THE EFFECTS OF HOUSEHOLD STRUCTURE AND AUTO AVAILABILITY CHANGES ON ELDERLY TRAVEL BEHAVIOR IN KOREA*

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1. Introduction

The baby boom in South Korea began immediately after Korea War in 1955, about 10 years after World War II while the end of World War II immediately brought a baby boom in most developed countries. This year 2010 is the starting point in Korea that the oldest baby boomers begin to be included in the population aged 55 or older which is equivalent to the age at which most of large enterprises consider retiring. In 10 years, when they are included in the elderly population aged 65 or older, the pace of Korea's aging will accelerate at a very fast rate. In this context, it's clear that a better understanding of propagation effects on the whole society is very important before the baby boomer generation shifts into elderly population. Therefore, from the point of view of transportation planners, the objective of this research is to better understand the different aspects of population aging in Korea from other developed countries and the impact of population aging on elderly travel behavior, especially, with a focus on household structure and transportation service availability changes using 2002 and 2006 household travel survey data for Seoul Metropolitan Area, Korea.

2. Key Issues in Korea's Aging Population

Undoubtedly, population aging and the shift of baby boomer generation into the elderly are world-wide phenomena now. However, there are three major differences in Korea compared with other developed countries which have already experienced aging population problems; rapid population aging, changing in household structure from multi-generational to single or couple household. In addition, the definitions of the elderly vary by organizations according to their own target population. Thus, in the following subsections, firstly, the definitions of the elderly and non-elderly are determined for this study and then examined about the major different aspects in Korea from other developed countries.

(1) Definitions of Elderly and Non-Elderly

There are many definitions of the elderly in the literature. In Korean society, adults are typically declared to be "seniors" when they reach the ages of 60-65, but the definitions of the elderly vary in different organizations and acts. The National Pension Act and Population Census reports consider people who are aged 60 or older. The Older Koreans Act and The Road Traffic Act consider people who are aged 65 or older. Meanwhile, the two transportation agencies, Seoul Metro and Seoul Metropolitan Rapid Transit Corporation offer free travel for the elderly only when they are aged 65 or older. Thus, in this study, we consider the elderly who are aged 65 or older for the purpose of subway service availability consideration. In addition, it is important to distinguish between "younger" and "older" age groups. Alsnih and Hensher[1)] suggest an age threshold of 75, which is when their health often starts to decline and has been frequently used in the previous elderly-related papers. This study also subdivides the elderly into young-elderly who are aged 65~74 and old-elderly who are aged 75 or older.

As for the non-elderly, the minimum age to obtain a driver's license in Korea is 18, but generally, it takes several months to obtain a driver's license and Korean parents usually don't allow high school students to obtain driver's license; most Korean students are required to continue their education until at least age 18. Therefore, in this study, we consider the non-elderly people who are aged 19~64 for the purpose of auto service availability consideration.

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*Keywords: trip generation, elderly household structure and auto ownership

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(2) Rapid Population Aging

The first difference is the rapid speed of aging. According to “Social Research ('08, '09) of the baby boom generation”, Korea National Statistical Office[2], the nation is aging rapidly, with a very low birth rate yielding statistics rarely seen in developed countries; 1.22 births per woman in Korea, 2010, 1.89 for France, 2.09 for the U.S., 1.27 for Japan. As shown in FIGURE 1, results of the report showed that the population of those aged 65 or older increased by 58 % to about 11%, only 10 years after it first exceeded the elderly ratio of 7% in 2000. At this pace, Korean society is expected to become a so-called "aged society" by 2018, only 18 years after its designation as an "aging society" in 2000. In an aging society, people aged 65 or older make up over 7 percent of the population, while in an aged society this number exceeds 14 percent by the definition of an aging population[3]. It took France 115 years and the U.S. 73 years to go from an ageing society to an aged society; Japan took 24 years for this change. In this context, Korea should take action immediately to prepare countermeasures against the low birth rate and rapid population aging.

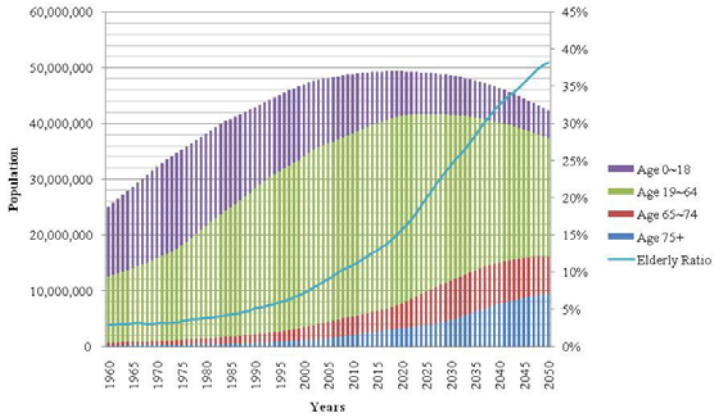

Figure 1: Population projections for Korea

(3) Change in Household Structure

The second is a striking change in elderly household structure. The issue of aging population did not receive much attention from Korea society in the past compared with other western societies. One of the reasons might be rooted in the strong Korean custom of the first son living with and supporting his parents. According to “2008 Social Survey”, Korea National Statistical Office[4], 55% of household heads in 1998 were living with their parents when one of their parents is still alive and about 40% in 2008. Recently, the trend living with parents is rapidly decreasing due to a low birth rate, rapid industrialization in Korea and the influence of western cultures. In other words, the aging population issue in the past was relatively not serious because the elderly ratio was quite small and most of elderly people could live with and get help from their adult-children in the household. When the elderly are living with their adult-children, most of household maintenance tasks are in charge of the children due to a traditional custom of care and respect for the elderly. However, recently, as single and couple elderly households not living with their adult-children are rapidly increasing, the transportation needs of the elderly will dramatically increase in the near future because they don’t have anybody to help them in the household.

Table 1: Relationship of household head to his/her parents

Year	Living with Parents (%)			Living away from Parents (%)	Others (%)
	First Son	Another Son	Daughter		
1998	30.8	19.4	4.3	44.9	0.5
2002	24.6	14.5	3.6	56.7	0.6
2006	21.8	14.9	5.7	56.3	1.2
2008	20.1	13.0	4.9	60.2	1.7

(4) Increasing Elderly Auto Ownership and Traffic Accidents

The third difference is the rapid increase of auto availability and traffic accidents. Most of studies from western societies showed that the elderly are very dependent on automobiles while most of studies from Asian societies showed the elderly are very dependent on public transit modes. Since the mid-1980s, the driver’s license ownership and vehicle ownership per driver have rapidly increased and especially, female drivers have dramatically increased for the last 20 years due to the rapid industrialization

and economic growth of Korea. As of 2008, about 84% of men and 65% of women are holding driver's license. In other words, when the oldest baby boomers were young adults, the driver's license and vehicle ownership began to increase. As the result, Korean baby boomers experienced auto usage in their young age. Therefore, even though current elderly people in Korea tend to be very dependent on public transit modes, the future elderly generation will also be likely to use automobiles much more than the current elderly like relatively auto-dependent western elderly people.

Table 2 shows that the number of licensed drivers and deaths by traffic accidents for each age group. The rate of increase in licensed drivers of the elderly has been increased by 384 % for the last 10 years while the rate of the non-elderly increased by 43%. In the same period, the number of the traffic accidents and deaths for the non-elderly has been decreased owing to the efforts of Korea to reduce but, still increasing for the elderly because driving reaction time and general skills deteriorate with age. The elderly deaths by traffic accidents have been nearly triple for the last 10 years. The increase in the driver's license ownership of the elderly will improve the mobility of the elderly and at the same time, lead to road traffic safety problems.

Table 2: Driver's license and traffic accidents/deaths

Years	Non-Elderly (Age 19~64)				Elderly (Age 65+)			
	Licensed Drivers(ownership)		Traffic Accidents	Deaths in Traffic Accidents	Licensed Drivers(ownership)		Traffic Accidents	Deaths in Traffic Accidents
1999	17,175,203	59%	273,195	9,145	243,675	9%	2,743	208
2002	20,787,609	69%	227,216	6,964	435,401	14%	3,810	258
2006	23,275,229	73%	206,595	5,854	813,000	20%	7,150	473
2009	24,642,149	77%	219,992	5,253	1,180,000	26%	11,998	585
2009 / 1999	143%	130%	81%	57%	484%	295%	437%	281%

3. Data Source and Basic Analysis

The Korea Transport Database Center conducts household travel survey every 5 years in Seoul Metropolitan Area, Korea which is composed of Seoul City, Incheon City and Gyeonggi Province and releases the raw data of the survey to the public, 16% of the entire data for 2002 and 20% for 2006 which are randomly sampled from the entire survey data on a household basis[5)-6)]. In addition, we requested 100% of the entire elderly sample for both years and allowed for this study because the going-out ratio is extremely small to get reliable results, but the attributes of other members in the household are not available in the 100% data.

(1) Survey Location

Figure 2 shows the survey location conducted in both years where the central area is Seoul City surrounded by Incheon City and Gyeonggi Province. In addition, the area can be divided into urban and rural areas based on the names of administrative units such as Dong, Eup and Myeon; the subdivisions of city in Korea which correspond to town level in other countries. In this classification, the place of residence is very important because the place where the residents live can be used an indicator for the level of transportation accessibility.

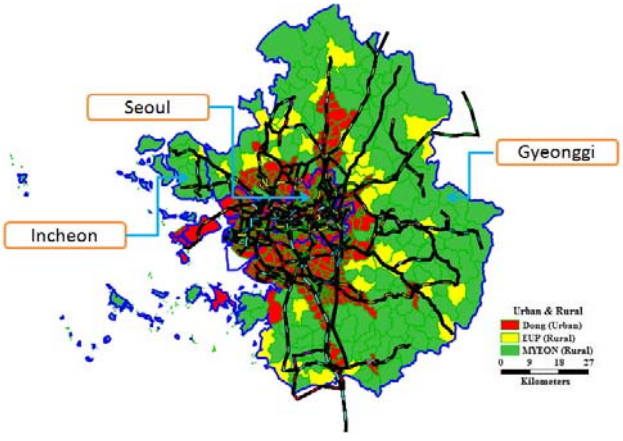

Figure 2: Seoul Metropolitan Area: Urban vs. Rural

(2) Sample Size by Household Structure

Table 3 shows the sample size and no. of persons traveled by household type. It shows the majority of the elderly people are living with other members because of the traditional custom of the first son living with and supporting his parents. For the analysis of the elderly, 100% data of the entire elderly sample were used because of very low going-out ratio while 16% and 20% of the entire sample were used for the non-elderly analysis.

Table 3: Sample size and no. of persons traveled by household type

Data Source	Household Type	2002 Household Travel Survey			2006 Household Travel Survey		
		No. of Household Members	No. of Persons	No. of Persons Traveled	No. of Household Members	No. of Persons	No. of Persons Traveled
Elderly 100%	Single	740	740	524	1,930	1,930	1,454
	Couple	2,649	4,037	2,191	5,853	9,293	5,872
	Multi-Generational	16,464	19,708	4,078	21,798	26,512	8,785
	Total	19,853	24,485	6,793	29,581	37,735	16,111
Non-Elderly Sample	Single	912	912	841	2,201	2,201	2,046
	Couple	1,616	3,228	2,173	3,157	6,314	4,649
	Multi-Generational	20,927	52,419	35,598	31,216	76,552	57,700
	Total	23,455	56,559	38,612	36,574	85,067	64,395

(3) Going-Out Ratio Changes of the Elderly

Going-out ratio of the elderly dramatically increased nearly 54% only for 4 years interval; in 2002, 28% of the elderly traveled and 43% in 2006. Especially, the elderly in multi-generational households increased nearly 60% from 0.43 to 0.70. In terms of trip purpose, mainly leisure and personal business trips increased the most. One of the reasons might be increased auto availability.

Table 4: Going-out ratio for non-work trip purposes: 2002 vs. 2006

	Household Type	Shopping	Leisure	Personal Business	Total (all purpose)
2002	Single	0.12	0.13	0.30	1.46
	Couple	0.09	0.08	0.20	1.13
	Multi-Generational	0.02	0.04	0.07	**0.43**
2006	Single	0.12	0.14	0.37	1.57
	Couple	0.10	**0.13**	**0.26**	1.33
	Multi-Generational	0.04	**0.07**	**0.13**	**0.70**

(4) Driver's License and Household Auto Ownership Changes

Only for 4 years interval, the driver's license ownership and household auto ownership dramatically increased especially, in the elderly of single and couple households and in rural area. The reason might be that the current elderly had experienced more auto usage in their young age than the past elderly in Korea. And also, the transit service quality in rural area is relatively poor compared with urban area and additionally, the subway agencies offer free travel for the elderly in urban but, not in rural area.

Table 5: Comparison of individual driver's license ownership: 2002 vs. 2006

Region	Household Type	Elderly					Non-Elderly				
		Frequency		Percent		2006 / 2002	Frequency		Percent		2006 / 2002
		2002	2006	2002	2006		2002	2006	2002	2006	
Rural	Single	18	76	7%	15%	**214%**	66	135	63%	68%	107%
	Couple	209	601	17%	28%	**166%**	266	523	47%	63%	133%
	Multi-Generational	275	477	9%	13%	153%	2,148	2,829	84%	104%	124%
Urban	Single	77	291	17%	21%	**127%**	512	1,383	65%	70%	107%
	Couple	880	2,866	34%	41%	**122%**	1,647	3,738	63%	69%	109%
	Multi-Generational	2,214	4,809	15%	22%	153%	31,184	51,797	86%	102%	118%

(5) Ratio of Intrazonal Trips and Dependency on Urban Area

In terms of the ratio of intrazonal trips, the elderly are increasingly likely to travel more for better activity opportunities especially,

the elderly living in rural area. The ratio of decreased about by 10~20% for 4 years.

In TABLE 6, the trips whose destinations are in urban area were calculated. The percentage of the elderly in rural, which traveled from rural to urban area for their activities, increased by 40~74%. This means more elderly people seek to better activity quality owing to increased auto availability. Meanwhile, the non-elderly living in rural area are also more likely to travel to urban area especially, for leisure trips than 2002.

Table 6: Comparison of dependency on urban area: 2002 vs. 2006

Region	Trip Purpose	Elderly					Non-Elderly				
		Frequency		Percent		2006	Frequency		Percent		2006
		2002	2006	2002	2006	/ 2002	2002	2006	2002	2006	/ 2002
Rural	Shopping	41	97	17%	23%	**140%**	89	112	35%	32%	93%
	Leisure	25	70	13%	20%	**148%**	17	72	16%	33%	**206%**
	Personal Business	120	376	17%	29%	**174%**	115	224	23%	32%	136%
Urban	Shopping	655	1,750	99%	99%	100%	3,029	5,604	100%	99%	100%
	Leisure	1,211	3,300	97%	97%	99%	2,151	5,211	97%	96%	99%
	Personal Business	2,046	6,308	97%	98%	100%	4,374	9,925	97%	97%	100%

(6) Trip Mode Choice of the Elderly

In rural area, the train mode share of the elderly is almost “zero” because the train service is not available in most of rural area while it’s available in most urban area for free. Because of poor transit service and spread activity opportunity locations in rural area, the elderly in rural area are more likely to use auto and less likely to use walk than in urban. For shopping trips, the auto mode share as a driver became nearly double. Instead of that, auto as a passenger decreased in rural area maybe, due to increased driver’s license ownership.

Table 7: Comparison of travel modes for shopping purpose: 2002 vs. 2006

Trip Mode	Frequency				Percent			
	Rural		Urban		Rural		Urban	
	2002	2006	2002	2006	2002	2006	2002	2006
Auto Driver	23	83	59	146	**9%**	**20%**	9%	8%
Auto Passenger	26	33	23	85	**11%**	**8%**	3%	5%
Train with auto access	0	0	0	1	0%	0%	0%	0%
Train with walk access	0	2	90	332	0%	0%	14%	19%
Bus with auto access	0	0	0	0	0%	0%	0%	0%
Bus with walk access	128	191	260	528	52%	46%	39%	30%
Walk	33	60	181	596	**13%**	**14%**	**27%**	**34%**
Motorbike	27	34	8	29	11%	8%	1%	2%
Bicycle	6	7	16	33	2%	2%	2%	2%
Taxi	2	0	11	18	1%	0%	2%	1%
Truck	1	5	12	3	0%	1%	2%	0%
Total	246	415	660	1,771	100%	100%	100%	100%

4. Estimation Results of Going-Out Models and Discussions

Based on the results of the basic analysis above, going-out models of the elderly for non-work trips were estimated using binary logit with a focus on auto availability and household structure. In terms of gender, woman are more likely to do shopping trips (traditional role of women) and less likely to do leisure and personal business trips. In terms of age, younger elderly are more likely to travel as previous studies[7] because younger elderly are physically healthier. In terms of household type, the elderly in single household tend to travel the most often regardless of age and purpose because for shopping and personal business trips, they don’t have anybody to help them and for leisure trips, they don’t have anybody to talk with in the household for pleasure. The elderly in multi-generational households tend to travel the least because, in general, when parents are too old or have problems to live alone, their children tend to start living with parents, that is, the elderly in multi-generational households are likely to have some physical problems to go out. The shopping trip of the elderly in rural area is the most influenced by auto availability compared with the elderly in urban and leisure/personal business trip purpose. According to T-Test, the differences between urban/rural, young/old and household types were significant at a 95% confidence level for shopping and leisure trips but, the differences between

auto-available persons in urban and auto-available persons in rural and between young single household and old single household were not significantly different.

Table 8: Model Estimation Results for Elderly from 2006 survey data

Variables		Shopping		Leisure		Personal Business	
		Coefficient	T-Statistic	Coefficient	T-Statistic	Coefficient	T-Statistic
Urban	Auto Available	0.359	4.056	1.125	14.484	0.596	11.110
	No Auto Available	0.164	2.448	0.825	12.274	0.233	5.568
Rural	Auto Available	0.858	6.555	**0.213**	**1.444**	0.595	6.478
	No Auto Available						
Low Income Dummy							
Median Income Dummy		**0.029**	**0.555**	0.228	5.474	-0.145	-4.656
High Income Dummy		**-0.031**	**-0.349**	0.304	4.510	-0.284	-5.072
Male Dummy		-0.314	-5.878	0.567	13.710	0.309	9.757
Commuted Part-Time Worker		-1.155	-9.596	-1.989	-16.442	-2.063	-23.380
Commuted Full-Time Worker		-1.879	-8.811	-2.537	-13.605	-2.797	-18.278
Preschool Children Dummy		-0.437	-4.063	**-0.078**	**-1.094**	-0.337	-5.871
Young -Elderly	Single Household	2.381	19.748	1.199	13.308	2.045	29.376
	Couple Household	2.180	22.524	0.908	15.413	1.286	27.800
	Multi-Generational	1.356	14.266	0.318	5.843	0.643	14.983
Old -Elderly	Single Household	2.119	12.373	1.018	7.151	2.050	20.138
	Couple Household	1.699	11.136	1.081	11.127	1.126	14.111
	Multi-Generational						
Constant		-4.255	-39.044	-3.841	-46.843	-2.453	-44.970
No. of Observations		37,735					
LL(B)		- 7,473		- 10,676		- 16,034	
LL(C)		- 8,058		- 11,448		- 17,578	
LL(0)		- 26,156		- 26,156		- 26,156	
Rho-Squared		0.714		0.592		0.387	

Note: Bold variables are not significant at a 95% confidence level

5. Conclusion

The above analysis showed strikingly rapid increases in the proportion of elderly population, driver's license/household auto ownership, single/couple households and going-out ratio of the elderly which have been rarely seen in other developed countries. As a result, it is obvious that the trends will cause the elderly in Korea to go out more frequently than now and lead to huge problems such as increasing elderly deaths in traffic accidents and unmet transportation service. In addition, the elderly in rural area are increasingly more likely to be auto-dependent due to poor transit service and attractive activity opportunities near their homes. Korean society should keep in mind that once they become auto-dependent, it's very difficult to change their preference on travel modes[8]. The major difference between Korea and other countries is the rapid speed in population aging, that is, Korean society doesn't have enough time to prepare countermeasures against the population aging. For this matter, Korean society should take action immediately, especially before Korean baby boomers begin shifting into elderly population.

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