TRANSPORTATION CENTER

CONSUMER ANALYSIS FOR TRAVEL TO WORK OR SCHOOL

by

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RESEARCH REPORT

ESTERN UNIVERSITY EVANSTON • ILLINOIS

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REPORT SERIES

This report is the second report in Series II of the Consumer Oriented Transportation Service Planning series.

Series I

1. Consumer Analysis and Strategies, Final Report
2. Consumer Views of Transportation Service in Evanston
3. The Development and Implementation of a Questionnaire to Determine Consumer Wants and Needs
4. Preliminary Analysis of the Survey
5. Models of Consumer Travel Choice Behavior

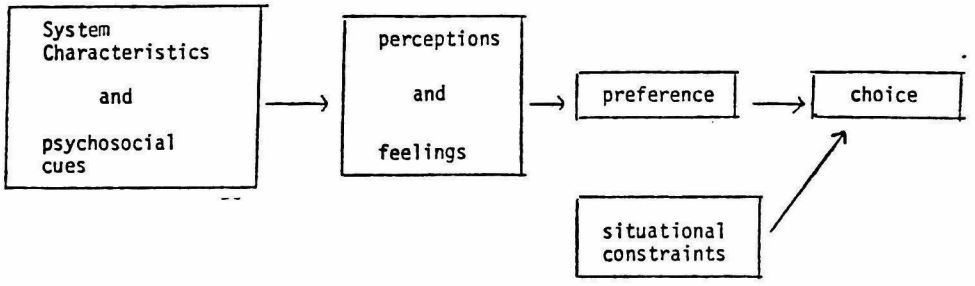
Series II

1. Consumer Analysis for General Travel Destinations
2. Consumer Analysis for Travel to Work or School
3. Evaluation of the Impact of Strategies

EXECUTIVE SUMMARY

This report studies the application of consumer-oriented transportation service (COTS) planning to trips to work or school. Two previous applications (to trips to downtown Evanston and to general travel) are reported in COTS Series I and Report 1 of Series II. The COTS approach integrates state-of-the-art techniques in consumer behavior, marketing research, and transportation demand analysis with a conceptual model of transportation behavior (see Figure i), resulting in a managerially relevant methodology for transportation planning. This report describes the COTS methodology in the context of the trip to work or school.

FIGURE i. A MODEL OF CHOICE BEHAVIOR



Work/school trips are analyzed separately because of their large number, their concentrated impact on the transportation system, and other unique characteristics related to their repetitive nature. This study analyzes work/school trips of Evanston residents both within Evanston and

to Chicago destinations. The major point of comparison is between short, local work trips and long, suburb-to-city work trips.

Preliminary Analysis

The data used in this analysis includes 177 Evanston workers/students and 179 Chicago destination workers/students. There are several differences between Evanston and Chicago workers. The proportion of Chicago workers/students who are male, middle-aged, highly educated, of medium-to-high income, and working full-time is greater than for Evanston workers/students. This is largely attributable to the unusually high percentage of college students (30.5%) found in the Evanston sample.

Comparison of the total work/school sample and the sample for non-work/school trips to downtown Evanston reveals demographic differences that are logical for a comparison of workers/students and their households to a more general cross section of the population. There are fewer elderly, more highly educated people, more men, and more moderately high income people in the work/school sample than for the downtown Evanston sample.

Variable Measurement

Measures were obtained for each of the variables in Figure i. Choice is assessed as choice of mode or mode combination (access and line haul modes for Chicago trips) for the most recent work/school trip. Ranked preference information is obtained, with first preference being the variable used in the quantitative models. Situational constraints are represented by an auto availability index, number of autos per licensed driver.

Perceptions are measured by a set of attribute ratings which represent the respondents' evaluation of each mode on various salient characteristics such as comfort and convenience. Evanston workers rated bus, walk, bike and car for the entire trip to work. Chicago workers rated train and el as line-haul modes; bus, walk and car as access modes to the train or el; and auto for the entire trip.

Feelings are measured by a set of statements dealing with affect, personal and social normative beliefs, and sensitivity to extraneous events. Since we are interested primarily in general, overall feelings about each mode rather than responsiveness to specific changes we analyze only statements which (a) are parallel across modes and (b) do not deal with extraneous events. The resulting twelve statements are factor-analyzed to obtain both mode specific and mode abstract feelings measures.

Models of Preference And Choice

Based on the paradigm of Figure i, the preference relationship describes the influence of perceptions and feelings on first preference for travel mode. The choice relationship describes the influence of a situational constraint, "autos per driver", and mode preference on travel choice behavior. This preference-linked choice model is compared to a direct choice model, that is, one in which choice is modeled as a direct function of perceptions and feelings (and autos per driver). We advocate use of the preference index model based on both statistical results and interpretability.

We compare preference and choice models for both Evanston and Chicago trips with the mode-specific formulation of opinions to those

with the generic formulation. In each case, the coefficients of the other significant variables are similar in sign and magnitude between the two formulations. The models containing the generic opinions provide better statistical results. Since the generic structure is superior conceptually, we propose that continuing research be undertaken to refine the measurement of "feelings" about travel modes in addition to perceptions of transportation services.

Conclusions

Here, as in the studies of trips to downtown Evanston and trips for various destinations in Evanston for non-work/school trips, we confirm the usefulness of the COTS methodology to transportation planning. The models obtained are statistically strong and provide a useful interpretation of travel choice behavior. The major findings which are unique to this application of the COTS approach are:

(i) the similarity of consumer perception space for local modes whether used for trips to Evanston work/school locations or as access to rail or el for the trip to Chicago and the difference between this perception space and that used by consumers to represent travel modes for the main trip to Chicago; and

(ii) the strong contribution of opinions about transport modes to mode choice and, particularly, the superiority of generic opinions measures over mode-specific opinions measures.

INTRODUCTION

Consumer-oriented transportation service (COTS) planning seeks to improve local transportation and its management by assessing the needs, desires, and satisfaction of consumers of transportation. The COTS approach integrates marketing research, consumer behavior theory, and transportation demand analysis techniques. The resultant methodology is useful for evaluating the effectiveness of the current transportation system, diagnosing problems with the system, suggesting solutions to problems, predicting the impact which changes would have on usage of the system, and assessing the effect of changes after they have been implemented.

This report examines work/school trips of Evanston residents within the framework of the COTS approach. The work trip is an important component of urban travel. In Evanston, for example, work/school trips account for 28.6% of all trips made -- by far the single most common trip purpose (Hauser and Wisniewski, 1980). Further, work trips demand special consideration not only because of their number, but also because of their unique impact on the transportation system. While other travel is diffused throughout the day, work trips occur in a few hours in the morning and evening. It is usually during these peak periods that the transportation system bears its heaviest load and thus presents a "worst case" situation to the planner as well as the user.

Work trips are intrinsically different from non-work trips in several ways. The study of non-work trips is usually complicated by (i) the presence of many diverse trip purposes, (ii) the fact that a destination choice is being made as well as a mode choice, and (iii) a high degree of day-to-day variability in other trip characteristics. Work trips, on the

other hand, are relatively homogeneous in purpose, generally have a fixed destination for each individual, and vary little from day to day.

It oftens happens that an individual traveler, over a long period of time, uses different modes for the same work trip (e.g., uses the train because the car is being repaired). Thus, these travelers may be more knowledgeable about alternative modes than they would be for other types of trips. However, this "familiarity" may not be related to current service characteristics if the individual uses a mode only rarely or during exceptional circumstances (e.g. taking the bus only during a blizzard). Some individuals may frequently use more than one mode, and thus may have more accurate perceptions of the characteristics (such as travel time) of these modes than would infrequent users of the same mode. Due to the repetitive nature of work travel, habit may be very important. Individuals who use the same mode each day may not change modes unless major changes in service occur and, even then, the switch may not occur for some time.

Because the work/school trip is repeated daily, workers/students may weight the characteristics of a mode differently for work/school trips than for other trips. Mental stress, or the frame of mind in which one arrives at the destination, may be more important for work trips. Reliability may be more important since one is generally expected to be at work/school at a specific time. Flexibility may be less important for a home-work-home trip than for a multi-stop, multi-purpose trip.

These differences between work/school and non-work/school may lead to differences in detail among models which describe mode choice behavior in various travel contexts; however, we expect the general process by which a mode is chosen to be the same. More precisely, while the parameter estimates

and even the explanatory variables themselves may vary from one context to another, we expect the COTS modeling approach to be valid and the techniques to be applicable in each case. The remainder of this report addresses these expectations. The following section presents the modeling approach used. Succeeding sections discuss the validation of the structural model itself while pointing out "differences in detail" from the previous applications of the model.

CONCEPTUAL MODEL

Until recently, travel behavior models predicted choice as the function of engineering measures of system characteristics (such as travel time and cost) alone (Charles River Associates, 1972; Ben-Akiva, 1973). However, other characteristics such as reliability, comfort, and convenience are also relevant determinants of choice (Bock, F.C., 1968; Paine et al., 1967; Gustafson et al., 1971). Techniques for quantifying these perceptions and incorporating them into mode choice models were developed in recent years (Spear, 1976; Nicolaidis, 1975; Prashker, 1977).

The COTS study integrates these techniques with an underlying conceptual framework which provides a reasonable model of transportation behavior. This framework, shown in Figure 1, postulates that an individual's preference for an alternative is a function of his perceptions of the characteristics of that alternative (e.g., safety, comfort, reliability) and his feelings towards the alternative (e.g., affect or liking, and social or personal pressures on behavior). Subjective perceptions and feelings, in turn, are functions both of actual characteristics of the transportation system and of psycho-social characteristics of the individual. Finally, choice is governed by preference unless situational constraints dictate otherwise.

The philosophy which underlies this study is that explicitly modeling each component of the choice process is more useful than modeling choice only as a function of system characteristics. This approach provides a more complete understanding of the steps in the consumer choice process. Thus, transportation planners and managers are better equipped to:

(i) diagnose the nature of transportation problems. For example, low utilization of a given mode of travel could be a result of any or all of the following:

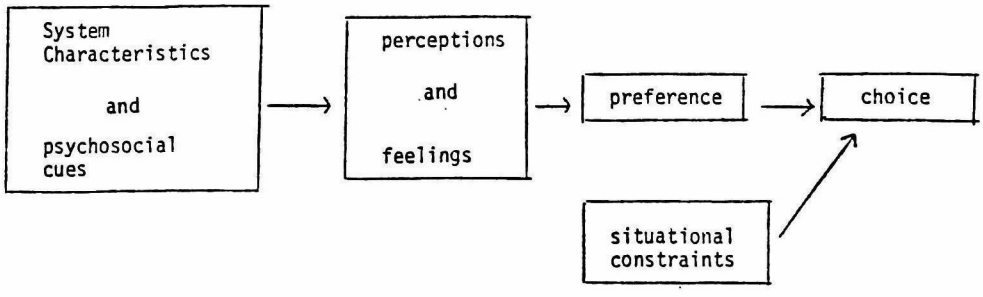
(a) poor performance on system characteristics,

(b) unfavorable perceptions of system performance (even if actual performance is quite good),

(c) negative feelings toward the mode (even if perceptions are neutral or favorable), or

(d) situational constraints (which may override even positive feelings and perceptions).

FIGURE 1. A MODEL OF CHOICE BEHAVIOR



By studying each link separately we are able to pinpoint the cause(s) of problems and identify opportunities for improved service.

(ii) influence consumer behavior. Isolating the problem within the behavior process indicates the point(s) at which efforts should be directed to have maximal impact on eventual choices.

(iii) predict the results of changes in attributes of the system or characteristics of the individual.

Having presented a conceptual framework for studying transportation behavior, we turn now to the operationalization of that framework within the context at hand.

PRELIMINARY ANALYSIS

Data on the components of the model in Figure 1 were obtained by means of a self-administered questionnaire mailed in January 1977. The questionnaire on work/school trips was one of three similar questionnaires mailed to different random samples of Evanston residents. The three questionnaires differed primarily in the type of trip for which responses were elicited: the first questionnaire to be analyzed dealt with trips to downtown Evanston, while the second one asked about general non-work/school travel within Evanston. The latter questionnaire will be referred to as the "many-to-many" questionnaire because it involves trips from many different origins (homes) to many different destinations (rather than to a single major destination such as "downtown"). Unlike the other two questionnaires (which dealt exclusively with non-work/school trips within Evanston), this report analyzes work/school trips with Chicago destinations as well as those with Evanston destinations. Thus, we will look for possible differences between short (local) work trips and longer (suburb-to-city) work trips.

A total of 1900 work/school questionnaires were mailed out; 724 were returned for a 38.1% response rate. This is about equal to the response rate for the many-to-many questionnaire and somewhat lower than the (41%) rate for the downtown Evanston questionnaire. The lower response rate may be due in part to the increased length and complexity of this questionnaire. Also, since it dealt in detail only with Evanston and Chicago work/school trips, we would expect a low return rate for people not working in Evanston or Chicago.

Of the 724 people who returned the questionnnaire, 290 worked in Evanston and 254 in Chicago. The others worked elsewhere or did not respond to that question. We analyzed the responses of those people with Evanston or Chicago work places.

The patterns of mode usage, summarized in Table 1, are very different between respondents who work in Evanston and Chicago. For the most recent trip, Chicago workers used the predominantly line-haul train and el modes much more heavily than Evanston workers. With respect to using a single mode for the entire trip, Evanston workers walked more, rode the bus more, and used the automobile more. Similar differences exist between modes chosen for work/school trips within the last month.

There are also substantial differences between respondents working in Evanston and Chicago in terms of demographic characteristics. Table 2 compares Evanston to Chicago workers on several key demographic variables. It is apparent that there are more middle-aged, highly educated, medium-to-high income, full-time working males among the respondents making work/school trips to Chicago than within Evanston. This difference follows the conventional profile of the suburban commuter. Much of the difference between Evanston and Chicago respondents is due to the disproportionately high percentage (30.5%) of students (mostly college students) among those respondents making trips within Evanston.

Table 1. PATTEPNS OF MODE USAGE

A. Most Recent Trip

	Evanston	Chicago
Walk (all the way)	24.1	.4
Car (all the way)	48.7	38.6
Train/El	5.5	53.9
Bus	16.2	2.8
Other/Missing	5.4	4.3

B. Within Past Month *

Walk (all the way)	34.8	1.2
Car (all the way)	83.8	67.7
Train/El	23.1	84.3
Bus	37.2	16.1
Other	12.7	7.5

* Columns will sum to more than 100 because multiple responses are permissible.

Table 2 DEMOGRAPHIC COMPARISONS:

Evanston Workers (n=177) vs. Chicago Workers (n=179)

(i)

Age

	Evanston	Chicago
14-19	16.4	0.6
20-29	26.6	14.5
30-39	18.1	39.1
40-49	14.1	17.9
50-59	13.0	19.6
60-64	5.1	6.1
65 +	5.6	1.7
Missing	1.1	0.6

(ii)

Level of Education

	Evanston	Chicago
Elementary	1.7	0.0
Some High School	7.3	0.6
High School Graduate	5.6	3.9
Some College	29.9	11.2
College Graduate	16.9	24.6
Some Graduate School	16.4	12.3
Graduate Degree(s)	21.5	46.9
Missing	0.6	0.6

(iii)

Sex

	Evanston	Chicago
Male	53.7	76.0
Female	46.3	24.0
Missing	0.0	0.0

(iv)

Income

	Evanston	Chicago
less than $10,000	20.3	2.8
10,001 to 15,000	16.9	6.7
15,001 to 20,000	15.3	16.2
20,001 to 25,000	14.7	19.0
25,001 to 50,000	20.9	40.8
more than 50,000	4.5	11.7
Missing	7.3	2.8

(v)

Work Group

	Evanston	Chicago
Full Time	53.7	92.7
Part Time	13.0	3.4
Homemaker	0.6	0.6
Student	30.5	2.2
Unemployed	0.0	0.0
Missing	2.3	1.2

Comparison of the total work/school sample and the sample for non-work/school trips to downtown Evanston reveals demographic differences that are logical for a comparison of workers/students and their households to a more general cross section of the population. There are fewer elderly, more highly educated people, more men, and more moderately high income people in the work/school sample than for the downtown Evanston sample.

Some of the questionnaires returned were not usable. We analyzed only those trips with Evanston or Chicago destinations since trips with other destinations did not constitute a large enough or homogeneous enough (in terms of trip length and available alternative modes and routes) sub-sample to warrant analysis.

Respondents were screened out also if they did not provide sufficient information on their choices, preferences, situational constraints, perceptions, or feelings to enable us to model their behavior in terms of the conceptual framework presented in Figure 1. Table 3 describes the final sample in terms of the number of alternatives rated by each respondent.

Table 3

BREAKDOWN OF USABLE RESPONSES

Work Place	Number of Alternatives Rated						Total Cases	Total Alternatives Rated
	2	3	4	5	6	7		
Evanston	6	19	152	N/A	N/A	N/A	177	677
Chicago	0	11	11	14	0	143	179	1148

N/A. Not applicable. Evanston workers were given an opportunity to rate up to four modes.

VARIABLE MEASUREMENT

In order to use the framework shown in Figure 1, we need to quantify the variables in the model. The first step in doing that is to clarify the choice context being studied. We use the most recent work/school trip as the basis for analysis. That is, perceptions and choices were obtained with respect to the most recent trip to work or school. This approach has the advantage of giving the individual a specific frame of reference from which to respond.

CHOICE, PREFERENCE, SITUATIONAL CONSTRAINTS

"Choice" in Figure 1, thus, refers to choice of mode (or mode combination, for Chicago workers) for the most recent trip. "Situational constraints" were measured by an "autos per driver" variable, a general index of auto availability within the household.

"Preference" was measured as the ranked preference for modes for a (general) work/school trip, assuming all modes were available. Since the study of downtown Evanston travel produced similar results for ranked preference and first preference models (Pas and Koppelman, 1979), consistent with strict utility based preference theory (Luce and Suppes, 1965), we chose to develop "first preference" models. That is, we predict the probability that an individual will most prefer a given mode.

A slight variation in the treatment of preference was necessary for Chicago workers. Preference rankings were obtained for auto all the way and for each of the three access modes (the modes of interest in Evanston) in conjunction with an unspecified line-haul mode (i.e. either train or el). Thus, we analyze first preference for this reduced set of alternatives.

PERCEPTIONS

Perceived characteristics were assessed by asking the respondent to rate each mode on a set of 22 Likert-type attribute statements. The statements are reproduced (for bus) in Table 4.

Table 4. ATTRIBUTE STATEMENTS FOR BUS

1. If I had to be somewhere on time, I would not take the bus.
2. I must schedule my trips when I travel by bus.
3. It is very relaxing to travel to work or school by bus.
4. I am often either too hot or too cold when riding the bus to work or school.
5. I worry about being mugged or assaulted when I travel to work or school by bus.
6. I can come and go as I wish if I travel by bus.
7. It is inexpensive to travel to work or school by bus.
8. It takes too much time to stop and do my errands if I travel by bus.
9. I worry about being knocked over or injured if I ride the bus.
10. I know how to get to work or school by bus.
11. Traveling to work or school by bus requires a lot of effort.
12. The bus is available when I need to go to work or school.
13. Other people make me feel uncomfortable when I ride the bus to work or school.
14. It is difficult to travel to work or school by bus when the weather is bad.
15. Bus drivers are pleasant and helpful.
16. I can get to work or school quickly when I travel by bus.
17. I am protected from people who are smoking when I ride the bus.
18. At night, it is safe to travel by bus.
19. I am often annoyed by other people when traveling to work or school by bus.
20. There is generally a long wait involved when I go to work or school by bus.
21. I can easily carry my briefcase or other packages when I travel by bus.
22. I can easily walk to the bus from my home or from work or school.

These statements are designed to cover various specific aspects of the transportation modes being evaluated (e.g., various aspects of comfort, convenience, reliability, mental stress, safety). We factor-analyze the attribute ratings to obtain a reduced set of orthogonal dimensions (or factors), and use the individuals' derived evaluation of each mode on each dimension (i.e. the "factor scores") as the independent "perception" variables in a preference or choice model.

Attribute Measurement

Prior to mailing the questionnaire, a usage audit was conducted in order to determine which of the available modes were used sufficiently (across the entire population of Evanston) to warrant obtaining perceptions for them. Based on the results, Evanston workers were asked to rate bus, walk, bike and car as alternatives for the entire trip to work. Chicago workers were asked to rate train and el as line-haul modes; bus, walk, and car as access modes to the train or el; and auto for the entire trip. Thus, Evanston workers had four single-mode alternatives, and Chicago workers had seven mode combinations; train or el, each with bus, walk, or car access; and auto all the way.

The attribute ratings for all modes were standardized for each individual to eliminate bias in the way the individual responds to the scale rating task. Also, to simplify interpretation, we reversed all negatively worded scales so that a higher score consistently implies a more favorable perception. Finally, for the modes which were missing three or fewer attribute ratings, we filled missing responses with the corresponding sample mean. The average standardized attribute ratings for Evanston local modes, Chicago access modes, and Chicago line-haul modes are shown in Figures 2 to 4, respectively. For the Evanston local modes and Chicago access modes:

. bus is perceived well on "no fear of assault" or "injury", but does poorly on such attributes as "no scheduling necessary", "come and go as I please", "errands take little time", and "get to destination quickly";

. walk is perceived as being "inexpensive", and "people know how to get around" by walking, but "requires effort", presents "problems in bad weather", and is "not safe at night";

. car is perceived as being "on time", "quick", safe from assault" and "safe at night", "quick for errands", "comfortable with respect to other people", and "easy for carrying things". Its major disadvantage is that it is perceived as being expensive.

For the Chicago line-haul modes:

. el does well on "know how to get around using" and "inexpensive", and poorly on "safe at night" and "correct temperature",

. train is perceived as being "safe", "relaxing", and "comfortable vis à vis other people", but rates low on the "no scheduling necessary" and "come and go as I please" scales. This affirms the subjective evaluation of commuter train which surfaced in the focus group interviews (Tybout et al., 1979): affording more privacy and luxury than other public transportation, but having a lower frequency of service than the el;

. auto perceptions here are similar to those for auto as an access mode, with the exceptions that as a line-haul mode, it is rated poorly on "relaxing" and "no problems in bad weather". This is logical, in view of the distance and traffic problems involved in a commute to downtown Chicago.

FIGURE 2
AVERAGE STANDARDIZED ATTRIBUTE RATINGS
EVANSTON LOCAL MODES

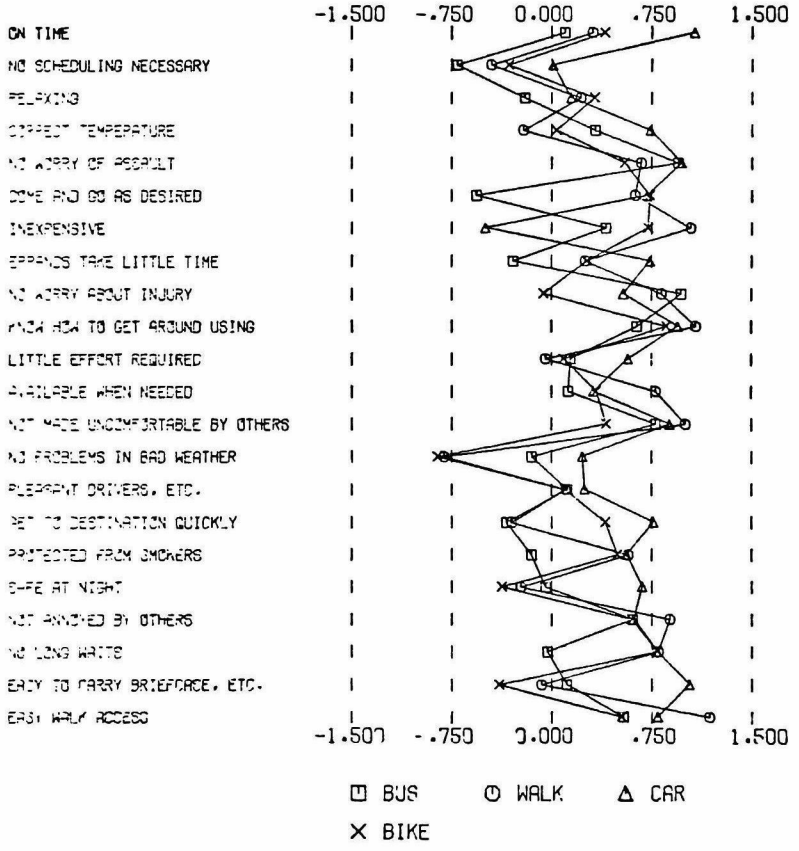


FIGURE 3
AVERAGE STANDARDIZED ATTRIBUTE RATINGS
CHICAGO ACCESS MODES

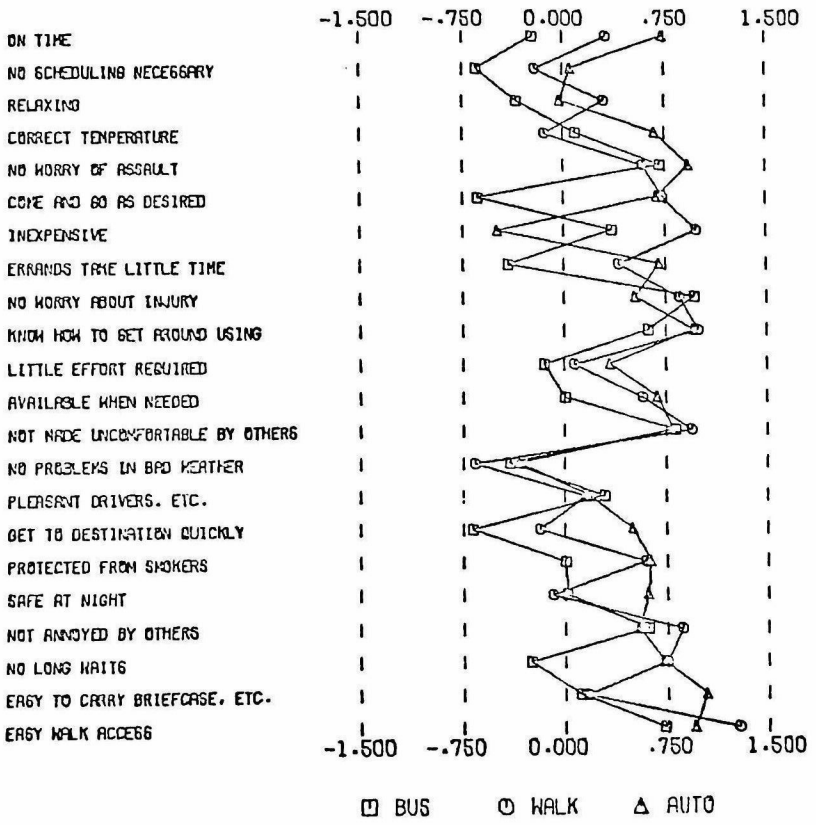
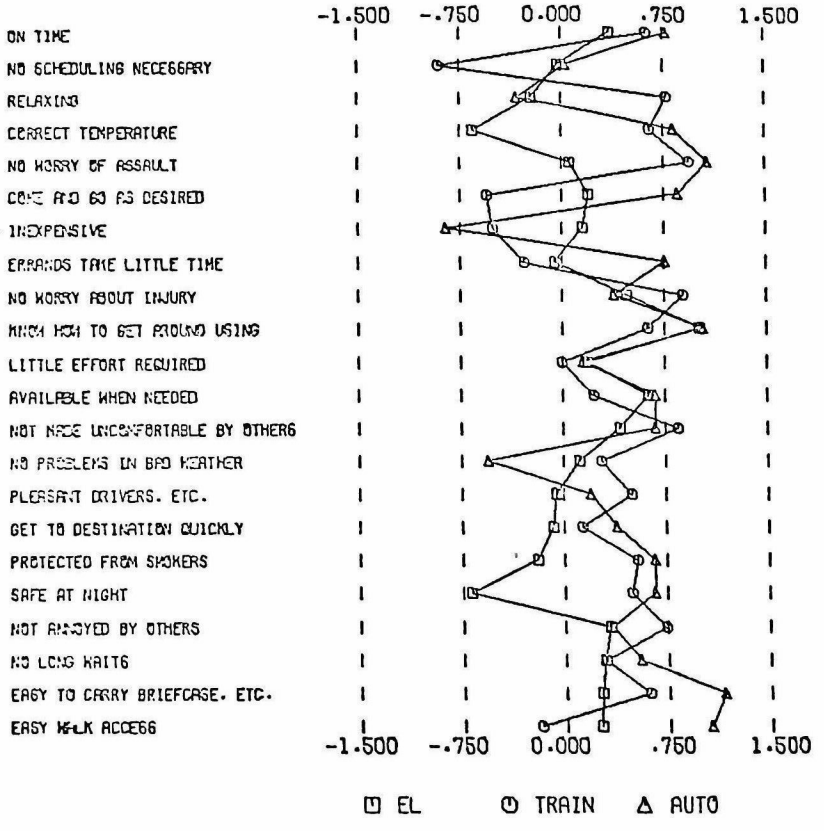


FIGURE 4
AVERAGE STANDARDIZED ATTRIBUTE RATINGS
CHICAGO LINE-HAUL MODES



Factor Analysis

We have noted the similarity between Evanston and Chicago workers in the ratings for the three local modes common to both: bus, walk, and car. It is reasonable that they are rated similarly since they are the same modes being rated (for a relatively short local trip) in either case. However one can not confidently expect such similarities a priori, since Chicago workers use these modes for different purposes (access to rail or el station) than Evanston workers.

Differences in perception may appear as (a) differences in structure (i.e., the two perceptual spaces are characterized by different sets of dimensions) or (b) as differences in evaluation within the same structure. To test (a), we compared separate 3-factor solutions for Chicago access and Evanston modes. The factor loadings, which measure the correlation between attributes and the underlying dimensions (factors), for these solutions appear in Tables 5 and 6.*

Visual comparison of the factor loadings matrices indicate that they are similar for both sets of workers. Heavy loadings on one set are also heavy on the other, and mixed loadings for one set are usually mixed for the other as well. Measures of similarity support this conclusion. The coefficient of congruence (Rummel, 1970) has values of 0.98, 0.94, and 0.95 for the convenience, general service, and psychological stress factors, respectively, compared to maximum values of 1.00. The root mean square difference for elements in the two factor loadings matrices is 0.10 which characterizes the small differences in factor loadings. We therefore, combine the data to obtain a joint three-dimensional solution, whose factor loadings

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* Ratings for "inexpensive" and "pleasant drivers, etc." are excluded from the factor analysis. "Inexpensive" is excluded because it is a separate concept and "pleasant drivers, etc." because it does not load well in any analysis undertaken.

Table 5. Factor Loadings for Three-Dimensional Solution
Evanston Local Modes

	Convenience	General Service	Psychological Stress
On time	.47	.39	.16
No trip scheduling necessary	.28	.23	-.10
Relaxing	.43	.27	.18
Correct temperature	.07	.57	-.01
No worry of assault	.05	.24	.59
Can come and go as I wish	.63	.12	-.07
Errands take little time	.48	.35	.08
No worry about injury	-.09	.14	.72
Know how to get around	.37	-.05	.37
Little effort involved	.39	.46	.26
Available when needed	.47	-.08	.37
Not made uncomfortable by others	.15	.02	.61
No problems in bad weather	-.02	.61	.11
Get to destination quickly	.53	.56	-.02
Protected from smoking	.38	.00	.14
Safe at night	.13	.56	.40
Not annoyed by others	.12	.05	.28
No long waits	.66	.06	.14
Easily carry packages	.07	.65	.10
Easy walk access	.31	.04	.26

Table 6. Factor Loadings for Three-Dimensional Solution
Chicago Access Modes

	Convenience	General Service	Psychological Stress
On time	.49	.51	-.00
No trip scheduling necessary	.31	.35	-.04
Relaxing	.43	.33	.27
Correct temperature	.04	.48	-.00
No worry of assault	.09	.36	.52
Can come and go as I wish	.67	.26	.02
Errands take little time	.58	.35	-.06
No worry about injury	-.03	.00	.73
Know how to get around	.40	.07	.23
Little effort involved	.38	.55	.21
Available when needed	.53	.29	.18
Not made uncomfortable by others	.20	.01	.63
No problems in bad weather	.10	.46	.15
Get to destination quickly	.48	.64	.00
Protected from smoking	.31	.13	.18
Safe at night	.12	.55	.37
Not annoyed by others	.22	.05	.50
No long waits	.63	.20	.16
Easily carry packages	.26	.57	.02
Easy walk access	.41	.00	.12

are shown in Table 7. The joint solution has the advantage that we can directly compare factor scores and parameter estimates (in subsequent preference and choice models) between Evanston local modes and Chicago access modes.

While Evanston and Chicago workers seem to have the same perceptual space for local/access modes, their evaluation of those modes within that space may be quite different. To test this possibility we perform a multivariate analysis of variance (MANOVA) on the factor scores of the joint three-factor solution. Whereas ANOVA tests for a significant difference in a single variable between groups, MANOVA permits us to simultaneously test for differences in a set of variables between groups (Morrison, 1976). The set of dependent variables we are testing is the nine factor scores (three each for bus, walk, and car), and the groups are Chicago and Evanston workers.

Table 7. Factor Loadings for Joint Three-Dimensional Solution

Local Modes

	Convenience	General Service	Psychological Stress
On time	.51	.43	.07
No trip scheduling necessary	.30	.28	-.06
Relaxing	.44	.29	.19
Correct temperature	.05	.54	-.00
No worry of assault	.11	.27	.55
Can come and go as I wish	.66	.17	-.05
Errands take little time	.52	.35	.02
No worry about injury	-.06	.08	.73
Know how to get around	.39	-.00	.30
Little effort involved	.41	.50	.23
Available when needed	.53	.06	.27
Not made uncomfortable by others	.18	.01	.61
No problems in bad weather	.03	.56	.12
Get to destination quickly	.52	.59	-.03
Protected from smoking	.36	.05	.14
Safe at night	.14	.54	.41
Not annoyed by others	.17	.05	.36
No long waits	.66	.11	.12
Easily carry packages	.14	.59	.11
Easy walk access	.32	.02	.22

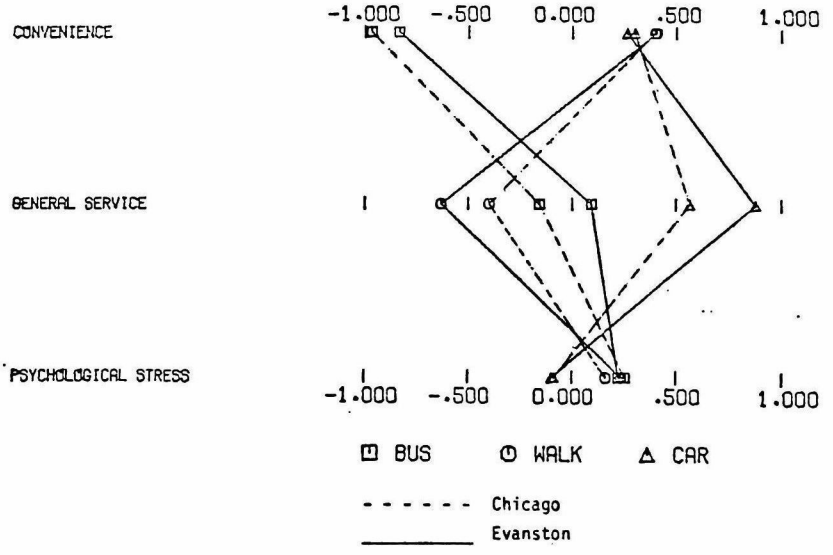
We find

(i) a significant difference between the two groups (α=.00001), and

(ii) the difference to be due almost entirely to scores on general service for each of the three modes (none of the other ratings are different at the 10% level of significance).

A visual representation of the average ratings of local modes with respect to convenience, general service and psychological stress is presented in Figure 5. The differences between Chicago commuters who use these modes for access to rail or "el" stations and Evanston commuters who use them for the entire work trip are very small for both convenience and psychological stress. However, Chicago commuters rate bus and car lower, and walk higher, with respect to general service than do Evanston commuters. Trips to access a Chicago line-haul mode are shorter, on the average, than an entire trip to work in Evanston, so it is reasonable to expect walk to be more serviceable for the former type of trip and bus and car to be more serviceable for the latter.

FIGURE 5
AVERAGE PERCEPTION FACTOR SCORES
LOCAL MODES



We also compare the perceptual structure between the three local modes (bus, walk, and car) and the three line-haul modes (el, train, and auto all the way). We factor analyze the ratings for the three line-haul modes and select the three-factor solution. The factor loadings are presented in Table 8; the dimensions have been labeled "convenience", "comfort", and "travel stress".

Table 8. Factor Loadings for Three-Dimensional Solution
Chicago Line-Haul Modes

	Convenience	Comfort	Travel Stress
On time	.39	.27	.29
No trip schedule necessary	.52	-.10	-.15
Relaxing	-.09	.23	.66
Correct Temperature	-.03	.71	.01
No worry of assault	.20	.65	.27
Can come and go as I wish	.69	.18	-.09
Errands take little time	.53	.28	-.14
No worry about injury	.03	.17	.59
Know how to get around	.43	-.01	.15
Little effort involved	.53	.04	.51
Available when needed	.53	-.02	.20
Not made uncomfortable by others	.09	.39	.45
No problems in bad weather	.07	-.06	.57
Get to destination quickly	.48	.28	.35
Protected from smoking	.06	.53	.14
Safe at night	.12	.70	.27
Not annoyed by others	-.04	.31	.47
No long waits	.44	.19	.39
Easily carry packages	.30	.58	.07
Easy walk access	.52	.21	-.05

Table 9 compares the line-haul solution to the joint solution for the local modes. The first factor, "convenience", is very similar between the two sets of modes, but the other two factors are not comparable. For example, the second factors in each solution have three attributes in common ("temperature", "easy carry-on", and "safe at night") but they each have several attributes not in common. A similar observation holds for the third factors in each solution. The coefficient of congruence for the first pair of factors is

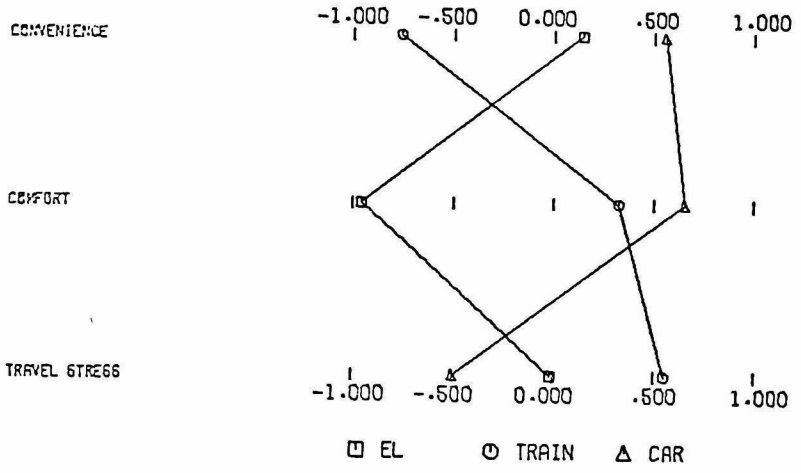
Table 9. COMPARISON OF LOCAL AND LINE-HAUL FACTOR SOLUTIONS IN TERMS OF ATTRIBUTE GROUPING BY FACTOR

LOCAL MODES	LINE-HAUL MODES: Convenience	Comfort	Travel Stress
Convenience	Come and go as I wish Available No long waits Know how to get around Easy walk access Errands On time	Protected from smoking	Relaxing
General Service	Little effort Quick	Temperature OK Easy carry on Safe at night	OK in bad weather
Psychological Stress		No worry of assault	No worry of injury Not made uncomfortable by others Not annoyed by others
Not Loading	No scheduling necessary		

0.92 while those for the second two pairs are 0.75 and 0.79, respectively. The root mean square difference for factor loadings is 0.23. Therefore, we conclude that the perceptual spaces for access and line-haul modes are different. This agrees with findings of Neveu, et al. (1979).

Average factor scores for the Chicago line-haul modes are shown in Figure 6. It can be seen that the automobile is perceived as being convenient and comfortable but stressful. The train is not stressful and is moderately comfortable, but inconvenient, while the el is moderately convenient but stressful and very uncomfortable.

FIGURE 6
AVERAGE PERCEPTION FACTOR SCORES
CHICAGO LINE-HAUL MODES



FEELINGS

Measurement

Feelings are measured by respondents' ratings ("strongly disagree" to "strongly agree") on 27 statements. These statements deal with affect toward each mode (i.e. liking/disliking), personal normative beliefs (i.e. what one thinks he should do with respect to transportation), social

normative beliefs (i.e. what one thinks others expect of him), and extraneous events (i.e. the influence of changes such as weather and pricing on behavior). In the context of the conceptual model shown in Figure 1, we are interested primarily in general, overall feelings about each mode rather than responsiveness to specific changes. Therefore, when factor-analyzing feelings for these data sets, we include only those statements which are parallel across modes, and which deal with travel modes as they presently exist.

The resulting twelve statements (four for each of the three modes) are reproduced in Table 10. The average ratings for Evanston and Chicago workers are shown in Figures 7 and 8, respectively. It is apparent that these average ratings are similar for the two work groups.

Table 10. Opinions Statements Used in Analysis

I really enjoyed traveling:	by car by bus by foot
I find it very depressing when I travel:	by car by bus by foot
I feel that I really ought to travel:	by car by bus by foot
My family and friends would be surprised if I drove a car regularly.	
My family and friends would be surprised if I rode the Evanston bus regularly.	
My family and friends would be surprised if I walked long distances regularly.	

FIGURE 7
AVERAGE STANDARDIZED OPINION RATINGS
EVANSTON

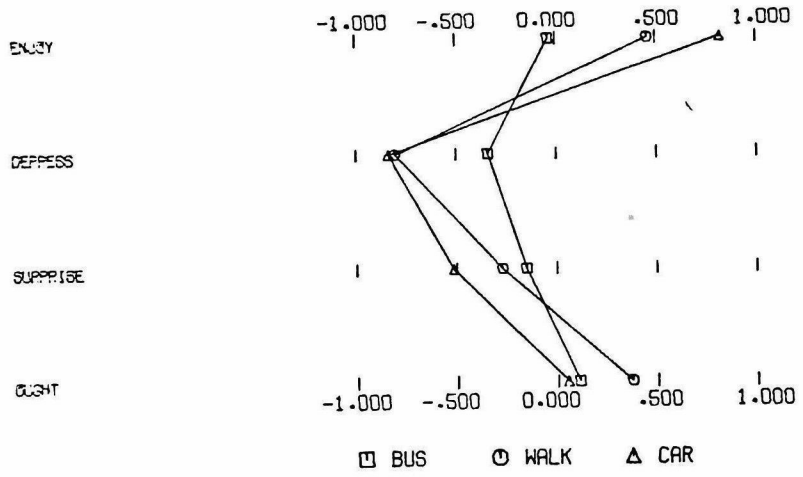
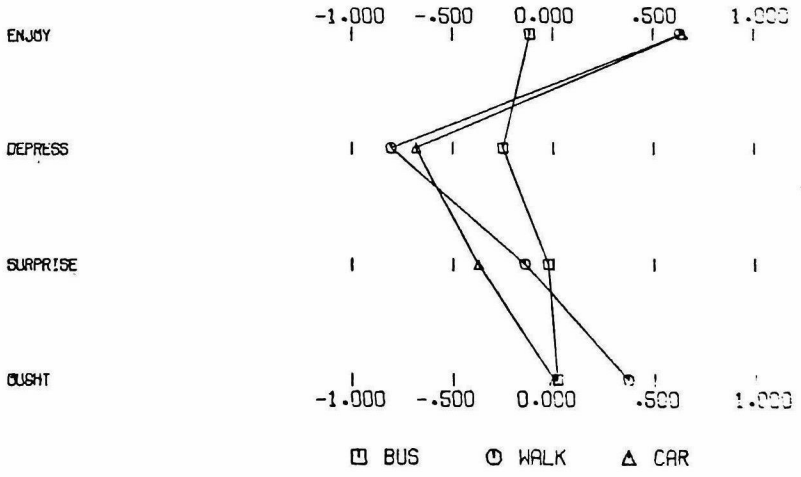


FIGURE 8
AVERAGE STANDARDIZED OPINION RATINGS
CHICAGO



Factor Analysis

Factor analyses of opinions for Evanston and Chicago workers are nearly identical. This indicates that the opinions structure for the three local modes does not depend on whether they are used for the entire trip or only as access modes. The factor analysis results reported below are for the combined data.

The twelve opinion statements are factor-analyzed in two different ways, as illustrated in Table 11:

(i) all twelve together to produce a three factor solution whose dimensions are "bus", "walk", and "car" feelings -- just as in the downtown Evanston and many-to-many analyses. The factor loadings for this solution are shown in Table 12, and the average factor scores* in Figure 9;

Table 11. Factor-Analyzing Opinions:
Mode Specific vs. Mode Generic Factors

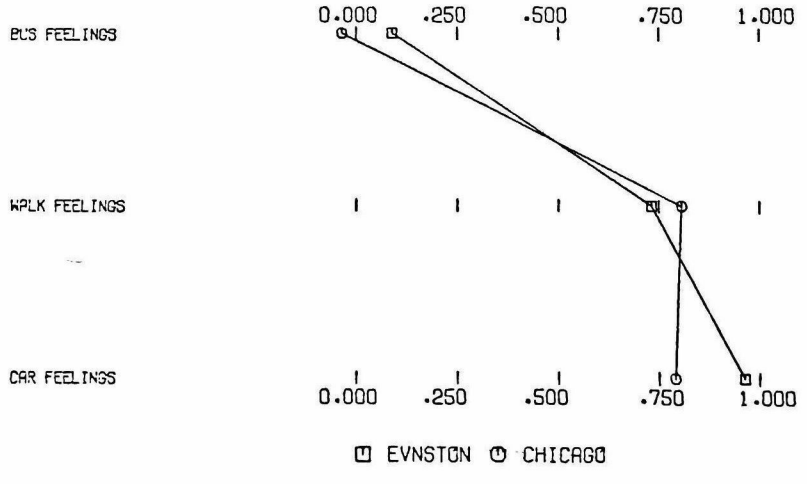
		Mode Specific Factors		
		Bus Feelings	Walk Feelings	Car Feelings
Mode Generic Factors	Affect	Enjoy bus Depressed by bus	Enjoy walk Depressed by walk	Enjoy car Depressed by car
	Normative Beliefs	Surprised if use bus Ought to use bus	Surprised if walk Ought to walk	Surprised if use car Ought to use car

* Factor scores are ordinarily mean-centered by factor. However, since we want to make comparisons across factors (e.g. compare average bus feelings to average walk feelings), the factor scores presented are not mean-centered.

Table 12. Factor Loadings for Three-Dimensional Solution
Mode-Specific Feelings

	Walk	Bus	Car
Enjoy travel by car	-.06	.03	.64
Enjoy travel by bus	.03	.78	.03
Enjoy travel by walk	.85	-.04	-.09
Depressing to travel by car	-.07	-.13	-.77
Depressing to travel by bus	-.10	-.72	-.19
Depressing to travel by walk	-.72	-.17	-.10
Ought to travel by car	-.25	-.18	.55
Ought to travel by bus	-.10	.53	-.12
Ought to travel by walk	.67	-.12	-.21
Peers surprised if rode car	.11	.12	-.29
Peers surprised if rode bus	.01	-.47	.14
Peers surprised if walk	-.56	.02	.14

FIGURE 9
AVERAGE ADJUSTED FACTOR SCORES
MODE-SPECIFIC OPINIONS



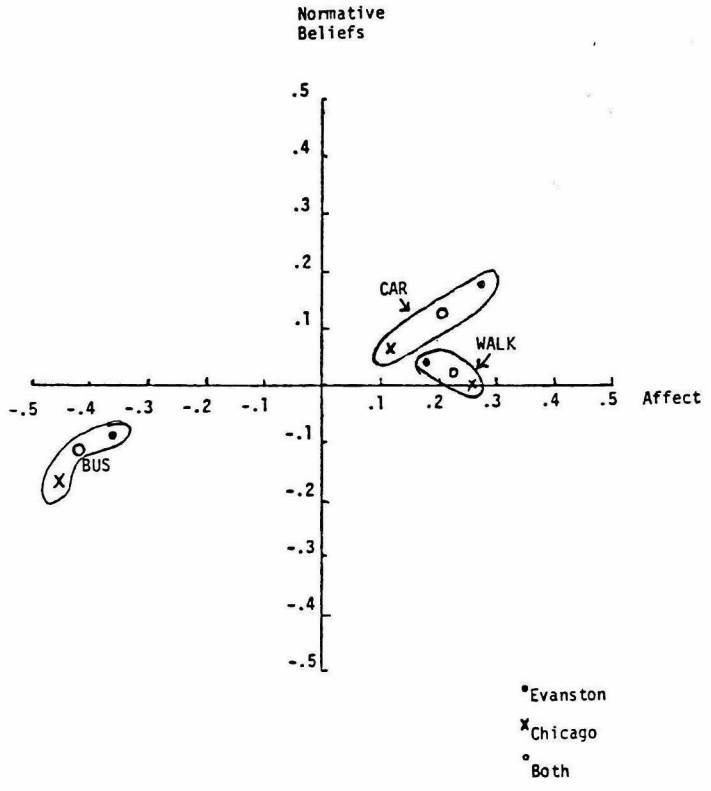
(ii) as three observations (one for each mode) on each of the four variables: "enjoy", "depressed", "surprised", and "ought". This leads to a two-dimensional solution in which "enjoy" and "depressed" load on one factor, "surprised" and "ought" on the other (see Table 13). The two factors represent "affect" and "normative beliefs", respectively. The average factor scores for this solution are pictured in Figure 10. They are congruent with the results of the first method in that here also, Evanston workers/students generally rate bus and car higher than, and walk lower than, Chicago workers/students (walk normative beliefs are an exception, but the differences are very small).

Table 13. Factor Loadings for Two-Dimensional Solution
Generic Feelings

	Affect	Normative Beliefs
Enjoy	.68	.42
Depress	-.83	-.17
Surprise	-.15	-.70
Ought	.35	.43

The second method of analysis is conceptually superior to the first because the factors represent fundamental, generic constructs, not mode-specific ones (however, since there are only two statements loading on each factor, the operationalization of these constructs may be only a rough measure of the underlying construct). Instead of a single overall opinion score for each mode, we have information on two component dimensions of opinion. This allows for greater depth of interpretation and policy analysis. For example, one's "affect" may favor one mode, while his "normative beliefs" favor another. Having information on each

Figure 10 AVERAGE FACTOR SCORES
GENERIC FEELINGS



variable rather than a single overall "opinion" enables us to see which of the two variables is more important in determining choice, and suggests specific ways to influence mode feelings.

There are no significant differences at the 0.10 level between Evanston and Chicago workers/students in the opinion factor scores themselves using multivariate analysis of variance (MANOVA) for both sets of opinion factors. Thus, we find that feelings are not significantly different between Chicago and Evanston workers either in structure or evaluation within that structure.

MODELS OF PREFERENCE AND CHOICE

The analysis of preference and choice is based on the two stage structure described in Figure 1. Perceptions and feelings determine preference. Preference and situational constraints determine choice. We first describe the sequence of analysis. Then, we discuss the correlation matrices for Evanston and Chicago workers/students. Next, we present the preference and choice models for Evanston work/school trips. We compare models with mode-specific opinions ("bus", "walk", and "car feelings") to models with generic opinions ("affect" and "normative beliefs"). Then, we present and discuss the parallel models for Chicago work/school trips. We also compare in general terms the models for work/school trips to the corresponding models for trips to downtown Evanston (Pas and Koppelman, 1979).

ANALYSIS PROCEDURE

The hypothesis represented in Figure 1 is that mode preference is a function of perceptions and feelings, while choice is a function of preference and situational constraints. A preliminary test of this hypothesis is provided by examination of the correlation across alternatives of the variables in the model. We expect system characteristics to be more highly correlated with perceptions than with preference or choice, perceptions and feelings to be more highly correlated with preference than with choice, and situational constraints to be most highly correlated with choice.

As a stronger test, we analyze (first) preference in a logit model whose explanatory variables are the perceptions and feelings factor scores (Koppelman and Hauser, 1979). We analyze choice in terms of a "preference index" (the sum, over perceptions and feelings variables, of the product of each variable and its coefficient estimate from the preference model)

and "autos per driver" (the operationalization of the situational constraints variable) (Koppelman and Pas, 1980). This model, in which the relative importances of perceptions and feelings on choice are determined by means of the reported preference, is compared to a model in which the relative importances are determined by the choice or "revealed preference" -- that is, in which choice is treated as a direct function of perceptions and feelings. Because the revealed preference model has more degrees of freedom, the goodness-of-fit measure for it will be higher than for the preference index model. However, if the paradigm of travel behavior which we are using is correct, we would expect the difference not to be statistically significant.

CORRELATION ANALYSIS

The correlation matrices for the Evanston and Chicago work/school data are presented in Tables 14 and 15, respectively. The correlations generally are consistent with our prior hypotheses. That is, system characteristics are more highly correlated with perceptions than with feelings, preference, situational constraints or choice. Perceptions and mode-specific opinions are more highly correlated with preference than with choice (except for psychological stress, where the correlations are essentially equal). Affect is more highly correlated with preference than with choice, but the reverse is true for normative beliefs. (This suggests the hypothesis that, as far as feelings are concerned, preference is basically a function of affect or liking, while normative beliefs may influence a person to choose a mode that he/she does not like or prefer the most. This hypothesis, which could only be identified by examination of generic opinions, is evaluated in the discussion of preference and choice models.) Autos per driver is largely uncorrelated with the system, perception, and feelings variables. However, autos per

Table 14. Correlation Matrix for Evanston Work/School Trips**

	Travel Time	Blocks to Bus	Bus Seat Availability	Convenience	General Service	Psychological Stress	Bus Feelings	Walk Feelings	Car Feelings	Affect	Normative Beliefs	Autos per Driver	Preference
Blocks to Bus	.21*												
Bus Seat Availability	.54*	-.07											
Convenience	-.14*	-.21*	.12										
General Service	-.21*	-.19	.19*	.05									
Psychological Stress	.04	-.13	.12	.04	.07								
Bus Feelings	.02	-.20*	.06	.49*	.30*	.36*							
Walk Feelings	-.16			.49*	.56*	.32*							
Car Feelings	.01			.29*	.29*	.25*							
Affect	-.04	-.25*	.01	.38*	.24*	.19*	.85*	.86*	.88*				
Normative Beliefs	-.07	-.07	.03	.33*	.26*	.10*	.64*	.76*	.41*	.23*			
Autos per Driver	-.08			.18*	-.00	.14			.06	-.01	.23*		
Preference	-.12*	-.05	.18	.31*	.42*	.11*	.38*	.42*	.30*	.29*	.38*	.29*	
Choice	-.05	-.06	.07	.25*	.36*	.12*	.34*	.42*	.23*	.23*	.43*	.19*	.54*

* significant α=.01

** The correlation between a pair of variables is computed only across the alternative(s) for which both variables are defined. For example, the correlation between autos per driver and other variables is computed for the car mode only. Similarly, correlations for bus seat availability are computed for the bus mode only. The correlations between convenience and normative beliefs, say, is computed across all modes.

Table 15. Correlation Matrix for Chicago Work/School Trips**

	Travel Time	Blocks to Bus	Seat Availability	Access Convenience	Access General Service	Access Psychological Stress	Line-Haul Convenience	Line-Haul Comfort	Line-Haul Travel Stress	Bus Opinions	Walk Opinions	Car Opinions	Line-Haul Car Opinions	Affect	Normative Beliefs	Auto Line-Haul Affect	Auto Line-Haul Normative Beliefs	Autos per Driver	preference	Choice
Blocks to bus	.12																			
Seat Availability	-.11	-.06																		
Access/Convenience																				
Access General Service				.31*																
Access/Psychological Stress				.10	.05															
Line-Haul Convenience	-.42*	-.25*	-.02																	
Line-Haul Comfort	-.32*	-.04	.18*				.07													
Line-Haul Travel Stress	-.14*	-.04	.18*				.05	.11*												
Bus Opinions				.33*	.40*	.41*														
Walk Opinions				.39*	.44*	.09														
Car Opinions				.16	.25*	.20*														
Line-Haul Car Opinions	-.40*						.33*	.01	.47*											
Affect				.42*	.24*	.18*				.88*	.89*	.93*								
Normative Beliefs				.26*	.31*	.13*				.57*	.70*	.47*		.25*						
Auto Line-Haul Affect	-.29*						.29*	.03	.39*				+.93*							
Auto Line-Haul Normative Beliefs							.36*	.04	.35*				.47*							
APD	-.04			.05	-.04	-.05	.06*	-.11	.09*			.02	.02	.00		.05	.00	.05		
Preference	-.43*			.32*	.15*	.14*	.33*	.10	.49*	.26*	.33*	.13	.44*	.19*		.24*	.29*	.52*	-.01	
Choice	-.32*	-.19*	.07	.27*	-.06	.06	.48*	.01	.24*	.10	.23*	.10	.44*	.13*		.11*	.27*	.53*	-.00	.58*

* significant $\alpha = .01$

** The correlation between a pair of variables is computed only across the alternative(s) for which both variables are defined. For example, the correlation between autos per driver and other variables is computed for the car mode only. Similarly, correlations for bus seat availability are computed for the bus mode only. The correlations between convenience and normative beliefs, say, is computed across all modes.

driver is more highly correlated with preference than with choice in the Evanston data and not correlated with either in the Chicago data. This correlation analysis provides general support for the conceptual structure except with respect to the role of autos per driver in mode preference and choice for trips to work or school. Later, we observe that autos per driver is not significant in choice models for either Evanston or Chicago work/school travel. Reasons for this result are suggested in discussion of those models.

EVANSTON WORK/SCHOOL TRIPS: Models with Mode-Specific Opinions

The preference model (with mode-specific opinions) for Evanston work/school trips is displayed in Table 16. The majority of the perceptions and feelings parameters are significant, and all have the expected sign. General service is estimated to be more important to preference formation than convenience. Psychological stress is unimportant, which suggests that the stress-related problems of congestion and safety are not important for work trips within Evanston.

The significance and relative magnitudes of the opinions parameters in this model which also includes perception variables indicates that measures of feelings, hitherto neglected in transportation demand modeling, are an important component of the travel decision making process and therefore deserve attention in future studies of this type. This result confirms the finding in our earlier analyses (Pas and Koppelman, 1979; Hauser and Wisniewski, 1980).

None of the "mode specific constants" are significant. This is desirable, since significant constants are a sign that the model is not well specified.

Table 16. Evanston Preference Mode-Specific Opinions**

		Parameter Estimate
GENERIC PERCEPTIONS	Convenience	.79*
	General Service	1.10*
	Psychological Stress	.13
MODE SPECIFIC OPINIONS	Bus Opinions	.88*
	Walk Opinions	.61*
	Car Opinions	.23
MODE SPECIFIC CONSTANTS	Bus Constant	-.86
	Walk Constant	-.31
	Car Constant	.14
	% correctly predicted	
	Unit weights	71.84
	Probability weights	62.01
	% information	48.46
	χ^2	225.6

* Significant at α=.05

**The opinions measures are represented by factor scores which are not mean centered. That is, the factor score values incorporate the average difference in mode feelings as well as individual differences. These factor scores have been adjusted so that the variance of feelings measures are equal to the variance for perceptions. Thus, parameter magnitudes can be directly compared, analogous to the use of regression beta weights.

The choice models for Evanston work/school trips are presented in Table 17. The parameters for perceptions and opinions in the preference index model are obtained indirectly as the product of their parameters in the preference model and the parameter of the preference index in the choice model (Koppelman and Hauser, 1979).

The same perceptions and feelings variables are significant here as in the preference model. However, the mode-specific constants are now significant as well, indicating that we are not entirely capturing the determinants of choice. The fact that the constants are insignificant for the preference model suggest that the problem is in the other component influencing choice, namely situational constraints.

Autos per driver, the operationalization of the situational constraints construct, is not significant in either the preference index or revealed preference choice model. A possible reason for this is that workers, especially full-time workers, may have priority use of the automobile if desired, so that general automobile availability does not sufficiently discriminate between those who choose their first preferred mode and those who do not. A more situation-specific variable, such as automobile availability for this particular trip, would better represent the relevant constraint.

Comparing the chi-squared goodness-of-fit statistic of the preference index model to that of the revealed preference model indicates that the former model is not statistically different from the latter at the .05 level of significance. Hence we obtain the conceptual advantage of the intermediate preference index formulation without losing anything significant in terms of goodness-of-fit.

Table 17. Evanston Choice Mode-Specific Opinions**

		Preference Index	Revealed Preference
	Autos per Driver	.42	.32
GENERIC PERCEPTIONS	Convenience	.48*	.86*
	General Service	.67*	.42*
	Psychological Stress	.08	.23
MODE SPECIFIC OPINIONS	Bus Opinions	.54*	.38*
	Walk Opinions	.37*	.60*
	Car Opinions	.08	.23
MODE SPECIFIC CONSTANTS	Bus Constant	3.12*	4.35*
	Walk Constant	3.30*	3.15*
	Car Constant	3.30*	3.92*
	% correctly predicted		
	unit weights	73.49	75.72
	probability weights	59.86	61.63
	% information	46.66	48.77
	χ^2	215.9	225.7
		9.8_5 (NS)	

* Significant at α=.05

** see footnote on Table 16

EVANSTON WORK/SCHOOL TRIPS: Models With Generic Opinions

"Feelings" were operationalized as mode-specific variables in the models of Tables 16 and 17. We previously argued that it is conceptually superior to operationalize feelings as generic constructs. In this section, we compare the statistical performance of generic feelings constructs to mode specific feelings in models of preference and choice.

The Evanston preference and choice models with the "affect" and "normative beliefs" feelings variables are shown in Tables 18 and 19. Comparison between the preference models using different feelings constructs (Tables 16 and 18) indicates that the perception variables have similar parameters in both models and the overall measures of goodness-of-fit are approximately the same. The comparison between choice models (Tables 17 and 19) provides similar results.

The affect and normative beliefs variables are both significant, in both preference and choice models, except for affect in the revealed preference model which was earlier rejected for conceptual reasons. We can assess roughly the relative contributions of perceptions and feelings variables to preference and choice formation by comparing the sum of the (absolute values of the) coefficients for each set of variables (this provides useful interpretation information since all the perception/opinions variables have been structured to have equal variance). For the preference and preference index models, perceptions account for 60% of the combined weight and feelings account for 40%. In the revealed preference model, perceptions account for 53% and feelings for 41% of the combined perceptions/feelings weights. Again, this demonstrates the importance of feelings to modeling the choice process.

Table 18. Evanston Preference
Generic Opinions

		Parameter Estimate
GENERIC PERCEPTIONS	Convenience	.70*
	General Service	1.08*
	Psychological Stress	.11
GENERIC OPINIONS	Affect	.41*
	Normative Beliefs	.58*
MODE SPECIFIC CONSTANTS	Bus Constant	.18
	Walk Constant	.18
	Car Constant	.08
	% correctly predicted	
	unit weights	70.69
	probability weights	61.80
	% information	48.42
	χ^2	225.4

* Significant at α=.05

Table 19. Evanston Choice
Generic Opinions

		Preference Index	Revealed Preference
	Autos per Driver	.37	.24
GENERIC PERCEPTIONS	Convenience	.49*	.67*
	General Service	.75*	.41*
	Psychological Stress	.09	-.21
GENERIC OPINIONS	Affect	.28*	.19
	Normative Beliefs	.40*	.69*
MODE SPECIFIC CONSTANTS	Bus constant	3.66*	4.17*
	Walk Constant	3.57*	3.64*
	Car Constant	3.19*	3.82*
	% correctly predicted		
	unit weights	72.83	75.72
	probability weights	61.75	63.73
	% information	49.12	51.80
	χ^2	227.3	239.7

$12.4_4(\alpha=.025)$

* Significant at $\alpha=.05$

The goodness-of-fit of the revealed preference model is better at the .025 level of significance than that of the preference index model, but because of (a) the insignificance of "affect" and the counter-intuitive sign on "psychological stress" for the revealed preference model, and (b) the managerial advantages of the intermediate analysis, we prefer the preference index model.

More importantly, however, we obtain useful insight by comparison between the preference index and revealed preference models. Specifically, the importance of normative beliefs relative to affect is greater in the revealed preference choice model than in the preference index choice model. This supports the hypothesis suggested earlier that the importance of normative beliefs is greater in choice than in preference formation.

Most importantly to this aspect of the analysis, we note that the chi-squared and information statistics are virtually identical between the two preference models of Tables 16 and 18, while for the choice models, they are higher for the generic constructs operationalization. This provides some empirical support for the superiority of the generic constructs.

CHICAGO WORK/SCHOOL TRIPS

We compared the two ways of measuring feelings in preference and choice models for Chicago trips as well, and found similar results. That is, the perceptions coefficients were comparable in magnitude and significance, while the chi-squared and information statistics were higher for the models containing the generic contructs. Therefore, we present only those models with generic feelings measures for Chicago. These models appear in Tables 20 and 21.

Table 20. Chicago Preference Generic Opinions

		Parameter Estimates
GENERIC PERCEPTIONS ACCESS MODES	Access Convenience	.68*
	Access General Service	.63*
	Access Psychological Stress	.06
GENERIC PERCEPTIONS LINE-HAUL MODES	Line-haul Convenience	.25
	Line-haul Comfort	.14
	Line-haul Travel Stress	.86*
FEELINGS-ACCESS MODES	Affect	.03
	Normative Beliefs	.53*
FEELINGS LINE-HAUL MODES	Auto line-haul Affect	.27*
	Auto line-haul Normative Beliefs	.74*
MODE SPECIFIC CONSTANTS	Bus Constant	1.74*
	Walk Constant	2.13*
	El Constant	-1.82*
	Train Constant	-1.93*
	% correctly predicted	
	unit weights	72.41
	probability weights	64.40
	% information	50.29
	χ^2	234.5

* Significant at α=.05

Table 21. Chicago Choice
Generic Opinions

		Preference Index	Revealed Preference
GENERIC PERCEPTIONS ACCESS MODES	Access Convenience	.49*	.08*
	Access General Service	.46*	.48*
	Access Psychological Stress	.04	-.15
GENERIC PERCEPTIONS LINE-HAUL MODES	Line-haul Convenience	.18	.67*
	Line-haul Comfort	.10	.08
	Line-haul Travel Stress	.62*	.70*
FEELINGS-ACCESS MODES	Affect	.02	-.37
	Normative Beliefs	.39*	.68*
FEELINGS LINE-HAUL MODES	Auto line-haul Affect	.20*	.06
	Auto line-haul Normative Beliefs	.54*	+.66*
MODE SPECIFIC CONSTANTS	Bus Constant	.15	-.45
	Walk Constant	2.94*	3.35*
	El Constant	-2.42*	-2.26*
	Train Constant	-3.35*	-2.89*
	% correctly predicted		
	unit weights	77.01	78.16
	probability weights	67.89	70.47
	% information	56.36	60.37
	χ^2	262.8	281.5
		$18.7_9(\alpha=.03)$	

* Significant at $\alpha=.05$

"Psychological stress" is the only perceptual characteristic of access modes which is not significant (as for Evanston work trips), while "travel stress" is the only perceptual characteristic of line-haul modes which is significant. Apparently, the important variables for the access portion of the trip are convenience and general service, which are related to the ease of making connections to the line-haul mode (see Table 9 for the constituent attributes). Psychological stress/safety doesn't seem to be important. This may be due to the short length of the access link or because all access modes meet some implicit minimum standard of psychological comfort. However, travel stress is evidently an important factor in the choice of mode for the longer line-haul portion of the trip.

The goodness-of-fit for the revealed preference choice model is significantly better than for the preference index choice model at the .03 level of significance. However, not only is the insignificant "psychological stress" coefficient negative, but the "affect" parameter is also estimated to be negative and marginally significant. The implication that a higher affect, or liking, for a mode makes one less likely to choose it is untenable. Neither of these models include the autos per driver variable as it has the incorrect sign and is negative in Chicago choice models which include it.

We have drawn comparisons throughout between the perceptions of the same alternatives when used as access modes for trips to Chicago and when used as local modes for the entire trip to work. We found similar perceptual dimensions (convenience, general service, psychological stress), and similar evaluations on those dimensions. Now we compare the relative importance of those dimensions in determining preference and choice. Evanston workers rate general service as somewhat more important than convenience, with psychological stress having relatively little importance (Table 16).

However, Chicago workers rate general service to be slightly less important than convenience. The importance of psychological stress is still weak. The slight increase in relative weight given to convenience may be traced to the increased importance of such convenience attributes (Table 7) as "on time", "available when needed", "get to destination quickly", and "no long waits" when a mode is used as part of a more complex (multi-modal) trip.

COMPARISON TO NON-WORK/SCHOOL MODEL

Since the perceptions factor analyses are not comparable between the study of non-work/school trips to downtown Evanston (Pas and Koppelman, 1979) and the study of trips to work/school, the individual coefficients in the preference and choice models are also not comparable. However, it is interesting to examine the relative contribution of each set of variables (perceptions, feelings, autos per driver) to explaining preference and choice. We do this by analyzing the percent of remaining information (analogous to the partial R^2 measure) provided by adding each set of variables to a model including all of the preceding variables.

The percent of remaining information explained by each set of variables for downtown Evanston, Evanston work/school, and Chicago work/school travel is presented in Table 23 for both preference and choice models. The market share variables reflect the degree to which the mode shares are unequal within each data set.

Perceptions contribute 30 to 40 percent additional information in perception models and 25 to 30 percent in choice models for all three studies. Feelings contribute substantially more information to the explanation of work travel than to the explanation of non-work travel in the local area. This suggests that feelings may be more important in the selection of modes in repetitive travel than for infrequent trips.

Table 23. Percent of Remaining Information Explain Comparison of Downtown Evanston and Work/School Models

	Downtown Evanston	Evanston Work/School	Chicago Work/School
Market Share	27.3	16.6	12.7
Perceptions	37.0	31.8	32.2
Feelings*	8.5	9.3	16.1
		Choice (Revealed Preference)	
Market Share	29.0	26.7	32.1
Autos per Driver	5.4	1.6	-
Perceptions	26.2	24.6	30.8
Feelings*	3.8	11.4	7.1

* "Feelings" are mode-specific for downtown Evanston and generic for work/school.

The magnitude of the remaining information explained measures reported in Table 22 are influenced by the order in which the sets of variables are evaluated. If the order of the perceptions and feelings variables were reversed, the apparent influence of feelings would be increased and of perceptions would be decreased. Thus, the small magnitude of the remaining information explained by feelings relative to perception understates the true importance of the feelings measures in explaining travel choice behavior.

Autos per driver contributes more information about travel choice for non-work/school trips than for work/school trips. This result seems, as stated earlier, to represent the idea that general car availability may be less of a constraint for work travel than for other trips.

Overall, the results reported above identify strong similarities in the identification of the relative importance between autos per driver, perceptions, and feelings. They also identify important differences in the importance of each of these sets of variables in different choice contexts.

SUMMARY

This report presents the third application of the COTS methodology, this time to work/school trips. Here, as before, the conceptual model is validated through significant statistics and interpretable results for the empirical models. That is, we have i) found support for the use of factor analysis as a meaningful way of quantifying perceptions and feelings, ii) verified that perceptions and feelings are significant in determining preference, and iii) verified that it is useful to model choice as a function of the intermediate preference index rather than as a direct function of perceptions and feelings.

There are several important additional results of this study. First, we find that the perceptual space for Evanston local and Chicago access modes is similar and the perception spaces for access and line-haul modes are different. Apparently, the same structure is used to evaluate a mode regardless of whether it is used as an access mode for a longer trip or used for the entire (local) trip. However, line-haul modes are evaluated along a different set of dimensions.

Second, not only are the perceptual dimensions the same for Evanston local modes as for Chicago access modes, the rating of the modes along those dimensions are also quite similar, except with respect to general service. Car and bus are perceived as being more serviceable for Evanston trips than for Chicago access trips; the reverse is true for walk. The weighting of the perceptions of the local modes in preference formation is also similar between Evanston and Chicago workers. Psychological stress is insignificant in both cases, and general service is the most important dimension for each. Convenience is more important for Chicago workers than for Evanston workers, presumably because of the necessity of using the access mode to connect with another mode.

Third, the generic opinions formulation of the feelings component of the model provides a superior interpretation to the mode-specific opinions formulation. This is an important conceptual result since predicting the response to a new mode can be more easily undertaken when the variables are generic. Further, information on two aspects of feelings provides better insight than a single composite score for each mode. In particular, we find evidence to support the idea that normative beliefs are more important in explaining choice than preference while affect is more important in explaining preference than choice.

Future studies incorporating feelings variables should improve the construct validity by providing a broader range of opinion statements in the survey instrument.

Fourth, autos per driver is not significant in any of our choice models. We hypothesize that workers generally get priority use of the automobile, and therefore that autos per driver is not a useful measure of situational constraints in this context.

Finally, we compared the work/school models in general terms to those for trips to downtown Evanston. We found that in each case, perceptions explained about the same amount of information beyond that contained in a market share model. The addition of feelings provided more information for work/school trips than for trips to downtown Evanston. This suggests that there are important similarities and differences in the choice processes for travel for different trip purposes.

These results support and extend the Consumer Oriented Transportation Service Planning approach. Further clarifications of the importance of attitudinal measures is provided. An improved representation of the feelings measure is shown to be superior to that previously used. Important differences between travel to work/school and other trips are identified.

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