participants. Working with people at the level at which they can most effectively participate will improve the results of a study.

In order to gain the most from the analysis of societal issues, analysts who understand the limitations, benefits, and requirements of the methods should select the method and execute the analysis. Understanding the methods requires understanding the quality and quantity of data required for the procedures to be undertaken; and how to collect data, conduct the procedure, and interpret the results. The results of performing the analytical method need to be included in the planning process, and the analyst must be connected with the appropriate procedure for having this occur.

As part of the inclusion of the analysis in the transportation-planning process, the possibility of the use of ITS technologies needs to be discussed in conjunction with the transportation needs of the potential users. Such discussions would include the organizations that provide the services or facilities that potential ITS users need for the conduct of their lives. An example would be the representatives of the health-care-delivery system. To most effectively meet the health-care-access needs of the elderly, for example, transportation services need to be planned in conjunction with the health-care-delivery system. There is a great likelihood that input from this constituency will modify the transportation solution so as to better meet the users' transportation needs.

In this study, it was found that those people who had not participated in the FAST-TRAC demonstration had only a vague awareness of ITS technologies. In order to increase awareness and acceptance of ITS technologies as potential solutions to transportation problems, it is recommended that efforts be undertaken to explain ITS technologies to the public.

Three research activities are recommended as follow-ons to this study. The first activity would be a demonstration of the use of analytical methods to address societal issues in an actual transportation-planning process at a local level. The second would be to conduct a test to determine whether, under actual conditions, the ITS technologies reported to be preferred in this study would actually better meet some of the transportation needs of the population studied than do existing transportation services. The third research activity would be to test, with a sample larger than the nine FAST-TRAC participants used in this study, the quality of the forecasts by the younger elderly of their future transportation needs.

APPENDIX A:
SOCIETAL ISSUES IN FAST-TRAC

Following the implementation of the operational field tests across the country, several documents were published which report the results of the tests. In addition to these case studies, several other documents studying the FAST-TRAC operational field tests by the Road Commission for Oakland County in Michigan and private consultants were prepared. These documents were reviewed to establish a list of societal issues considered relevant to the evaluation of ITS technologies. The two ITS technologies in FAST-TRAC are en-route information and route guidance, both of which are advanced traveler-information systems (ATIS) technology, and traffic control and incident management, which are examples of advanced transportation-management systems (ATMS) technology.

To illustrate the societal issues mentioned and addressed in FAST-TRAC reviews, the ITS applications they were related to, where they were reported, and the analytical method used, two-dimensional matrices were established. The societal issue categories is the vertical dimension, and the ITS technology is the horizontal dimension. The first matrix records the societal issues mentioned in FAST-TRAC documents, while the other lists the analytical methods used in addressing societal issues in FAST-TRAC. For each matrix, the cells include a number, a Roman numeral, and a page number in parentheses. The first number denotes a specific societal issue. The Roman numeral refers to the document in which the societal issue was referenced, and the page number locates it within the document. The cells in the analytical methods matrix include a letter to represent the type of method used for analysis. The numbers, letters, and Roman numerals correspond respectively to a societal issue, a citation, and an analytical method listed in the attached key. The matrices and key follow.

SOCIETAL ISSUES MENTIONED IN FAST-TRAC DOCUMENTS

SOCIETAL ISSUE GROUPS AFFECTED BY TRANSPORTATION SYSTEMS	Advanced Traveler Information Systems		Advanced Transportation Management Systems		General FAST-TRAC
	En-route Information	Route Guidance	Traffic Control	Incident Management	
1) Access	7X (22) 7XI (3) 7I (14,18)	7X (2) 7XI (3) 7I (14,18)	7X (2) 7XI (3) 7XVI (3) 7I (14,18) 3,4IV (11-16, 8) 8II (2-4)	7X (2) 7XI (3) 7XVI (3)	7IV (8) 7I (18,19) 7X (2-3)
2) Equity					
3) Economic Factors			6XII (4)	6XII (4)	
4) Organizational Issues					
5) Traffic Effects	2,8,12 III 2XI (2) 8XIV (3) 2,8 I (14,15,18)	2,8,12 III 2XI (2) 8XIV (3) 2,8 I (14,15,18)	8,2,1,12 VIII (4) 2XI (2) 8XVI (3) 8XIV (3) 2,8 XIII (5-7) 2,8 I (14,15,18) 2,8XV (5) 8 XVII (3) 1,2,3,5,8 IV (8-16,20-21) 2,8 III (2) 8 II (2)	2XI (2) 8XVI (3) 8XIV (3) 2,8 XIII (5-7) 2,8XV (5) 8 XVII (3)	8,1,2,12 II (2-4) 2,3,8VI (2) 1,2,8,5,12 IV (8) 2,1, I (18-19)
6) Transportation Issues	7X (3) 1I (19)	7X (3) 1I (19)	7X (3) 1I (19)	7X (3)	

SOCIETAL ISSUE GROUPS AFFECTING TRANSPORTATION SYSTEMS	Advanced Traveler Information Systems		Advanced Transportation Management Systems		General FAST-TRAC
	En-route Information	Route Guidance	Traffic Control	Incident Management	
1) Demographic Factors					
2) Economic Factors			6 IV (8)		10V (1-2) 10I (5-8)
3) Organizational Factors					11V (1-2) 11II (2,4) 11X (2-3)
4) Transportation Factors					

ANALYTICAL METHODS USED TO ADDRESS SOCIETAL ISSUES IN FAST-TRAC

SOCIETAL ISSUE GROUPS AFFECTED BY TRANSPORTATION SYSTEMS	Advanced Traveler Information Systems ◄►		Advanced Transportation Management Systems	
	En-route Information	Route Guidance	Traffic Control	Incident Management
1) Access	7A I, (14) 7A I, (18)	7A I, (14) 7A I, (18)	3,4B IV, (11-16) 4A IV, (8) 7A I, (14) 7A I, (18) 8A II, (2-4)	
2) Equity				
3) Economic Factors				
4) Organizational Issues				
5) Traffic Effects	2A I, (14) 8A I, (18)	2A I, (14) 8A I, (15)	1,2,3E IV, (9) 1,2,5A IV, (8) F IV, (20) 1,2D IV, (21) 1,2,5B IV, (11-16) 1,2C IV, (16) 2A I, (14) 8A I, (15) 2A III, (2) 8A II, (2) 8A III, (2)	
6) Transportation Issues	1A I, (19)	1A I, (19)	1A I, (19)	
7) Users / Non-users of Systems	9A I, (59)	9A I, (59)	9A I, (59) 9A II, (7) 3,4A IV, (8) 4B IV, (11-16)	
SOCIETAL ISSUES AFFECTING TRANSPORTATION SYSTEMS				
1) Demographic Factors				
2) Economic Factors			6A IV, (8)	
3) Organizational Factors				
4) Transportation Factors				

KEY FOR APPENDIX A

References*

I. DeBlasio, Borg, Gehring, and Underwood 1994
II. Gruber 1995
III. Mitchell 1995
IV. Levine and Underwood 1995
V. Ghosh 1995
VI. University of Michigan 1995
VII. Euler and Robertson 1995
VIII. Moore & Associates 1994
IX. Barbaresso, Bair, and Relyea 1995
X. Barbaresso and Tyrrell 1994
XI. Grubba and Barbaresso 1995
XII. "Lessons Learned from Phase I of FAST-TRAC" 1994
XIII. "Lessons Learned from Phase I of FAST-TRAC - City of Troy" 1994
XIV. Bauer et al. 1995
XV. Bair et al. 1995
XVI. Barbaresso and Kemp 1993
XVII. Barbaresso 1994

Methods

A. Survey instruments
B. Analytical hierarchy process
C. Analysis of variance
D. Clustering techniques
E. Cross-impact matrices
F. Step-wise regression

Societal Issues

1. Air pollution / emissions
2. Safety
3. Quality of life / driver stress
4. Non-vehicular traffic (pedestrians, cyclists, non-drivers)
5. Noise
6. Affordability
7. Mobility
8. Congestion
9. Public perception
10. Intellectual property
11. Public / private issues
12. Energy conservation

*Complete citations are in the References section at the end of the report.

APPENDIX B
FOCUS GROUP QUESTIONNAIRES

Analysis of Societal Issues in a Michigan Intelligent Transportation System Operational Field Test

Demographic Information

1) Date of birth (month, day, year) _____, _____, _____
2) Gender Male _____ Female _____
3) Highest level of education. High school _____ Undergrad _____ Graduate _____
4) Do you currently hold a valid driver's license? Yes _____ No _____
5) Do you currently drive? Yes _____ No _____
6) If no, did you allow your license to expire? _____

Transportation Access Ranking

One may need and/or desire access to one or all of the following. Please, using the space provided, rank their importance to you where "1" is most important and "7" is least important.

1) Health Care _____
2) Shopping _____
3) Recreation _____
4) Employment/Job Training _____
5) Worship/Religion _____
6) Education _____
7) Socializing _____
8) _____ _____
9) _____ _____
10) _____ _____

Transportation Access Rating

One may need and/or desire access to one or all of the following. Please, using the space provided, rate their importance to you on a scale of 1 to 10 with "10" being very important and "1" being unimportant.

1) Health Care _____
2) Shopping _____
3) Recreation _____
4) Employment/Job Training _____
5) Worship/Religion _____
6) Education _____
7) Socializing _____
8) _____ _____
9) _____ _____
10) _____ _____

Analysis of Societal Issues in a Michigan
Intelligent Transportation System Operational Field Test
Preferences - ITS Services

For each pair below, please check which ITS user service you would prefer to be available or applied to improve your access.

(1)	Pre-Trip Planning	_____	or	Personal Public Transit	_____
(2)	Pre-Trip Planning	_____	or	Traffic Signal Optimization	_____
(3)	Personal Public Transit	_____	or	Route Guidance	_____
(4)	Traffic Flow Optimization	_____	or	Personal Public Transit	_____
(5)	Personal Public Transit	_____	or	Safety Readiness	_____
(6)	Traffic Signal Optimization	_____	or	Safety Readiness	_____
(7)	Route Guidance	_____	or	Pre-Trip Planning	_____
(8)	Safety Readiness	_____	or	Personal Public Transit	_____
(9)	Traffic Signal Optimization	_____	or	Route Guidance	_____
(10)	Safety Readiness	_____	or	Route Guidance	_____
(11)	Safety Readiness	_____	or	Pre-Trip Planning	_____
(12)	Route Guidance	_____	or	Traffic Signal Optimization	_____

NOTE: These are reduced and not to scale.

APPENDIX C:
Individual Preference Matrix*

	user service pair groupings											
Subject No.**	a	b	c	d	e	f	g	h	I	j	k	l
1	4>2	3>2	4>1	---	5>4	5>3	---	---	---	---	---	---
2	4>2	3>2	4>1	4>3	5>4	5>3	1>2	5>4	3>1	5>1	5>2	1>3
3	4>2	3>2	4>1	4>3	5>4	5>3	1>2	5>4	3>1	5>1	5>2	1>3
4	4>2	2>3	4>1	4>3	4>5	5>3	1>2	4>5	1>3	1>5	2>5	1>3
5	2>4	2>3	1>4	3>4	5>4	---	2>1	---	---	1>5	5>2	1>3
6	4>2	3>2	4>1	---	5>4	---	1>2	---	---	---	---	---
7	4>2	3>2	4>1	3>4	4>5	5>3	2>1	4>5	3>1	5>1	5>2	3>1
8	4>2	3>2	1>4	3>4	5>4	5>3	2>1	4>5	3>1	5>1	2>5	3>1
9	2>4	2>3	4>1	4>3	4>5	3>5	1>2	4>5	1>3	1>5	2>5	1>3
10	4>2	3>2	4>1	3>4	5>4	5>3	1>2	5>4	3>1	5>1	2>5	1>3
11	4>2	2>3	1>4	3>4	5>4	5>3	1>2	5>4	3>1	5>1	2>5	1>3
12	2>4	3>2	1>4	3>4	5>4	3>5	2>1	5>4	3>1	5>1	2>5	3>1
13	2>4	3>2	4>1	4>3	5>4	5>3	2>1	5>4	1>3	5>1	5>2	3>1
14	2>4	3>2	1>4	3>4	5>4	5>3	1>2	5>4	1>3	5>1	5>2	1>3
15	4>2	3>2	4>1	4>3	4>5	5>3	1>2	4>5	3>1	5>1	5>2	3>1
16	2>4	3>2	1>4	3>4	5>4	3>5	2>1	5>4	3>1	5>1	5>2	3>1
17	2>4	3>2	1>4	3>4	5>4	3>5	2>1	5>4	3>1	1>5	2>5	3>1
18	4>2	2>3	4>1	4>3	5>4	5>3	1>2	4>5	1>3	5>1	2>5	1>3
19	4>2	2>3	1>4	3>4	5>4	3>5	1>2	5>4	1>3	5>1	2>5	1>3
20	4>2	2>3	4>1	4>3	4>5	5>3	1>2	4>5	1>3	5>1	2>5	1>3
21	4>2	3>2	4>1	4>3	4>5	5>3	2>1	4>5	3>1	5>1	5>2	3>1
22	4>2	2>3	4>1	4>3	5>4	5>3	2>1	4>5	1>3	5>1	5>2	3>1
23	4>2	2>3	4>1	4>3	4>5	5>3	1>2	4>5	1>3	1>5	2>5	1>3
24	4>2	3>2	4>1	4>3	4>5	5>3	1>2	4>5	3>1	5>1	5>2	3>1
25	4>2	3>2	4>1	4>3	4>5	5>3	1>2	4>5	3>1	5>1	5>2	3>1
26	4>2	2>3	4>1	4>3	4>5	5>3	1>2	4>5	1>3	5>1	5>2	1>3

*Subjects 1 through 8 are the assisted-living-facility participants; subjects 9 through 17 are the FAST-TRAC participants; subjects 18 through 26 are based on the FAST-TRAC participants predictions of future transportation needs.

**Shaded areas denote inconsistencies in data.

KEY

1 Route Guidance
2 Pretrip Planning
3 Traffic-Signal Optimization
4 Personal Public Transit
5 Safety Readiness

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