Effectiveness of Transit Strategies Targeting Elderly People

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Abstract

The problem of the aging population has brought new challenges for transportation researchers. The Department of Health and Human Services predicts by the year 2030, the elderly population (65+) in the US will approximately double. As the percentage of seniors rapidly increases within the population, it becomes more important to provide them with innovative transportation alternatives that help them maintain their independence while also assuring the safety and comfort of other transit users. Exploring the strategies that can improve seniors' perception of the public transit system was the main goal of this study. A comprehensive survey was designed and seniors' travel attributes in the Chicago Metropolitan Area were collected. The survey covered four common trip purposes (shopping, doctor visit, social, and work) and different travel modes available in the Chicago region including various combinations of non-motorized, auto drive, and the three commonly used public transit modes of Metra Commuter Rail, Chicago Transit Authority (CTA) and PACE Suburban Bus. Survey respondents were also asked to provide their opinions about the existing and alternative transit services within the region. A descriptive analysis of the stated preference data was then conducted. The results of the analysis represent seniors' preferred alternatives and effective strategies for system improvement. Policy analysis using the modeled results examines the effective factors that could be considered and applied to improve transit services to encourage senior citizens to use public transportation facilities more often.

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1.0 Introduction

The United States experienced a baby boom during the 1946-1964 postwar period. This event will soon result in the doubling of people in the US population aged 65+, causing drastic changes to the transportation system. The Census data suggest that 12.4% of the total US population of 282 million in the year 2000 were 65 years of age or older. According to the US Census Bureau, the elderly population (65+ years old) was estimated at 36.8 million in 2005, presenting an increase of 1.8 million since the year 2000. More importantly, the number of Americans aged 45-65 who will reach 65 over the next two decades increased by 38% during a one decade period.

The US Department of Health and Human Services reported that 3.6 million seniors lived below the poverty level in 2002, while another 2.2 million were classified as "near-poor". The median annual income of older persons in 2002 was $19,436 for males and $11,406 for females (U.S. Department of Health and Human Services, 2003). According to the Federal Highway Administration's (FHWA) 2001 National Household Travel Survey (NHTS) data, while 1.6% of the total 642,292 trips surveyed were transit trips, only 10.3% of transit users were elderly, accounting for only 0.2% of the nearly trips 643,000 surveyed. While transit use by the elderly does not appear to differ significantly from the overall population, there may be opportunities to increase transit use within this particular segment.

As the percentage of elderly people rapidly increases within the population, it becomes more important to provide them with innovative transportation alternatives that would help them maintain their independence while also assuring the safety and comfort of other transit users. As a result, public transit providers should examine different short- and long-term strategies for attracting more senior riders by addressing their preferences and expectations and by meeting their needs and limitations. Unfortunately, little is known about the factors that can influence seniors' preferences and travel behavior, making this an important research topic.

In the Chicago Metropolitan Area, the Chicago Transportation Authority (CTA) provides public transportation services including bus and rail services in Chicago downtown and surrounding areas. Moreover, PACE bus service provides bus services in Chicago suburban areas and para-transit services in the Metropolitan Area. Additionally, *Metra* provides public rail transit services to Chicagoans who want to make trips between Chicago downtown and the suburbs. These agencies utilize many strategies targeting seniors and the handicapped in order to offer better services to transit users and attract more none-transit users. These strategies include; accessible ramps to the stations, buses equipped with lifts for wheelchair users, priority seats for seniors and handicapped people, visual and vocal information systems inside the buses and trains for those who have visual or hearing impairments, and many other strategies. However, the portion of seniors who make their trips using transit in Chicago Metropolitan Area is still very small. Therefore, other innovative and more interesting strategies should be considered to encourage seniors to give up the driving mode and use transit as an alternative mode of transportation.

It has been suggested in the literature that lack of knowledge and confidence to use transit is one of the most significant factors that prevent seniors of using public transportation (Coughlin and Lacombe, 1997). Therefore, other alternatives that have not been utilized in Chicago region, such as fixed route transit services designed specifically for seniors or providing real time waiting information might be attractive to senior travelers. In a large metropolitan area like Chicago, providing a transit service, in which both frequency and service coverage are high, might be impossible. Hence, a practical solution specially designed for seniors can be providing

"door to station" services for seniors so that their wait time decreases and using transit services becomes more attractive for them.

In this study; a comprehensive survey was conducted to explore seniors' expectations and preferences about the transit system. Detailed travel characteristics were collected for the four different trip purposes of shopping, doctor visit, social or recreational, and work. The survey result provides key information about the characteristics of different trip types made by seniors. Transit users were also asked to rank existing transit services in the Chicago Metropolitan area by answering questions about transit system attributes and ranking various characteristics of the existing transit system. The questionnaire consisted of five parts; the first four sections covered trip attribute questions for each trip purpose as well as stated preference, opinions, and system rankings. The last section of the questionnaire asked respondents about the socio-demographic characteristics of the individual and household including location, income, age, ethnicity, number of vehicles, *etc*.

The survey results provide the opportunity to analyze various policies that may improve the transit system and increase elderly transit ridership. Additionally, the survey results facilitate evaluation of seniors' perception of transit services. This can be used to develop strategies targeting senior travelers and to encourage them to use transit more often. Due to the lack of other available data sources of transportation planning applications for the elderly, it was felt necessary to increase the response rate and enhance the quality of the completed questionnaires as much as possible. Therefore, various strategies suggested in the travel survey methods literature were applied with the goal of evaluating options that may increase survey response rate. It is worth noting that some of the common approaches used in other surveys to increase response rate were not found to be effective for senior respondents.

The rest of the paper is organized as follows: the next section provides a brief review of the literature and previous studies related to seniors' travel behavior, then, the structure of the survey questionnaire designed for this study and definitions of different scenarios tested are presented, followed by empirical results and a descriptive analysis of the survey data. A final section presents conclusions and recommendations.

2.0 Background

The aging of the generation born during the 1946-1964 baby boom period in the US will bring about new challenges for transportation agencies and transit service providers. In order to handle the transportation problems that the trip patterns of this age group will bring about in near future, several studies have attempted to analyze and understand the travel pattern of seniors and have recommended various strategies to improve transit level of service. It has been projected that the number of 65+ seniors will double from almost 35 million to nearly 70 million by 2030.

Rosenbloom (2003) shows that in year 2003, 56% of seniors lived in the suburbs and 23% lived in rural areas. She predicted that this demographic pattern will remain steady or increase until 2030. Many of these seniors drove more than 85% of the time and used public transportation less than 3% of the time. This travel pattern of the elderly may help policy makers picture the situation of the future transportation system as well as environmental, land use, and congestion conditions, if no realistic solution is considered to shift the travel pattern of seniors from predominantly driving automobiles to using transit services more often.

Another new challenge brought about by the increased number of seniors is that it is projected by 2020 over 80% of all Americans including seniors will be licensed drivers,

including the 100% of males and 60-90% of females who will retire as licensed drivers (Burkhardt *et al.*, 1998; Evans, 1999; Rosenbloom, 2001 and Alsnih and Hensher, 2003). Studies have shown that individuals tend to maintain their travel behavior even after a lifecycle change, therefore, it is expected that the seniors of 2030 will still prefer to use their private car rather than changing their travel mode. The expected increase in the number of aged licensed drivers is significant and should be carefully considered in order to prevent or alleviate the effects of the projected traffic situation and safety related problems in the near future. Planning for and solving the impending senior traffic problem requires understanding their needs and the traffic attributes which affect their mode choice. If the influential factors that affect seniors' travel behavior are not known, useful and practical solutions may not be offered to mitigate the anticipated congestion and safety problems.

Contrary to common belief, seniors do not reduce their number of trips once they retire. Bush (2005) found that 75 years of age can be considered the time when a decrease in travel occurs. There are many factors influencing seniors' travel choices. Stern (1993) found that age, sex, marital status, education level, and walking difficulties have greatly affected seniors' transportation decisions. Schmocker, *et al*., (2005) further asserted that disabilities (particularly, walking difficulties), household structure, ethnic background, difficulty in understanding directions, age, car availability, geography, possession of a drivers license, and household income have significantly influenced the number of trips seniors and people with disabilities make.

Consequently, before recommending any policy alternatives to change seniors' travel behavior and encourage them to use transit more, it is important to understand the severity of the problem and to identify the important influential factors. Rosenbloom (2003) recommended explicitly planning for seniors' mobility needs by targeting public transit services and facilities that are specifically planned for seniors, supporting alternative public transportation options, and improving highway and street infrastructure. Applying market research techniques, Koffman (2001) compared different improvements and technologies that may motivate seniors to use public transportation more frequently. He concluded that bus stop information, telephone information, and vehicle clearance are the least attractive improvements for seniors. The U.S. Department of Transportation (2003) recommended developing and evaluating public transportation best practices for seniors and developing comprehensive, one-call-does-it-all mobility managers to coordinate local providers and their services. These approaches, however, can be very challenging, especially in suburban or rural communities. In another study, Burkhart and Eberhard (2003) looked at seniors' transportation mobility issues and emphasized that low-density areas need more cost-effective public transportation solutions.

For more than a decade, researchers have considered issues related to transportation in an aging society. In 1999 a conference with topics related to the problems caused by increased elderly population, was held in Bathesda, Maryland and reported in the proceedings of the Transportation Research Board (TRB, 1999). As reported by many researchers, it appears that the availability of practical information and datasets is one of the biggest challenges in studying seniors' travel behavior. This limits our ability to examine strategies that can increase senior transit ridership. Therefore, there is a vital and urgent need to evaluate strategies that are able to encourage seniors to give up driving and switch to transit alternatives.

In this study, a survey of the elderly was designed and conducted to collect the required data from the senior population in the Northeastern Illinois region. Senior travel attributes and needs were collected, making it possible to evaluate the effectiveness of various policy scenarios

and service or technology solutions in the Chicago Metropolitan Area. The survey was designed considering guidelines recommended in Stopher *et al.* (2004).

3.0 Survey Structure

The survey questionnaire designed for this study was five pages long on legal size paper and was prepared in booklet form. It contained all the critical questions in an easy-to-read format. The font was *Times New Roman* and the letter size was no smaller than 12 points per inch to allow for easy reading. The booklet format made this survey as manageable and as easy to grasp as possible.

The questionnaire had five parts. Each of the first four parts focused on a particular type of trip: the respondents' most recent shopping trip; doctors' visit; social/recreational trip and work trip. Each of these parts listed the trip type in boldface, followed by symbols that illustrated the trip type. This may have helped respondents focus on the trip type being discussed. The research team placed the most common trip types first to increase the likelihood that respondents would answer the questions.

The fifth part was shown at the end of the booklet because it asked about respondents' socio-economic information. Given the personal nature of this data, the research team wanted to develop a rapport with the respondents before asking them personal questions. They also used euphemisms, which would likely increase respondents' willingness to answer these questions (such as using physical limitations for physical disabilities). To help respondents recall their travel behavior, the research team only asked respondents about their most recent trip for each of the above trip types. This technique seemed to increase the quality of the answers.

In each of the first four sections, the research team asked respondents about their most recent trip characteristics, including their travel mode, trip frequency, trip length, origin, and destination. Other questions included trip cost, if any; trip length; waiting time for the vehicle, and mode of travel from the transit stop to the final destination, if public transportation were used. These strategies and alternatives were selected from those suggested in the literature as the most preferable alternatives to resolve problems resulting from the increase in senior population (Stopher *et al.* 2004 and Smiley 1999) The respondents were also asked about potential incentives that might encourage them to switch to public transportation or use it more frequently, including service improvements and technological conveniences. The service improvements were:

- Reducing fares;
- Providing shuttle access to public transportation;
- Having brochures with schedules;
- Having brochures, which describe how to use transit;
- Increasing service frequency;
- Operating more services on weekends and holidays;
- Operating fixed routes specifically planned for seniors;
- Adhering to the schedule more;
- Adding early morning or evening services;

and the technology solutions were:

- Providing more wheelchair lifts and ramps;

- Having lower height buses;
- Providing audio-visual displays;
- Installing station telephones;
- Providing Braille signage;
- Displaying real time expected wait time information at stops and stations; and
- Providing real time transit information on cell phones.

The subsequent section of the general trip attributes asked the respondent if he/she made his/her most recent trip biking, walking or using a wheelchair, and what the travel time for the trip was. If the respondent made the trip using any transit services, the non-motorized mode attributes section was skipped and questions about the cost and attributes of the transit mode were answered.

In the transit attributes section, initially, the respondent was asked how they paid the transit fare including cash\single ticket, 10-ride ticket, Monthly Transit Pass, Chicago Card Plus and several other options. Next, it was asked whether a reduced fare was used and then in-vehicle travel time and transit wait time were recorded. Alternatives to transit were the topic of the next question which provided information about the mode that might be used if transit were not used. The cost of transit was the last question in this part, followed by questions asking respondents to rate the quality of transit services. The rating table questions required the respondent to rate the service and equipment provided by the transit service that was used in the most recent trip. Finally, the last section in each trip purpose was about the cost and travel time if auto drive or taxi modes were used. The same structure was repeated for the other trip purposes.

The only difference among the question sheets for different trip purposes was that there was an option box "*same as shopping trip"* in doctor visit, social and recreational, and work trip question sheets that allowed respondents to check mark it if answers to some of the questions such as improvements and technologies and transit ratings are the same as their response on the shopping trip question page.

In the final section, the research team asked about respondents' socio-economic attributes, such as age, ethnicity, income, residence, vehicle ownership, cell phone and/or Internet use, and employment status. The research team also asked the respondents whether they could contact them with follow-up surveys and/or phone calls.

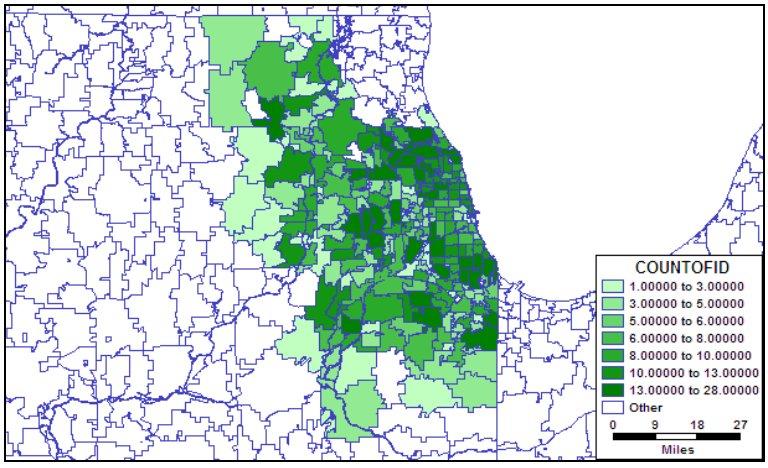
4.0 Experimental Results and Data Analysis

4.1 Response Rate and Sample Validation

Out of 1500 questionnaires mailed out to a randomly drawn county-based list of seniors in the region, 280 complete and useful questionnaire booklets were received. Seniors were recruited from a stratified sample of seniors by county of residence, based on the distribution of population in each county. Spatial distribution of the sample population by zip code is presented in Figure 1 that seems to be consistent with the population distribution in the area.

Response rates tend to deteriorate with the age cohort of the respondents, as Kaldenberg *et al.*, (1994) presented in their paper. Nevertheless, the response rate obtained in this study seems to be a little below the best recommended response rates. However, the average response rate for surveys without pre-notification and incentive in mail surveys for the whole population is only about 22% (Larson and Poist, 2004).

Figure 1
Spatial distribution of mailed questionnaires in Chicago region



For validation purposes, the data obtained from the returned questionnaires were compared with Census 2000 data. The Kolmogorov-Smirnov statistic (Chakravarti *et al.*, 1967 and Eadie, *et al.*, 1971) is used to test whether two underlying one-dimensional probability distributions vary, or whether an underlying probability distribution differs from a hypothesized distribution. The hypothesis that Census 2000 and the results of this study have the same distribution was tested using a 0.05 confidence level.

Table 1 shows the distribution of people within each county. It can be seen in Table 1 that percentages are close to the statistics from Census 2000 except for Cook County where a majority of minorities reside. Based on Kolmogorov-Smirnov test results (D=0.23776) the null hypothesis of no difference is not rejected at the 0.05 confidence level.

Table 1
Distribution of respondents in each county

County	Total	Percentage	Census
Cook	178	63.56%	72.40%
DuPage	38	13.58%	10.20%
Kane	19	6.78%	3.90%
Lake	20	7.14%	6.32%
McHenry	13	4.64%	2.44%
Will	10	3.57%	4.78%

In a similar manner the sample was validated against Census 2000 data for distribution of household vehicle ownership by county and distribution of different age groups in the six in neither case was the null hypothesis rejected of representation rejected by the Kolmogorov-Smirnov test.

The total number of seniors in each county is also consistent with the data in the Census. In other words, the distribution of seniors in the sample within the six counties studied is similar to the actual distribution of seniors reported by the Census. As previously mentioned, the

research team recruited respondents from a random sample of senior residents in the Chicago region, which was stratified by population distribution in each county from U.S. Census data.

In general, 58 percent of the respondents were at the ages between 66 and 75 and the rest were older than 76 years, Almost 51 percent of them had access to the Internet, 68 percent had cell phones, 90 percent had drivers' license, and 28 percent of the senior respondents reported some form of disability.

As mentioned before, four different trip purposes were asked about in this survey. Results show that 96% of the people answered the shopping trip questions, 91% doctor visit and social or recreational trips and just 35% work trip questions. This suggests that as expected the majority of the respondents were retired and the first three trip types were the dominating types.

4.2 Stated Preference Analysis

The answers to the set of questions about preferred technologies and improvements that may encourage seniors to use transit more often are grouped by trip purposes in Tables 2 and 3.

Table 2
Descriptive Analysis of Transit Technologies Grouped by Trip Purpose (Percentages in brackets)

	Providing more wheelchair lifts and ramps	Lower height buses	Audio-visual displays	Station telephones	Braille signage	Real time expected wait time information displayed at stop	Real time transit information available by cell phone	Others
Doctor	10(6.5)	32(21.0)	6(3.9)	13(8.5)	1(0.6)	64(42.1	22(14.4)	4(2.6)
Shopping	13(7.5)	34(19.6)	5(2.8)	17(9.8)	0(0.0)	70(40.4	24(13.8)	10(5.7)
Social/recr.	7(5.2)	27(20.3)	5(3.7)	13(9.7)	0(0.0)	57(42.8	20(15.0)	4(3.0)
Work	1(1.9)	9(17.6)	3(5.8)	3(5.8)	0(0.0)	23(45.1	11(21.5)	1(1.9)

Table 2 presents the number of respondents who answered the preferred technology questions in the questionnaire. As can be seen, real time expected wait information seems to be perceived as the most effective technology among all groups together with lower-height buses. It is interesting to note that for work trips, people valued real time transit information provided to them on their cell phone more than lower height buses, perhaps because working seniors may have fewer mobility problems than those who are retired. Although, real time information provided by either cell phone or at the stations might be interesting to other age cohorts, seniors might be the main group that benefit from these types of improvement more than other age groups. However, lower height buses are among the technologies in which seniors (the age group with largest mobility restrictions) are more interested in. Additionally, as was noted in the literature review section, long waiting times and lack of knowledge, are two of the main factors which deter seniors from using public transportation. Hence, any technology that can provide

real time transit information and reduce wait time might significantly increase the seniors' transit usage.

Another set of questions asked seniors about improvements that may encourage them to give up using their private vehicle and use transit or use transit more often. Table 3 presents the summary of the proposed improvements grouped by trip purpose. The results imply that printing brochures that provide the transit schedule, increased frequency of services, and fixed routes specially planned for seniors are the most attractive alternative among those presented.

Table 3
Proposed Improvements Grouped by Trip Purpose
(Percentages in brackets)

	Brochures describing how to use transit	Early morning or evening services	Adhering to the schedule more	Reducing the fares	Shuttle access to transit	Brochures providing the schedule	Increasing the frequency of services	More services on weekends and holidays	Fixed routes specially planned for seniors	Others
Doctor	27(8.0)	15(4.4)	19(5.6)	43(12.7)	36(10.6)	59(17.5)	54(16.0)	22(6.5)	50(14.8)	12(3.5)
Shop	35(9.1)	16(4.2)	22(5.7)	53(13.9)	41(10.7)	62(16.2)	59(15.4)	24(6.3)	57(14.9)	12(3.1)
Soc/rec.	28(9.0)	17(5.4)	21(6.7)	35(11.2)	34(10.9)	52(16.7)	47(15.1)	29(9.3)	39(12.5)	9(2.8)
Work	2(1.4)	13(9.7)	8(5.9)	7(5.2)	16(11.9)	11(8.2)	23(17.1)	21(15.6	8(5.9)	25(18.6)

Table 3 summarizes the average number of seniors who are interested in different improvements for transit system enhancement. The most attractive improvement that seniors stated in this study was to provide brochures giving information about transit schedules. Additionally, increasing the frequency of service and fixed routes specially planned for seniors were found to be the second and third most liked alternatives. Similar to the results of Table 2, work trip preferences are different from other trip purposes. For instance, information provided by brochures is less necessary for work trip purposes; instead, more services on weekends and holidays are preferred. Similarly, results presented in Table 3 support those from Table 2, that improvements that can provide more information about the schedule of the transit services are an important factor for seniors. Moreover, seniors are interested in any types of technologies or improvements that can reduce their waiting time such as providing fixed routes specially designed for seniors.

4.3 Transit Performance Analysis

Besides providing information about their preferences, the respondents were asked to rate their satisfaction with existing transit services, highlighting its strengths and weaknesses. Table 4 shows respondents' average satisfaction ratings with Northeastern Illinois' existing transit services. These ratings could range from "1" meaning highly dissatisfied to "5" meaning highly satisfied. The results presented in Table 4 imply that, although PACE suburban bus's overall quality of service seems to be generally better than Chicago Transit Authority (CTA) services, it

is clear that respondents value the fact that CTA provides better services during non-peak hours of early morning, late evening and on Saturdays and Sundays. Standard deviation is also shown for the total values.

Table 4

Average rankings by different trip purposes for two transit providers (CTA and PACE)

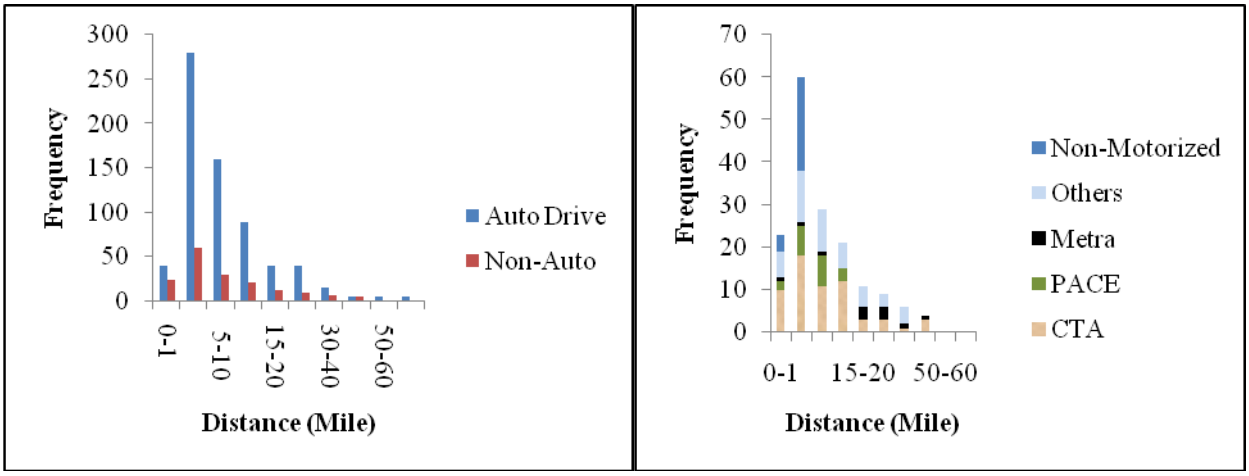
	Doctor visit				Shopping				Social/Recreational				Work			
	Total	St.Dev.	PACE	CTA	Total	St.Dev.	PACE	CTA	Total	St.Dev.	PACE	CTA	Total	St.Dev.	PACE	CTA
Overal Service	3.85	0.90	4.60	3.62	3.87	0.83	4.00	3.64	4.07	0.89	4.60	3.54	4.35	0.74	0.00	4.22
Service coverage	3.68	0.99	3.50	3.84	3.80	0.76	3.71	3.70	3.81	0.90	3.75	3.54	4.21	0.80	0.00	4.20
Reliability	3.54	0.97	4.50	3.53	3.65	0.98	4.00	3.61	3.84	1.08	4.80	3.18	3.93	1.03	0.00	3.80
Courtesy of driver	4.11	1.07	4.20	4.20	4.18	0.84	4.25	4.20	4.39	0.94	4.80	4.00	4.46	0.74	0.00	4.60
Cleanliness of vehicle	3.50	0.90	4.40	3.26	3.46	0.87	3.75	3.14	3.59	1.21	4.00	3.00	3.93	0.85	0.00	3.72
Comfort on board	3.66	0.76	4.40	3.50	3.58	0.86	3.75	3.54	3.73	1.04	4.40	3.18	3.93	0.79	0.00	3.80
Noise on board	3.30	0.87	3.25	3.28	3.00	0.86	3.00	2.75	3.26	1.09	2.75	3.10	3.66	0.97	0.00	3.50
Cost of transit	3.61	1.23	4.60	3.53	3.53	1.10	4.00	3.23	3.96	0.91	4.40	3.54	4.00	1.07	0.00	4.10
Route information	3.63	1.17	3.75	3.77	3.50	1.14	3.71	3.18	4.04	1.08	4.40	3.44	3.78	0.97	0.00	3.55
Shelter availability	3.19	1.07	2.00	3.44	3.42	0.98	3.60	3.15	3.30	1.30	3.50	2.91	4.15	0.80	0.00	3.88
Service Frequency	3.37	0.97	3.33	3.50	3.28	1.01	3.16	3.35	3.29	1.26	4.00	2.91	3.76	1.01	0.00	3.60
Early morning	3.52	1.34	2.75	4.00	3.45	1.14	2.80	3.88	3.30	1.34	3.00	3.22	4.18	0.87	0.00	3.83
Late_Evening	2.42	1.50	1.00	3.50	2.76	0.97	2.40	3.00	2.50	1.27	1.50	2.78	3.44	1.13	0.00	2.80
Saturday	2.50	1.34	1.00	3.50	2.73	0.96	2.50	3.00	2.43	1.20	1.60	2.63	3.00	0.63	0.00	3.00
Sunday	2.40	1.40	1.00	3.22	2.52	1.23	2.00	3.00	2.17	1.18	1.40	2.55	2.66	0.81	0.00	2.66
Station Condition	3.22	0.73	2.00	3.38	3.52	0.87	3.50	3.40	3.41	0.95	3.00	3.27	3.85	0.86	0.00	3.90
Priority_seating	3.71	0.91	4.50	3.81	3.77	1.01	3.83	3.76	3.47	0.96	4.66	3.20	4.20	0.56	0.00	4.10
Audio-Visual	4.05	0.87	4.50	4.16	3.82	0.77	3.20	3.91	3.50	0.85	4.00	3.37	4.30	0.67	0.00	4.28
Seat Availability	3.95	0.78	4.50	3.92	3.68	0.80	3.57	3.76	4.04	0.84	4.40	3.80	4.14	0.86	0.00	3.90
Safety	4.04	0.92	4.20	4.07	4.07	0.82	4.00	4.09	3.96	0.85	4.20	3.66	4.46	0.74	0.00	4.30
Observation Number	27		5	16	32		8	14	27		5	14	15		0	10
Total Responses	92		20	61												

4.4 Trip Attributes Statistics

The main part of the survey asked questions about respondents' most recent shopping, doctor visit, social and recreational, or work trips. The research team divided questions for each of these trip purposes into four sections. The first section for each trip type asked respondents general questions about trip attributes, such as time-of-day, mode, flexibility, *etc*. The next three sections covered trip attributes like travel time, trip cost, and waiting time for each travel mode. The results of these questions are tabulated and summarized in this section.

The first analysis in the trip attribute shows the relationship between distance and mode choice. The left diagram in Figure 2 presents the comparison between the frequency of the private vehicle mode and non-private vehicle mode. Here frequency refers to the number of people who made a trip within a specific distance. The frequency of private vehicle mode is by far greater than other modes for seniors as shown in the left diagram of Figure 2. Details of the frequency of non-auto modes are presented in the right hand figure. As shown, the CTA is the non-auto mode most chosen by seniors, however, as also shown in Figure 2, for longer trips the CTA is not a preferred mode choice.

Figure 2
Frequency of Auto and Non-auto Modes for Different Distance Categories



Time-of-day is another factor included in this survey. Shifting the non-essential trips from peak hours to non-peak hours requires an understanding of the reasons behind the peak hour trips. Five time period categories are defined in this project according to the frequency distribution of trips within a day. Thus the day is divided into: early morning ("EM", 4:00 – 7:59); morning peak ("AM", 8:00 – 10:59); midday ("MD", 11:00 – 14:59); afternoon peak ("PM", 15:00 – 19:59); and nighttime ("NT", 20:00 – 3:59). These five time periods were derived from the daily trip distribution reported by the respondents. In total, 7% of all reported trips occurred in the early morning; 43% in the morning peak; 30% at midday; 17% in the afternoon peak and 3% at night. The time-of-day frequency distribution is shown in Figures 3 for the four trip purposes.

The doctor visit and shopping trip distributions have just one peak which occurs in the morning peak period. The work trip peak is spread over the early morning and morning peak periods but mainly falls in the morning peak period. The social and recreational trip pattern has two peaks that begin in the morning peak period and end in the afternoon peak period. It can be readily observed from Figure 3 that the main portions of seniors' trips occur during the peak traffic hours.

Majority of the respondents were suburbanites, as evidenced by the survey, which shows that almost 90% of their trips were made in Chicago's suburbs. Table 5 shows the results of the origin-destination matrix for reported trips, including actual values and percentage estimations. Most of these trips ended in suburban areas, even those which originated from downtown Chicago (69% of recreational and work trips originated from downtown Chicago destined to suburbs). Table 5 includes entire reported trips and whether they were made by auto, transit, or other mode of transportation. Therefore, it seems that improving the CTA system would not be an efficient alternative for encouraging seniors to use transit more often because only small portion of trips happen in Chicago on average. It is also worth noting that a small portion of trips happen in rural areas and that providing transit services for them is nearly impossible. Although the relative values presented in Table 5 are meaningful and intuitively consistent with commonly

held beliefs, the actual reported percentages should be utilized with caution due to the small sample sizes in some of the cells.

Figure 3
Time of day frequency distribution for various trips purposes

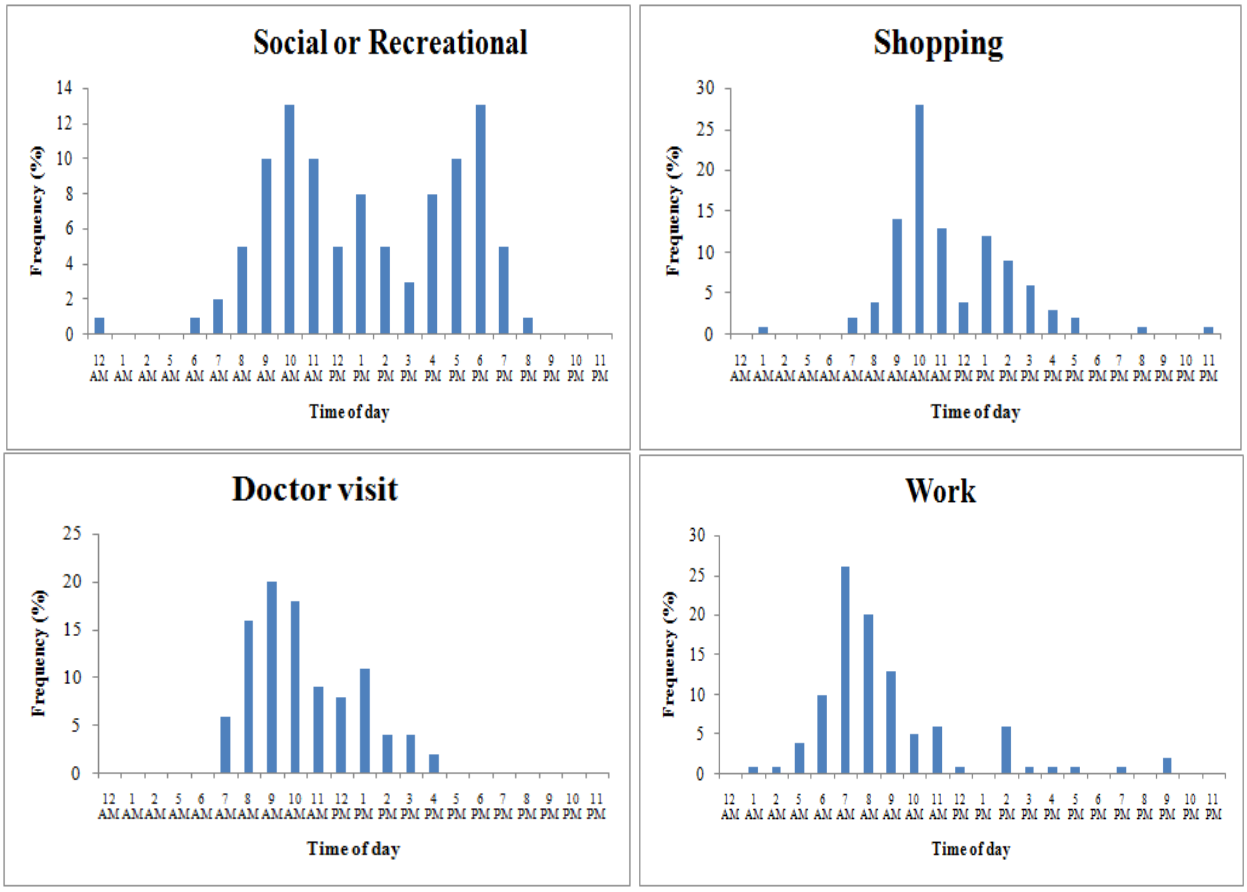


Table 5 Origin-destination tables for four trip purpose categories

4.5 Mode Choice Cross Classification Tables

One of this project's primary goals was to recommend ways for increasing senior citizens' transit ridership. Since the number of licensed seniors will double in the next two decades, this objective is very important. Two simple cross classification models for doctor visits, shopping trips, social or recreational travel, and work trips are presented, considering disability and income as independent variables. These are the factors, according to the literature, that can play significant role in mode choice. It can be postulated that people with higher incomes tend to use their vehicles and non-motorized modes more than other transportation alternatives, whereas, people with lower incomes mainly use transit.

Table 6 presents a cross classification table representing the interaction between mode choice and income for different trip purposes. In Table 6, other refers to travel modes like vanpool, taxi and combination of several modes. Additionally it can be interpreted from Table 6 that as the income goes up tendency of using auto increases and this fact is more obvious in the case of

work trip. Like Table 5, due to the small size in some of the cells of Table 6, the actual reported percentages should be studied with caution. Nonetheless, the relative values are meaningful.

Table 5
Origin-destination Tables for Four Trip Purpose Categories.

		To (Destination)			
		City of Chicago other than downtown	Chicago downtown	Suburb	Rural area
	Shopping Trip				
From (Origin)	City of Chicago other than downtown	23(82%)	2(7%)	3(11%)	(0%)
	Chicago downtown	9(53%)	4(24%)	4(24%)	(0%)
	Suburb	10(5%)	(0%)	180(91%)	7(4%)
	Rural area	(0%)	(0%)	3(43%)	4(57%)
	Doctor Visit				
From (Origin)	City of Chicago other than downtown	26(79%)	4(12%)	3(9%)	(0%)
	Chicago downtown	4(57%)	3(43%)	(0%)	(0%)
	Suburb	13(6%)	(0%)	188(91%)	5(2%)
	Rural area	2(11%)	(0%)	10(53%)	7(37%)
	Social Recreational				
From (Origin)	City of Chicago other than downtown	15(50%)	3(10%)	12(40%)	(0%)
	Chicago downtown	6(21%)	3(10%)	20(69%)	(0%)
	Suburb	15(10%)	4(3%)	129(87%)	(0%)
	Rural area	1(7%)	(0%)	8(57%)	5(36%)
	Work				
From (Origin)	City of Chicago other than downtown	7(54%)	2(15%)	4(31%)	(0%)
	Chicago downtown	4(25%)	1(6%)	11(69%)	(0%)
	Suburb	6(11%)	2(4%)	47(85%)	(0%)
	Rural area	(0%)	(0%)	3(60%)	2(40%)

Table 6
Interaction between Mode Choice and Income

	Under $15,000	$15,000 - $29,999	$30,000 - $44,999	$45,000 - $59,999	More than 60,000
Shopping Trip					
Auto Drive	12(67%	28(72%	25(78%	25(93%	53(90%
CTA	4(22%)	4(10%)	3(9%)	(0%)	1(2%)
PACE	(0%)	1(3%)	2(6%)	(0%)	(0%)
Non-Motorized	(0%)	2(5%)	1(3%)	1(4%)	3(5%)
Others (Esp. Combination)	2(11%)	4(10%)	1(3%)	1(4%)	2(3%)

Doctor visit trip					
Auto Drive	13(59%	32(78%	30(86%	25(86%	50(86%
CTA	4(18%)	5(12%)	2(6%)	(0%)	1(2%)
PACE	2(9%)	(0%)	1(3%)	1(3%)	(0%)
Non-Motorized	1(5%)	(0%)	1(3%)	3(10%)	4(7%)
Others (Esp. Combination)	2(9%)	4(10%)	1(3%)	(0%)	3(5%)
Social and Recreational trip					
Auto Drive	12(71	29(85%	24(80%	18(72%	49(84%
CTA	3(18%)	2(6%)	2(7%)	2(8%)	2(3%)
PACE	(0%)	(0%)	1(3%)	1(4%)	(0%)
Metra	(0%)	(0%)	(0%)	3(12%)	2(3%)
Non-Motorized	1(6%)	1(3%)	1(3%)	1(4%)	2(3%)
Others (Esp. Combination)	1(6%)	2(6%)	2(7%)	(0%)	3(5%)
Work trip					
Auto Drive	2(33%)	4(50%)	9(75%)	8(100%	28(80%
CTA	2(33%)	2(25%)	2(17%)	(0%)	1(3%)
PACE	(0%)	(0%)	(0%)	(0%)	(0%)
Metra	(0%)	(0%)	(0%)	(0%)	2(6%)
Non-Motorized	1(17%)	1(13%)	(0%)	(0%)	1(3%)
Others (Esp. Combination)	1(17%)	1(13%)	1(8%)	(0%)	3(9%)

It can readily be observed from Table 6 that, in contrast to the common belief, even if their annual income is very low, seniors usually make their shopping, social and recreational, and doctor visit trips by automobile. Therefore, it can be expected that the door-to-door transit travel and wait times need to be reasonably comparable with auto drive times if they are to meet with any success in attracting seniors to transit services. The transit schedule should also be reliable and the information should be easily available. The results presented in Table 6 suggest that Transit fare does not influence seniors' decision on using transit, because even low income seniors mainly prefer to use auto drive mode more often.

5.0 Conclusion and Recommendations

Despite commonly held beliefs, seniors greatly lessen the number of trips only once they stop driving, not because they get older or retire. The burgeoning senior population and seniors' reliance on their cars will continue to result in more highway congestion and age-related accidents. Immediate attention is therefore required to develop strategies to encourage seniors to switch to or more frequently use public transportation. However, lack of useful datasets and ample information about the travel behavior of this age group calls for more studies to gather information about the travel needs and transit constraints of elderly people. To answer some of these questions, this study conducted a survey of seniors' travel behavior and their transit service preferences. The paper summarizes the survey methodology and approach, as well as the preliminary descriptive analysis of the results.

Public transportation data specially targeting seniors is also available via other sources. For instance, U.S. National Household Travel Survey 2001 has only less than 200 senior households in the entire state of Illinois sample. Pace Chicago suburban bus service provider also

conducted a survey targeting seniors in which 140 seniors were surveyed. Therefore, obtaining detailed information from 280 senior households is a great achievement. Specifically, it has been shown that the dataset is statistically valid and is the representative of the Census data; therefore, it should be usable for modeling and further analysis purpose. Nonetheless, this study was one of the early attempts that hopefully will encourage further research on senior's travel behavior.

A key finding of the research is that seniors would like to have better access to transit services and desire more information about the available services. This finding suggests that providing brochures describing the schedule, real time expected wait time information, and shuttle access to transit would be the most effective ways to encourage seniors to use transit systems.

Understanding the effectiveness of different transit strategies and services targeting seniors will require further analysis of the dataset collected in this study. Developing econometric models of travel behavior for various trip purposes and across different modes of transportation will offer a suitable tool for practical policy analysis. To better understand the behavioral foundations of the observed travel patterns, a complementary survey also should be conducted to study the scheduling behavior, tour formation, and decision process of seniors.

In this study several recommendations are presented with the goal to encourage seniors to use transit services more often, however, these alternatives represent some generic solutions only, where many other detailed alternative strategies should be identified. According to the findings presented in this paper, strategies that are capable of increasing transit ridership among seniors include policies that can improve transit schedule reliability, reduce waiting time and door-to-station and station-to-door travel time. Additionally, it was shown that seniors value lower-floor entry buses to be more attractive than other solutions, such as providing better waiting amenities, for example, benches and shelters.

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