私立東海大學工業設計研究所

碩士論文

A Pilot Study on Scooter Riding Barriers with Pre-elderly and Elderly

中高齡及高齡者於機車駕駛障礙之初探性研究

研究生：洪麒鈞

指導教授：渡部紀綱

中華民國九十六年七月

碩士學位論文口試委員會審定書

工業設計研究所 洪麒鈞 君所提供之論文

A Pilot Study on Scooter Riding Barriers with Pre-Elderly and Elderly

經本委員會審定通過，特此證明。

論文口試委員會

委　　員：

指導教授：

中華民國 96 年 6 月 14 日

Abstract

Mobility issues are frequently correlated with personal activities and life style, and it becomes a more critical topic for the elderly as coming of the aging society. However, Taiwan traffic environment and personal declined riding ability have threatened them while facing aging symptoms gradually.

Observing the Taiwan aging population structure, Baby Boomer(1946-1964) generation will emerging into elderly age level in the decade, which they are referred to the group of pre-elderly (preliminary elderly). However, the study indicates present scooter bring riding barrier for the elder groups (elderly and pre-elderly) through evaluations in aspect of universal design and aging symptoms.

The purpose pilot study is to obtain the interviewee's opinions in first hand. Therefore, descriptive questionnaire survey is held by random sampling elderly and pre-elderly (50-64) in Taichung urban area. Distribution, cross and cluster analysis are applied into the questionnaire result to acquire the attributes cause elder groups riding barrier experiences

From previous literature review, survey results and discussion, the findings of the study are concluded as following four points: (1) Nervous, control vehicle balance, avoid night riding, and waste efforts on turning are main four scooter riding obstacles that the elder group meets in their scooter riding experiences; (2) Inattention, vision degrading, slower reaction time, and sense of balance disorder is the major attributes that happen with high frequency among obstacle experiences; (3) Age level cross analysis shows no widely differences on riding barriers. But the results indicates pre-elderly has riding obstacles gradually; (4) Safety and saving efforts riding behaviors are suggested for the elder groups who lack of safety conscious.

The aim of the study is not only to reveal the potential hazard of elderly scooter riding, but also to summarize the effecting attributes concretely. Finally the author promotes mobility suggestions to clarify mobility barriers that the elder groups might facing and contribute for further elderly transportation issues.

Keywords: elderly, pre-elderly, scooter, riding barriers,

中文摘要

近年來，由於高齡化社會的來臨，台灣對於高齡化的議題逐漸的興起。在食衣住行育樂等構面中，行動能力往往動輒牽扯高齡者的活動行為及生活型態。現行高齡者族群中，多數使用機車作為代步工具，但面對著日漸老化的來臨，在騎乘機車中需面對台灣交通環境及己身駕駛能力退化的威脅。

觀察台灣社會人口的老化中，大量的戰後嬰兒潮(1946-1964)的人口在未來十年終將邁入高齡人口的族群，而該族群被政府歸類為中高齡者。藉由通用設計及老化因素的考量，本研究中發現目前機車的功能對於高齡者及中高齡者帶來騎乘上的障礙，也提高了肇事之後的死亡率。

初探性研究立意是為取訪談者的第一手意見，故本研究採用描述性問卷訪談作為實驗方式，並加入交叉及群組分析進行討論。因此本問卷訪談以台中地區中高齡及高齡族群為訪談對象，由研究過程中觀察訪談高齡族群(含高齡者集中高齡者)在使用機車上可能遇到的障礙經驗，並藉由人因及老化特徵等現象中歸結出背後影響要素。

從文獻、問卷及討論中可歸結得知高齡族群在機車騎乘經驗上的不便性，並歸納為以下幾項相關要點：

1. 緊張、控制車身平衡、避免夜間駕駛、及轉彎的費力為主要遭遇的障礙狀況。
2. 注意力分散、視力退化、緩慢的反應時間及平衡感失調為受訪者中歸結得主要造成障礙經驗的因素。
3. 年齡交叉結果並無顯著差別，但可看出中高齡者開始面對騎乘障礙的影響。
4. 對於缺乏安全意識的的高齡駕駛族群，建議採取安全及省力的駕駛行為

本研究主要目的為凸顯機車對於高齡族群所引起的潛在風險，並將潛在要素具體化。此外藉由移動能力議題中，明瞭高齡族群的使用需求及行動障礙的遭遇，最後整理出相關的建議方向，能有助產學界上對於高齡者交通工具議題上重視。

關鍵字：高齡者、中高齡者、機車、駕駛行為

誌　謝

初離大學校園之際，投身產業界兩個年頭，兀自深知己身所學之限，決心重返學術研究的殿堂，追尋知識的奧秘。自入學啟始，光陰荏在，匆匆一眨已然三年有餘，論文完成的時刻，也代表著我的里程碑要邁向另一個段落。

本論文得以順利完成，首先誠摯的感謝指導教授渡部紀綱老師悉心的教導，不時的討論並指點我正確的方向，使我在這些年中獲益匪淺。老師對設計上的堅持及設計哲學的深厚，更是我輩學習的典範。此外，亦感謝口試委員謝志成老師及雲科工設所李傳房老師的大力協助。因為有你們的鼓勵與疏漏處之指正，使得本論文更臻完備，在此謹深致謝忱。

三年有餘的的日子，研究所內共同的生活點滴、互動之熱切、言不及義的閒扯皆盈盈繚繞于我心，縱然時日如梭，亦無法輕易割捨。在此感謝學長姐耿暉、豐順及明月；同學寬憲、珍瑋、宏偉、佳安、靜怡及家菁；以及學弟妹至哲、煜明、雅棻、姿依，還有許多研究所的好友們。

承蒙好友們的不吝指導教誨，糾察待人處事的不經意，時值今日，幕後的功臣乃來自於諸位堅定不移的支持。在此感謝各位的好友們的協助，聖富、奇隆、振宇、仲廉、徐揚、偉榮、婷芬、靜薇、于雅、郁仁、齡儀、雅欣、玟君等，你/妳們的幫忙及搞笑使我銘感在心。

最後，謹以此文獻給我摯愛的家人們，你們在背後給予我默默的支持協助是我前進的動力。你們的體諒與包容是永遠是我突破難關最有利的支持。

最後，要感謝的人太多，就如天天陪伴寫作的晨星與明月，感謝你們！

Contents

List of Tables

List of Figures

Chapter1. Introduction

1.1 Background and motivation

The characteristics of scooter are economical, convenient, and high mobility in Taiwan traffic environment and it becomes one of the major transportation in Taiwan. However, the vehicle numbers are rising to 13,641,807 until Mar. 2007, and scooter volume among the total vehicles in 66.85 %(20,405,743), still the volume of the scooter rising gradually in 4% every year. The reasons bring this tendency are as followed:

1. Scooter is a convenient and economical transportation in the area lacking of public transportation, such as mid-southern, eastern Taiwan, or suburbs.
2. Scooter provides high mobility through place to place in rush hours, crowded, and narrow parking spaces.
3. Younger people love to ride scooters because of its lower sell price.

The elderly population is unspeaking group and is ignored as long as their visual, physical and cognitive functions decline. As coming of the aging society, many researches attach the importance to the problems come while aging with people. Foreign research has demonstrated that many elder drivers restrict not only the time spent driving but also their driving circumstances.(e.g. avoid driving in the rain or at night) (Marottoli et al., 1996; Forrest et al., 1997; Stutts, 1998). Therefore, this phenomenon should be concern and to study what attributes cause in behind in case to bring barriers to future aging society.

Driving behavior is the bridge between vehicles, drivers, and environment; it helps to interpret the accident fatalities as well. Therefore, investigations are held to view the associations between the elderly driving behaviors and vehicle itself. By observing their driving behaviors and driving problems would help finding potential need from vehicle.

Society phenomenon might observe form previous mentioned background and are addressed by following three points:

1. Rapid growing on the elderly population and comes with elderly aging topics gradually year by year.
2. Mobility is the first priority of elderly activities and the main cause are the aging symptoms lead to declining on physical and cognitive.
3. Scooter is applied in divided age levels by many different usages, and same applying scoter situations happen on the elderly as well. However, most statistic data locates on young adults, fewer data of elder drivers has been collected. Therefore, elderly scooter riding is seldom discussed.

1.2 Research subjects

The subjects of this study were required to pre-elderly (age 50-64) and elderly (age over 65) keep using scooter frequently but start facing aging situation. There are many definitions for age level before elderly such as mature age, middle age, and pre-elderly (EICP and Council of Labor Affairs); the study use pre-elderly (preliminary elderly) represent age from 50 to 64 instead because it is easy the comprehend the meaning of people going step into elderly age level. In aspect to survey the future vehicle development effect by aging impact, pre-elderly is included into this study subjects in ahead to investigate the elder scooter user's riding barriers to predict the Taiwan traffic situations and environment in decades.

1.3 Research objective

The major results obtained in this study are summarized as followed:

1. Exploring the scooter riding situation how senior citizens riding in Taiwan.
2. Understanding the riding behavior risks of the elders and how aging situation affect them on physically.
3. Understanding the aging physical attributes affect them on riding behaviors.

1.4 Research Contribution

The results of study might contribute for several areas as followed:

1. Give a sketch for scooter and vehicle makers to refine scooter in considering of elder riding group.
2. Provide design references for develop next generation personal mobility vehicle in the way replace scooter and considering in universal design.

1.5 Methodology

The pilot study applies a descriptive questionnaire survey method to explore the attributes of problems that pre-elderly and elderly facing when they riding scooters. The purpose of descriptive

1.5.1 Research structure

The contents of this study might divide into five phases and the purposes of each phase are summarized as followed:

1. Introduction: it provides a quickly review of the motivation and outline of this pilot study as the guide of study.
2. Literature review: Relative literatures and statistic data are reviewed for examine the motivation of the study, and contents finding for questionnaires design.
3. Questionnaires design: Arrange questionnaire contents and execute questionnaire survey.
4. Review of questionnaire results: Administrator questionnaires results and analysis via statistic software also compare with previous literature to check the result differences.

5. Conclusions: summery of the pilot study and suggestions for future studies.

1.5.2 Research procedure

Figure 1.1 summarized the procedure of the study which the contents of procedure are addressed by following five points which correspond to research phases:

1. Define the research objectives: Setup the study background, motivation and subject and limitation.
2. Literature review: It is divided into two parts through literature study; one is search the statistic data and related aging issues for determined the motivation of the study, the other part is to explore the issues of riding behaviors and evaluation for scooter and elder users. Finally attributes affecting riding mobility are inferred through mentioned literatures.
3. Executing questionnaire survey: After construction the attributes, questionnaires is held to survey the subject's opinions to examine the disadvantage and barriers bring from scooter. Random sampling population chooses from pre-elderly (age 50 to 64) and elderly (aged 65 or older) in Taichung urban area.
4. Statistic analysis: Administrator questionnaire distributions: distributions of descriptive questionnaire results, cross analysis, and cluster analysis
5. Suggestions: conclusion and suggestion based on questionnaires results and observation of literature review including personal opinion.

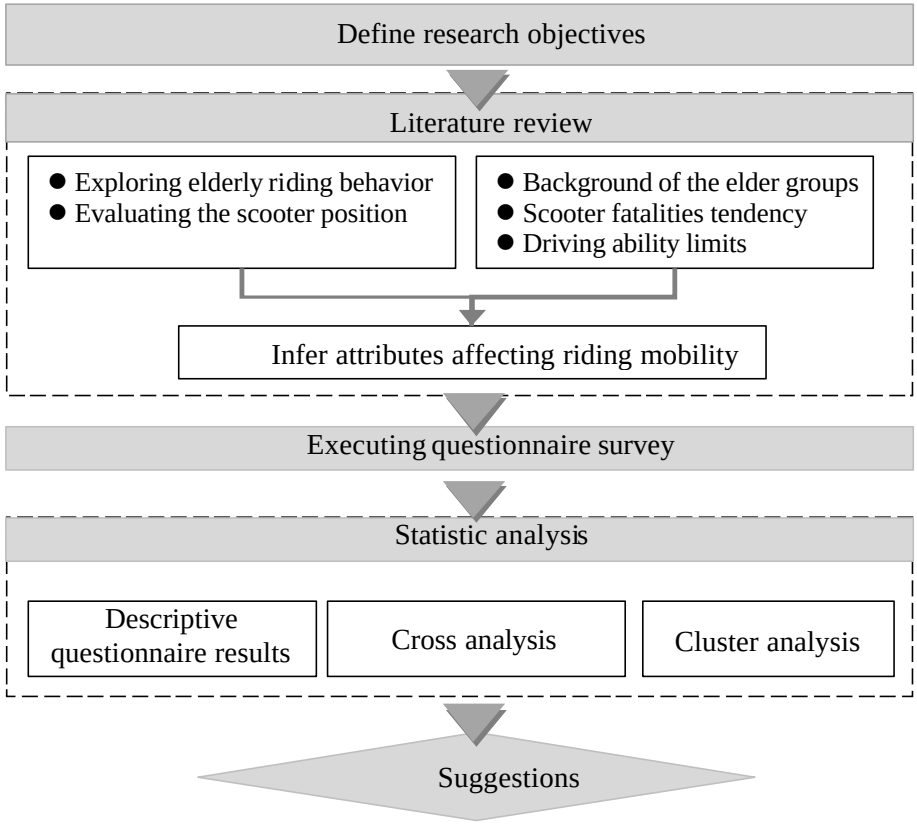

Figure 1.1 Dissertation process

1.6 Limitation of Dissertation

Base of limit research resources and the elder groups' (elderly and pre-elderly) conservative attitudes and characteristics, the proceeding limitations of study are as addressed as below:

1. The elder groups involved within questionnaire subjects sometime have defense attitudes through the survey that might reduce the accuracy of survey.
2. The elder groups might over-estimate their scooter riding skills that reduce the accuracy of survey results as well.
3. Subjects of the pilot survey are sampled from the pre-elderly and elderly in the Taichung urban area due to limited time and research resources.

Chapter2. Literature Review

This chapter will review on literatures from the view of elderly society, and discuss with their abilities of scooter riding, riding habits and riding safety in Taiwan. Furthermore, the vehicle position of scooter needs to be examined the correlation between scooter and the elder groups after reviewing scooter fatalities.

2.1 Review change of the elderly society

Elderly population in Taiwan increasing year by year steadily but the impact of aging society is inevitable. Observing the development of the society development is the basic method to reach prediction of future society problems. According to the United Nations definition, the percentage of the population aged 65 or older among the total population in 7% calls "aging society", up to 14% among total is called as an "aged society" by definition. Taiwan has stepped into an aging society y by 1.49 million elderly people in 7% among total population in 1993(Population statistics from MOI); Research indicates that Taiwan will step into an aged society by the proportion of the population over 65 reach to 15.89% before 2011(Projections of the population of Taiwan area, R.O.C. 2002 to 2051, 2002) as shown in the following Figure2.1.

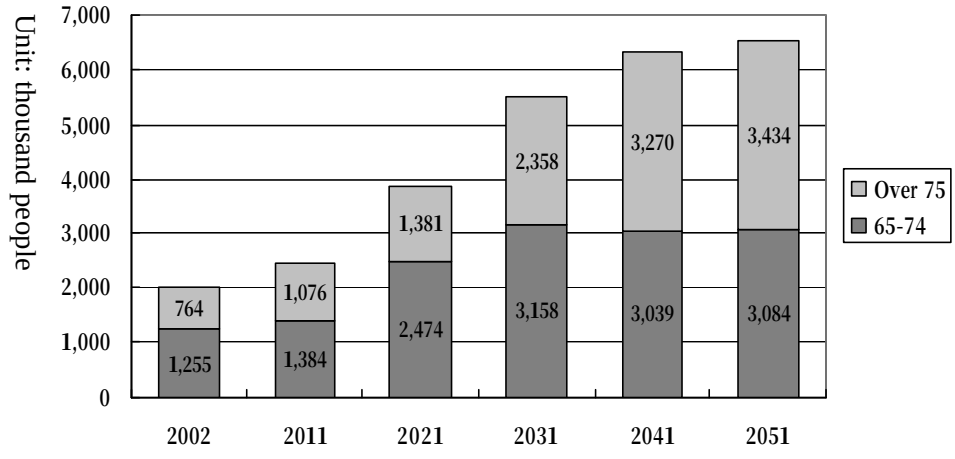

Figure 2.1 Elderly population growth developments by decades

Source: Projections of the population of Taiwan area, R.O.C. 2002 to 2051, 2002

Taiwan population comes different than it did in earlier 21 century, and it happens on the population structure as well. As shown in Figure 2.1 and Figure 2.2, elderly population not only increasing year by year and the elderly population structure will change gradually year by year; in 2011, the population of age above 75 years old will reach to 44% among the whole elderly population.

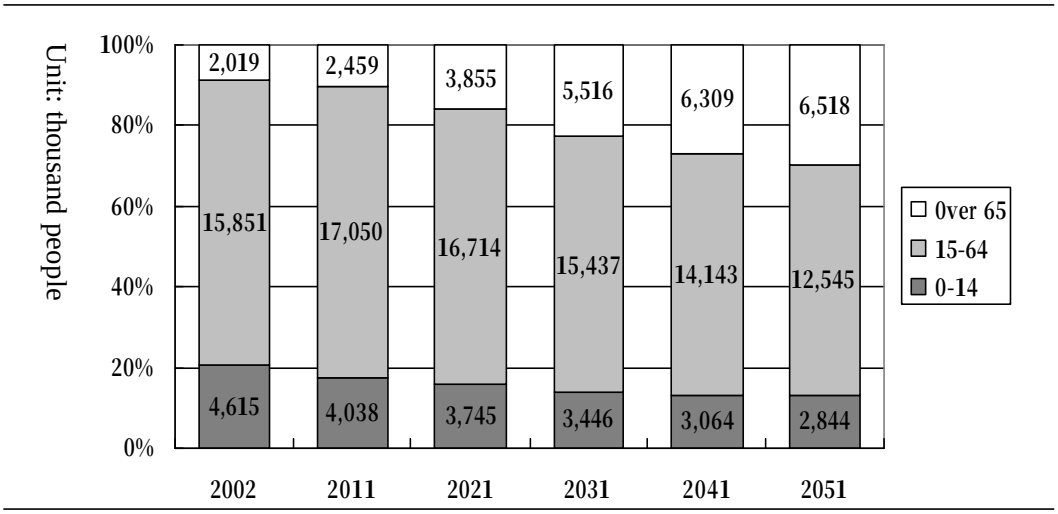

Figure 2.2 Population growth developments by decades

Source: Projections of the population of Taiwan area, R.O.C. 2002 to 2051, 2002

In aspect of evaluating impact for population infrastructure, as shown in Figure 2.3, the age-sex pyramids comparison indicates negative growth situation by 2015. In the view of predict the next generation development, the investigation is suggested to be held to observing the future population development and explore how current elder citizens' opinions. Moreover, pre-elderly aged between 50 to 64 years old in 2004 will step in to elderly age on 2015. They are born under the pace of the huge Baby Boomer generation (born between 1946 and 1964) and will stepping into the ranks of senior citizens in next decades. The pace of elderly population growth will continue into the elderly society, and the huge Baby Boom generation involved into the aged society will lead with more elderly that change the infrastructure of population. Therefore, the solution to predict their behaviors and attitudes in advance will rely on how to acquire those pre-elderly opinions nowadays.

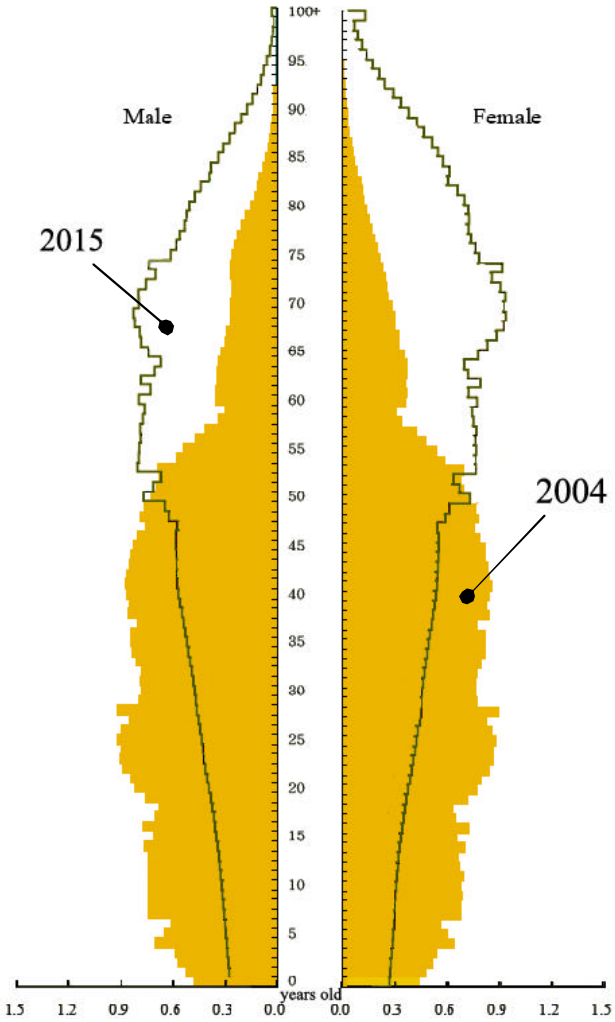

Figure 2.3 Population age-sex pyramids comparison

Source: Health and vital statistics, Dept. of Health, R.O.C., 2004

2.2 Background of Taiwan pre-elderly

From previous researches, the results indicate the change of society infrastructure on elder population due to numerous pre-elderly people emerging into elderly age level. There are several definitions of pre-elderly according to researcher. In Taiwan, pre-elderly which age from 55 to 64 was we called “mature age generation” defined by

E-ICP (Eastern Integrated Consumer Profile); Those people age locates between 43 and 61 on 2007 according to the definition of Baby Boomers (born between 1946 and 1964) as well; Age from 45 to 65 is defined as middle age by employment services law. From this study, we use the noun "pre-elderly" to describe the person going step into elderly age level and observe the aging impact he/ she will face. However, compared with the age-sex pyramids comparison in Figure 2.3, the population structure changed rapidly since from age 50. Table 2.1 concluded the recent aging groups' ratio as followed. From the results, pre-elderly's age from age 50 to 64 contents mature age generation and Baby Boomers generation will be step in to main elderly group in this decade.

Table 2.1 Ratio of elder age group in whole population

Year	50-64 (ratio)	65+ (ratio)
2004	3,287(14.5%)	2,150(9.5%)
2005	3,452(15.2%)	2,217(9.7%)
2006	3,630(15.9%)	2,287(10.0%)
End of Mar, 2007	3,672(16%)	2,299(10.0%)

Source: Dept. of Household Registration Affairs, MOI (Unit: thousand people)

The Baby Boomer steps into retirement phase gradually since 2006 and bring the retirement trend. The lifestyles of them might divide into six types according to E-ICP research base on age 60 to 64: ①Conservative and traditional (23%); ②Silence (21.6%); ③Easygoing (21.6%); ④Regular and cagily; ⑤Active and energetic; ⑥Confidant and modern. Passive attitude on new technology and product but rely on famous and stable quality products are their characteristics and evidences indicates pre-elderly tends to keep status and thing as they are without change. But generally speaking, the current pre-elderly belongs to the group which is healthy, active, and with their own economical force.

2.3 Review of scooter development with the elder groups

2.3.1 Mobility effects on the elder groups

All evidence suggests that the elderly population of today and tomorrow will continue to depend on the private car to give them freedom, independence, and choice--as do younger travelers (Rosenbloom S., 1993). The decline of personal mobility is not under-estimate impact as a result of it related to the personal mobility autonomy and routine activity area constrain. Therefore, the greater degree of personal mobility might bring the more flourished in economics, society activities.

The present elderly health condition is better than past times. According to government survey (Dept. of Statistics, MOI, 1999), 39.48% of the elderly belong to "healthy elderly" and 45.83% of them belong to "average without mobility barriers". As for the mobility of pre-elderly which going step in to elderly stage, the first place vehicle as short distance transportation is "scooter" by first place among age 50 to 59, and "car" is in the second place while walk by the second place among age 60 to 64. In the other hand, "walk" becomes first place but "scooter" is in the second place by 20% among the elderly age 65 above. But the average rate of taking bus as transportation is low than any other transportation (Watanabe N., 2005). Generally speaking, current car driving ratio of the elderly is under 20%, but the ratio of scooter is stay in 50% (Shen T., 2003). The researches indicate the elderly mobility and potential travel demand are unusual as traditional citizens. Planning and targeting the elderly transportation contains safety, accessibility, economic and comfort base on the elderly mobility characteristics and current transportation weak points (Lan and Yang, 1992). To observe the mobility influences of pre-elderly and elderly, this study takes scooter applying situation with elder groups by exploring their scooter riding habits and barriers with traffic environment. Moreover, potential user's need, influences of traffic environments and limits of present vehicles might investigate in the view of correlation among human, vehicle, and environment.

2.3.2 Definition of scooter

"Moped" means a motorized device designed to travel with not more than 36 inch or larger diameter wheels in contact with the ground, having fully operative pedals for propulsion by human power, and an electric or a liquid fuel motor with a cylinder displacement not exceeding 50 cubic centimeters which produces no more than two gross brake horsepower (developed by a prime mover, as measured by a brake applied to the driving shaft) that is capable of propelling the device at not more than 30 miles per hour on level ground (The Washington state patrol, RCW 46.04.304).

Most scooters have smaller engines than motorcycles (between 30 cc and 250 cc with a single cylinder, though some models have twin cylinder motors). Most jurisdictions have no legal definition for "scooter". In general, 50 cc and under scooters are classified in most states and countries as a moped and are subject to reduced safety restrictions and licensing fees. Scooters above 50 cc are generally legally considered motorcycles, though some states have an in-between definition for motorized bike for scooters and motorcycles between 50 and 150 cc (Wikipedia). Motorcycle industry contains two-wheel, three-wheel, electric, and specific motorcycles. As shown in Table 2.2 concluded the scooter types which popular riding in the present traffic environment.

Table 2.2 Category of Taiwan motorcycle classified by exhaust volume

	< 50 cc (moped)	50-125 (scooter)	125-250 (scooter)	Over 250 (maxi-scooter)
Sample	Sym Mio 50	YAMAHA Breeze DX 125	KYMCO GRAND DINK 150	YAMAHA Majesty 250
Sample picture				
Exhaust	49	124	149	249
OVA L*W*H (m)	1.7*0.7*1.0	1.8*0.7*1.0	2.0*0.8*1.4	2.1*0.8*1.4
Weight	80	106	155	173

Source: Official website of Sym, YAMAHA, and KYMCO, 2006.

2.3.3 Scooter development in Taiwan with the elderly

The history of scooter development in Taiwan is divided into four stages which are addressed as followed:

1. Initial stage (Japanese colonization - 1961): Scooters are imported gradually from 1940s but only for limited high-income customers due to high price then. The scooter is popular after the vitalization of agriculture, industry and economics in 1961, while the government encourages building local scooter industry to rise Taiwan economics development.
2. Competitive stage (1962-1974): Main Taiwan scooter makers such as Sanyang, Kwan Yang, YAMAHA and PGO were founded before 1966 on this stage, and start scooter mass production in the market. PGO entering into technological cooperation with Italy's Vespa-Piaggio; the technological cooperation promotes scooter with great sales volume and push the trend of personal transportation by purchasing a scooter. In the same time, scooter industry development faced two barriers; one of the barriers is the government polices to restrict scooter industry development that make unhealthy companies closed, the other barrier is the scooter companies self-production rate up to 90% due to technological cooperated with foreign makers that defeat other rivals without technology cooperated.
3. Growing stage (1975-1990): The local content rate of motorcycles increased to 90%, which was a daunting challenge to the industry; however, it also brought a chance for part of vendors. With advantages of brand, technology and marketing, most vendors were keeping grow up in this period.
4. International stage (After 1991): The sales volumes grow up steadily since 1990s, especially the growing export sales volume. Kwan Yang motor created an original brand "Kymco", and setting the first year of international era while Sanyang industry established an international brand "SYM"; these two companies went to invest in Mainland China and Vietnam respectively.

Compared with the stages of scooter development, Baby Boomer generation (born

between 1946 and 1964) is under the growing scooter environment and take scooter for personal transportation or commute tool in their younger age. They are the first group of scooter users which continue riding habits in matured age nowadays.

There is a great amount of scooter riders in Taiwan compared with other countries and plenty of the elderly scooter riders as well; The scooter numbers has reached to 13.16 million until the end of 2005. From the motorcycle ownership ratio, the results show there are 580 scooters in every thousand person as shown in Table 2.3. According the investigation of scooter applications in Taiwan (The investigation scooter use in Taiwan area, 2004) indicates 10.3% scooter users are age over 60 years old (60~65 years by 4.6% and age over 65 years by 5.7%) base on 27,133 scooter users.

The elder group takes the scooter as the short distance transportation instead of walking and taking public transportation due to inconvenient public transportation environment. The research (The investigation scooter use in Taiwan area, 2004) indicates the scooter users whose age over 60 years old have lower intension replacing scooter with public transportation, the reasons are as follows:

1. Factors continue using scooter of age 60 to 64 years old: ① public transportation is inconvenient (37.2%); ② nearby their work location (35.5%);
2. Factors continue using scooter of age 65 to 69 years old: ① nearby their work location (24.5%); ② alternate work location (26.9%);
3. Factors continue using scooter of age over 70 years old: ① public transportation is inconvenient (31.7%); ② nearby their work location (30.5%).

Table 2.3 Scooter ownership ratio divided by countries

Country	Scooter ownership ratio per thousand person (year)
Italy	125(1999)
German	64(2002)
USA	15(1999)
UK	28(2000)
Japan	110(2000)
Taiwan	497(1999) 580(2005)
Malaysia	233

Source: IRF (International Road Foundation), World Road Statistics 2003

2.4 Review of scooter fatalities tendency by year

2.4.1 Scooter accident analysis with the elderly

There are three major features to explain Taiwan traffic safety environment: plenty of scooters, growing scooter accidents, and high elderly fatality rate. The elderly lives under more severe impact at same traffic situation and numbers the elderly traffic accident fatalities is raising year by year, as shown in Table 2.4 indicates the raising numbers of traffic accidents the elderly involved.

Table 2.4 Number of road traffic accident fatalities by age

Years	45-54	55-64	65-69	70 +	Unknown
1994	295	330	161	282	66
1995	273	336	186	271	76
1996	300	353	152	286	67
1997	262	294	187	232	38
1998	279	283	139	269	23
1999	255	260	154	258	28
2000	402	368	198	377	21
2001	404	376	224	446	13
2002	343	300	157	482	11
2003	339	296	193	440	27
2004	360	278	187	444	26

Source: National police agency, MOI (Unit：Person)

Review the government data of scooter fatality deaths and crude mortality rates which conclude in the Figure 2.4, the result indicate the number of scooter accident death increasing acutely from the age 50 including male and female. As the result, it corresponds why this research extends to the target group from age 50 years old while the elder citizens might involve within the scooter riding barriers since this age level.

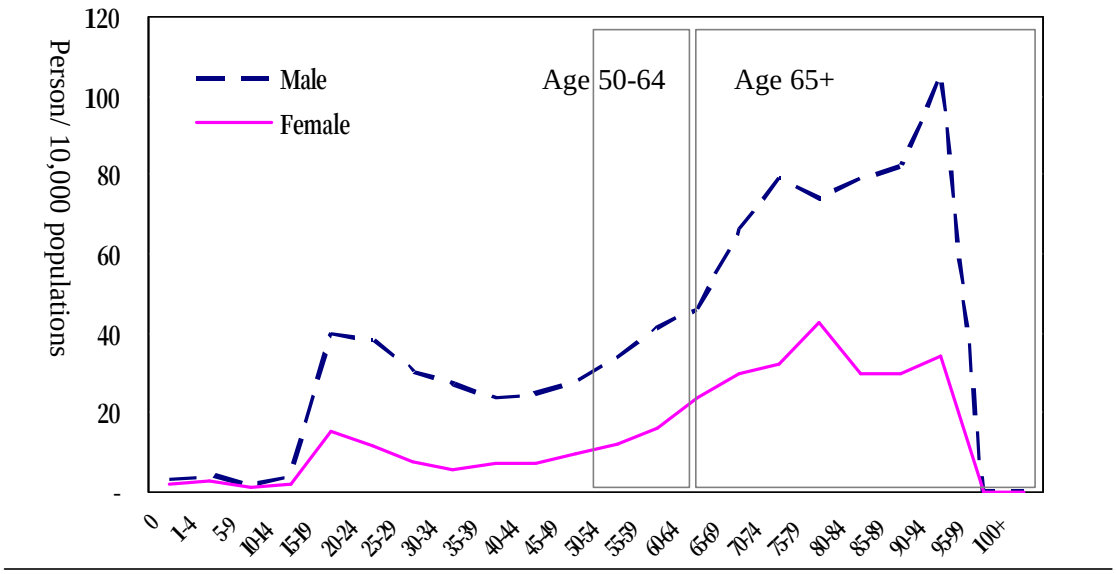

Figure 2.4 Number of scooter fatality deaths and crude mortality rates by gender and age groups

Source: Dept. of Health, MOI, 2005

The research indicates that the aging elderly reduce the times of riding to avoid long time riding, and mobility is the major attribute effecting them applying scooter. (The investigation scooter use in Taiwan area, 2004) It also indicates that the main use age of scooter applied for their daily shopping, and relies on high mobility of the scooter; On the other hand, the elderly start to reduce long time riding the scooter while aging. The important advantage of scooter for the elderly is to help them get rid of inconvenient mobility life and raise their personal independence.

In the aspect to analysis the correlation between Taiwan aging society and traffic safety, Traffic accidents analysis 2004 investigate Taiwan traffic accidents and summarized in Figure 2.5 below; the results indicate the highest death rate accident is the scooter, and the pedestrian by the second place.

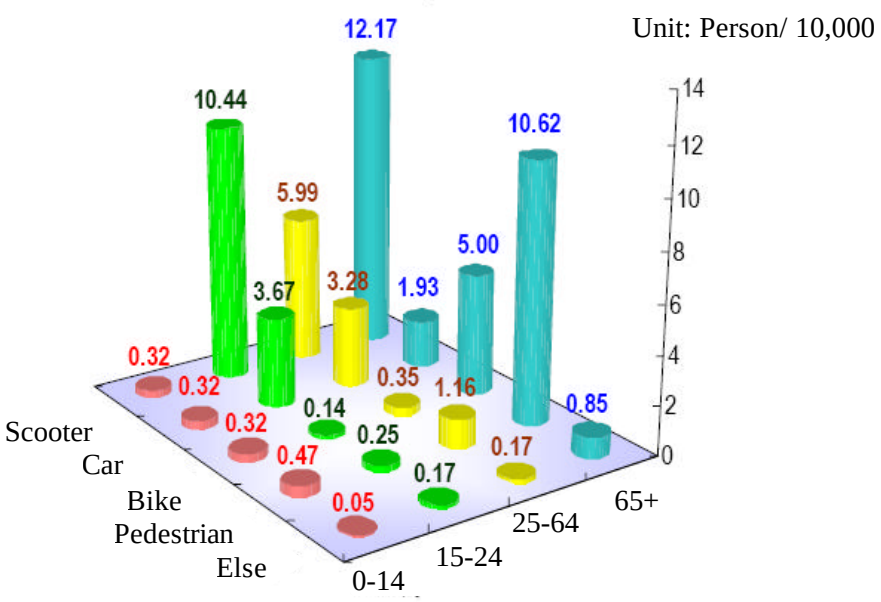

Figure 2.5 Death and crude mortality rates cataloged by vehicle types

Source：Traffic accidents analysis 2004

Scooter is the most convenient tool in the elder citizen's life but comes with under estimated danger. On the other hand, scooter accident is the first high rate among whole elderly vehicle accidents, and major injured parts located on the head, leg and feet, and synthetic parts as well. Accident involved vehicle types which elderly used are as follows: Scooter(47%), pedestrian(26%), and bike(12%), and scooter is the highest medical cost among three types (Chen, W., 2004). Table 2.5 summarized Head, leg and feet, and synthetic part are main injure with high percentages in the scooter accident. Traffic crash involved elderly people (Lin F., 2005) investigated 198,0000 subjects from the national police agency traffic accident database from 1990 to 2001, the results indicates most passenger car drivers not injured in the accidents, but most scooter riders are belong to the injured group; Moreover, extremities and synthetic parts are the major symptoms of the injured elder scooter riders.

Table 2.5 Comparison of accident vehicles and injured elderly parts

Part Injured	Scooter accidents	Bike accidents	Pedestrian accidents
None	20(2.65%)	1(0.53%)	0(0.00%)
Head	228(30.16%)	101(3.16%)	215(50.59%)
Neck	8(1.06%)	2(1.05%)	1(0.24%)
Bosom	34(4.5%)	6(2.11%)	16(3.76%)
Abdomen	7(0.93%)	2(1.05%)	10(2.35%)
Waist	17(2.25%)	4(2.11%)	8(1.88%)
Backing	15(1.98%)	2(1.05%)	3(0.71%)
Hand& wrist	64(8.47%)	5(2.63%)	8(1.88%)
Leg& feet	171(22.62%)	30(15.79%)	60(14.12%)
Synthetic	192(25.40%)	37(19.47%)	104(24.49%)
Total number	756(100%)	190(100%)	425(100%)

Source: Chen W. (2004), "An analysis traffic accident injury and medical cost on the elderly", Committee of Road Safety and Traffic Injury Prevention, ROC

In the next 20 years, the amounts of senior scooter users will not decrease as well due to the users continue their habit riding scooter since their adult's hood, especially the pre-elderly belong to Baby Boomer generation. Taiwan elderly scooter rider population (age over 65 years old) are larger than elderly passenger car drivers, and greater involved within accidents. The definition of elderly age range is too wide that the numbers of elderly scooter riders start declining if calculate from age over 70 years old (Lin F., 2005). Therefore, divide the age level of the elderly will help to figure out the characteristics of scooter users and pedestrians. In the other hand, the senior citizens age on 55 years olds are much rely on the convenient; on the other hand, observing the mobility habits of 50 years old will indicate a huge amount of scooter users which counts on its convenient mobility.

2.4.2 Feature of scooter accident involved with the elderly

Elderly has fewer opportunities involved in the accidents, but higher possibilities injured in the accidents (Lin F., 2005). It indicates elderly hazard rate leading death is two to five times higher than younger in single vehicle, vehicle to vehicle or vehicle-pedestrian accidents. Hazard rate leading elderly death is higher when injure part on the head. Another result also indicates Taiwan elderly rider hazard rate leading

death is higher than foreign countries when injured part on the head.

The death rate of elderly is higher than any age level when involved in the accident. Lin F. (2005) points out five points of elderly traffic accident feature as following：①The elderly traffic accident death rate is 3 to 4 times higher than younger; ② elderly scooter rider death rate is 10 times higher than passenger car driver; ③ the elderly accident death rate still 3 to 4 times higher than younger even equipped with safety protection; ④ the death rate are 9 times higher than any body parts when injured on head no matter with safety protection or not; ⑤ accident death rate will increase on drivers and pedestrians while age increasing, and the death rate of elderly is higher than age 50 by 3 to 5 times higher when involved in the accident.

Danger avoidance is characteristic of elderly due to their long term riding experience and observation with traffic and the research indicates the elderly reduce stepping out while at night or bad weather. But the elderly involve into well traffic circumstance (sunny day, barrier free, or inside vision distance) higher than any other type of traffic accidents, and involved within intersection accidents as well. The following four points is how the elderly vehicle driver involved into accident as followed (Lin F., 2005):

1. Elderly crash risk is not lower than younger while in high traffic expose level;
2. Elderly might involved within well traffic circumstance (sunny day, barrier free, or inside vision distance) by danger avoidance is characteristic;
3. The elderly used to ignore safety protection while applying light transportation and it raise the death rated if the traffic accident happens;
4. The elderly might feel confused with the suddenly right turn by car when they riding the scooter and it indicate the conflict phenomenon of present traffic environment.

In the aspect of the elderly life development and vehicle safety, the overall researches point out that the elderly are under the risk to continue using the scooter in their life, but still no evidence indicates what kinds of physical or environment attributes threaten the elder scooter users in behind .

2.5 Driving Abilities Limits on Elder Drivers

Aging will lead to declining cognitive, psychomotor and perceptual abilities, determining the relationship between the various health problems (i.e., functional limitations, vision symptoms and conditions, and medical conditions). Age-related illness problems and illness-related functional impairment are the main causes that affect elder driver's ability (Hakamies-Blomqvist and Wahlstöm, 1998; Waller).

Healthy problems might impact on an individual's mobility. Specific functional limitations and medical conditions associated with driving status. Therefore, the following section discusses the changes or limits of the elder group, including visual and hearing abilities, reaction, and cognition, which might affect their abilities and safety of driving.

2.5.1 Visual and hearing abilities

Pitts (1982) indicates that visual acuity remains relatively constant throughout life until approximately age 50, and then declines faster with increasing age. Other research has confirmed changes beginning around age 45 (Decina and Staplin, 1993) and more severe declines after age 60 and older (Burg, 1966; Pitts, 1982; Laux and Brelsford, 1990). Another obvious change of older people' s visual process is presbyopia, or loss of accommodation, which means one' s disability to see things close clearly (Yanik, 1989). It makes elder drivers moving their heads back and forth while driving to adjust the distance to read the display or control labels clearly. Furthermore, side vision reduces as people aged (Eby et al., 2000).

Vision, perception and extremity reaction are basic three abilities for control vehicles; while environment information is sent via vision to brain to make perception, finally output in extremities reaction to process driving behavior. Moreover, many driving behaviors count on vision ability; therefore, vision ability playing an important role on affecting driving skills (Lin F., 2005).

Hearing degradation will start degrading since age 30, but middle and low

frequency degrading is not obvious as high frequency degrading. The whole hearing degradation begins after age 70 and it cause error of judgment on sound source (Lin F., 2004). Figure 2.6 concluded how vision and hearing degrading according by age as following.

Figure 2.6 Vision and hearing degrading condition divided by age

Source: Fukuda R., Course content of environment design for the elderly

2.5.2 Reaction

The decreased action symptoms may affect the ability of safe driving, and raise the chance of getting involved in an accident. Boren and Chiang measured the braking response time through the driving simulator in their research in 1996. The result showed that older people need longer time for reacting to unexpected barriers. Moreover, according to the experimental result of Schlag in 1993, elder drivers, compared to other age groups, need longer time tracking and reacting. Table 2.6 concluded the degrading symptoms correspond to disease in the view of human factor.

Table 2.6 Degrading symptoms cause by diseases

Diseases / Symptoms	Senescence	Arteriosclerosis	Hypertension	Parkinson's	Peripheral	Drowsiness	Cataract/ glaucoma	Arthritis	Paget's disease	Osteoporosis	Lower back pain	Bronchitis/emphys	Pneumonia	Diabetes	Senile dementia
Degradation	●		●	●	●			●	●	●	●	●	●	●	●
Mobility	●	●		●	●		●	●	●		●				
Posture	●			●			●	●	●	●	●				
Pain		●		●	●			●	●		●				
Incoordination		●		●	●		●	●							
Sensation input decline	●	●			●		●								
Balance declining	●	●		●	●		●								
Joint weaken						●		●	●	●	●				
Muscle declining	●			●				●							
Auditory disorders	●					●		●						●	●
Gravity loss		●					●	●							
Short of breath		●		●								●	●		
Memory impairment		●				●									●
Visual impairment	●	●												●	
Disorientation		●		●											●
Perceptual decline	●				●	●									
Cognition disturbance		●		●											
Incontinence		●													
Speech disorders				●		●	●								●
Touch disabilities	●				●			●						●	

Source: Human Factors Design Handbook, 1992

Ranney and Pulling (1989) proposed, "The slowing of reaction time associated with aging has effects on driving skills related to vehicle control. Figure 2.7 summarized the procedure of human reaction affect driver's decision process, and shows that reaction related with driver's skill such as observation, judgment, and action.

Therefore, once if the driver with slower reaction time, it comes with higher danger.

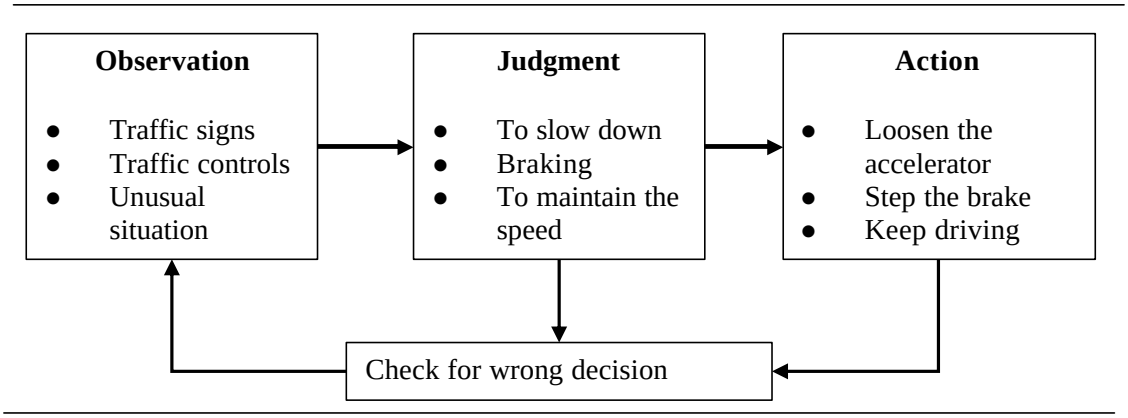

Figure 2.7 Procedure of human reaction

Source: Committee of traffic safety supervision, MOTC, ROC, 1994

2.5.3 Cognition

The difference of the elderly conscious changes may describe from the outside physical degrading into inner of their mental situations. Physical effects on aging: ①physical declining; ②brain function declining; ③physical information inputs declining; and ④comes with the society environment changes (cultures, religions, and sense of self value, etc) effect the developments of the elderly life, conscious, life styles, and personality gradually.

Elder drivers have declined abilities of cognition or psychomotor (Guerrire et al., 1995). While age relates significantly to cognitive characteristics, distinct characteristics relate to particular tasks. Elder drivers significantly higher estimated the car velocity and the car distance (Scialfa et al., 1987), and when making decisions in the driving task, they needed more time and might have difficulty locating targets in visual searching (Ranney and Simmons, 1992).

Figure 2.8 is the framework to develop the Driver Decision Workbook (DDW, Eby et al., 2000). From the framework of DDW shows a complete assessment instrument that contains the dimension of health (including health condition and medication condition), driving abilities (including visual ability, cognitive ability and motor ability)

and driving experiences, attitude and behavior.

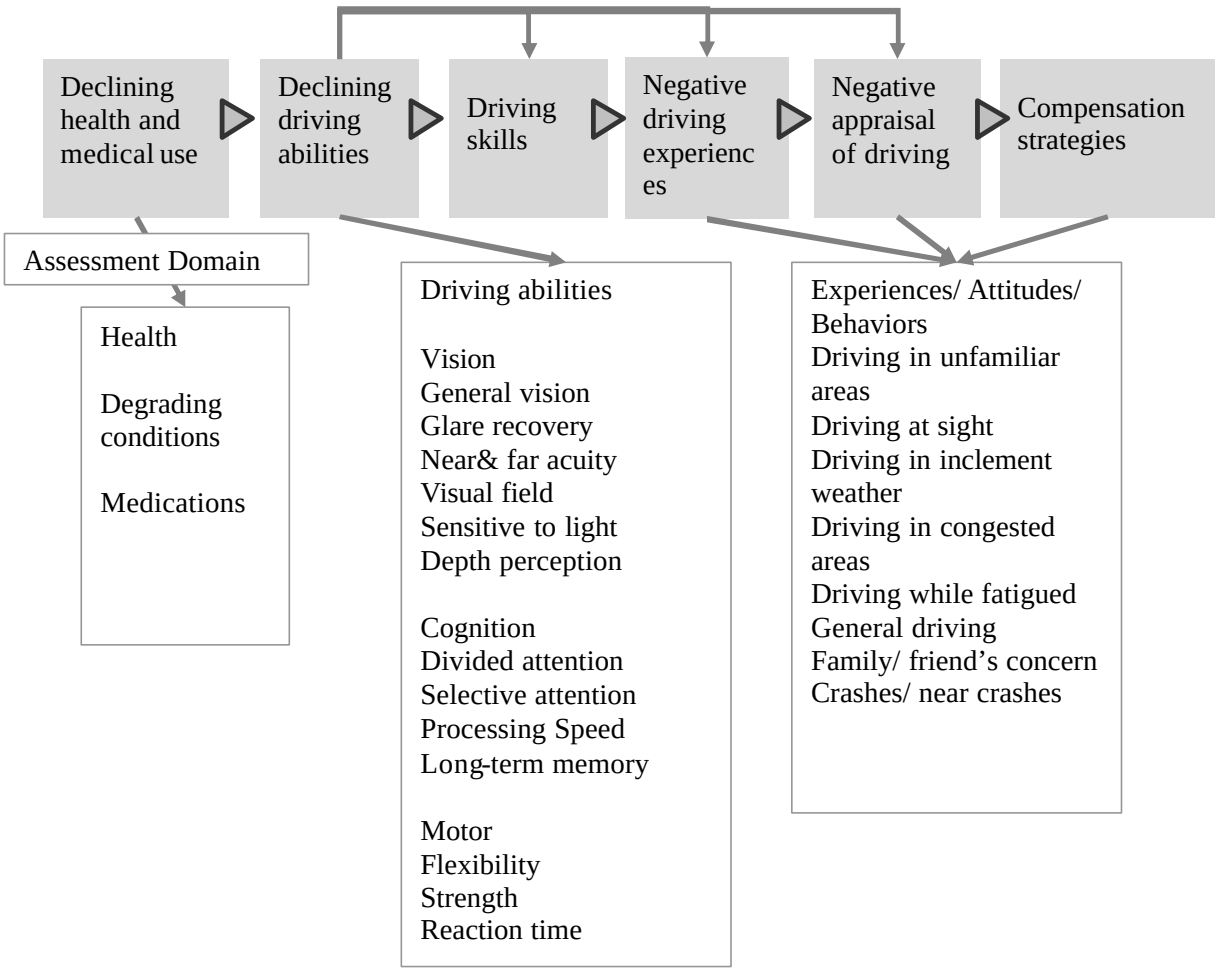

Figure 2.8 Influences on older driver decision making

Source: Eby et al., 2003

Based on reaction and recognition review, the author concludes six points that effect on scooter riding behaviors as following, and the relations are concluded in Table 2.6: ①Visual impairment; ②Hearing impairment; ③Memory impairment; ④Posture; ⑤Disorientation and ⑥Balance declining.

Table 2.7 Degrading symptoms effecting on scooter riding

Degrading symptoms	Effecting subjects on riding skill
Vision impairment	Information receiving Night riding Reaction time
Hearing impairment	Reaction time Information receiving
Memory impairment	Cognition Judgment
Balance declining	Skill to balancing scooter
Posture	Comfortless riding Fatigue Reaction time Keep scooter balance
Disorientation	Cognition

2.6 Elderly scooter rider riding behaviors

Benekohal (1994) indicates the elderly population tendency by following three points: ① as growing of elderly population, the driver population rate of elderly driver driving on high way and street will increasinge as well; ② elderly population resident area changes from downtown to suburban; ③ the increasing ratio of the elderly drive vehicles by themselves alone. U.S. researches (Kara E. MacLeod, 2004) point out that elderly adults reduce or modify their driving behavior or stop driving, increased age is associated with reduced and modified driving behavior as well. Marottoli, Fonda, Ragland, Carp, et al. indicate that these elderly adults decrease their activity, mobility, and independence and increased depressive symptoms. In the other hand, Taiwan is under the traffic environment with great amount of scooters, but the elder citizen starts facing the inconvenient public transportation and applying scooter under undetected risks.

“Driving safety while aging gracefully” this slogan is from NHTSA (National Highway Traffic Safety Administration, USA) injury prevention for older driver website. It indicates that older adults continue to drive into very old age, while many older adults continue to drive safely, others develop declining functional abilities that negatively

impact safe driving.

The elements of vehicle evasion content with prevision, speed, reaction time, and reaction distance (Zhang, 2006). To riding a scooter need to acquire skills to keep the scooter balance, but the scooter is belong to high risk transportation due to weak protection for the rider. As shown in Figure 2.9 taken by the author, elder scooter rider makes turning in carefully attitude but keep in slow speed but keep their feet closed to the ground.

Figure 2.9 Conditions how the elder riders make turns

Elder drivers generally perceive their driving ability to be better than or equal to that of their peers (Holland, 1993; Marottoi and Richardson, 1998) and better than that of younger drivers (Groeger and Brown, 1989). As shown in the following Figure 2.10 taken by the author, the elderly scooter riding behaviors might leading to traffic accidents in potential such as ignore safety protection, carrying too many passengers, or put too much goods on the footpad.

Figure 2.10 Conditions how the elder riding scooter

Shen T.(2003) investigated the primary events that effect the elderly while riding scooter in Taiwan area by five locations as shown in the following Table 2.8, the results

shows not only prove elderly has scooter riding barriers but also uncover those similar barrier events no matter with each location; he indicates four directions of ITS (Intelligent Transportation Systems) information services in considering elderly scooter riding barriers as shown in Table 2.9 as well：① Provide driving information; ② Vision enhancement; ③ Safety warning; ④ Awareness and reaction enhancement.

Table 2.8 Primary events the elderly facing while riding scooter

Location	Primary	Second	Third
Taipei	Sideswiping by vehicle	slower reaction with sudden event	Road Roughness
Tainan	slower reaction with sudden events	Easy felt fatigue	Lack of attention to vehicle, pedestrian or barriers
Chiayi	Balance disorientation	slower reaction with sudden events	Lack of attention to vehicle, pedestrian or barriers
Hualien& Taitung	Road Roughness	slower reaction with sudden events	Sideswiping by vehicle

Source: Shen T.(2003), Application of ITS Technology for the Aging Society

Table 2.9 ITS driving application on aging society

User	Transportation need of the elderly	ITS solution
Car and scooter drivers	Provide driving information	Navigation system
	Vision enhancement	Night vision enhancement
	Safety warning	Bump prevent warning
	Awareness/ reaction enhancement	Vehicle auto pilot system Driver monitoring system

Source: Shen T.(2003), Application of ITS Technology for the Aging Society

2.7 Evaluating the scooter position with the elderly

A motorcycle or motorbike is a single-track, two-wheeled motor vehicle powered by an engine. Styles of motorcycles vary depending on the task for which they are designed, such as long distance travel, navigating congested urban traffic, cruising, sport and racing, or off-road conditions (Wiki).But scooter is unlike the design position of motorcycle, but in the way to present high mobility through urban city with limited speed. In the view of scooter users, there two point to address if the scooter is qualified

for the elder groups:

1. Suitability: Suitability represents the quality of having the properties that are right for a specific purpose.
2. Necessity: Necessity represents the quality or state of being necessary, unavoidable, or absolutely requisite.

2.7.1 Universal design

Universal design, which is related to "inclusive design" and "design for all," is an approach to the design of products, services and environments to be usable by as many people as possible regardless of age, ability or circumstance. Mr. Ron Mace introduced the approach in his famous UD seven principles. He defines universal design as "The design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Mace, 1997), and his seven principles are:

1. Equitable use: The design is useful and marketable to people with diverse abilities. The guidelines are as followed:
   (1) Provide the same means of use for all users: identical whenever possible; equivalent when not.
   (2) Avoid segregating or stigmatizing any users.
   (3) Provisions for privacy, security, and safety should be equally available to all users. Make the design appealing to all users.
2. Flexibility in use: The design accommodates a wide range of individual preferences and abilities. The guidelines are as followed:
   (1) Provide choice in methods of use.
   (2) Accommodate right- or left-handed access and use.
   (3) Facilitate the user's accuracy and precision.
   (4) Provide adaptability to the user's pace.
3. Simple and intuitive: Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level. The guidelines are as followed:

(1) Eliminate unnecessary complexity.

(2) Be consistent with user expectations and intuition.

(3) Accommodate a wide range of literacy and language skills.

(4) Arrange information consistent with its importance.

(5) Provide effective prompting and feedback during and after task completion

4. Perceptible information: The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities. The guidelines are as followed:

   (1) Use different modes (pictorial, verbal, tactile) for redundant presentation of essential information.

   (2) Provide adequate contrast between essential information and its surroundings.

   (3) Maximize "legibility" of essential information.

   (4) Differentiate elements in ways that can be described (i.e., make it easy to give instructions or directions).

   (5) Provide compatibility with a variety of techniques or devices used by people with sensory limitations.

5. Tolerance for error: The design minimizes hazards and the adverse consequences of accidental or unintended actions. The guidelines are as followed:

   (1) Arrange elements to minimize hazards and errors: most used elements, most accessible; hazardous elements eliminated, isolated, or shielded.

   (2) Provide warnings of hazards and errors.

   (3) Provide fail safe features.

   (4) Discourage unconscious action in tasks that require vigilance.

6. Low physical effort: The design can be used efficiently and comfortably and with a minimum of fatigue. The guidelines are as followed:

   (1) Allow user to maintain a neutral body position.

   (2) Use reasonable operating forces.

(3) Minimize repetitive actions.

(4) Minimize sustained physical effort

7. Size and space for approach and use: Appropriate size and space is provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility. The guidelines are as followed:

(1) Provide a clear line of sight to important elements for any seated or standing user.

(2) Make reach to all components comfortable for any seated or standing user.

(3) Accommodate variations in hand and grip size.

(4) Provide adequate space for the use of assistive devices or personal assistance.

The concept of UD (Universal Design) contents human, society and environment instead of previous thought that only concentrate the relation of users and product maker with limited views. Therefore, in aspect of considering whole age levels and environments, several UD evaluations and UD process are involved into product design developments as references for product designers and managers. There are related definitions from different field as shown in Table 2.10 which include the definition from Mace, Five A-principles form Kansas State University and three supplementary rules from Tripod design Japan base on original UD seven principles.

Table 2.10 Collections of universal design principles

Promoter	Contents
Mace	Equitable use Flexibility in use Simple and intuitive use Perceptible information Tolerance for error Low physical effort Size and space for approach and use
Mace	Better design; More beautiful; Good business
Kansas State University	Accessible; Adjustable; Adaptable ;Attractive ; Affordable
Tripod design Japan	Universal design seven principles plus three supplementary rules: Durability and economic compatible Quality and aesthetic compatible Healthy and environmental compatible

2.7.2 Evaluate by universal design

The evaluations of the usage of scooter from the view of universal design seven principles which refer to the hard and soft attributes from scooter and aging symptoms from elder riders and are summarized in following Table 2.11.

Table 2.11 Evaluation on scooter by universal design principles

Universal design principle	Negative points
Equitable use(#1)	Security and safety is not equally available to all users
Flexibility in use(#2)	Facilitate the user's accuracy and precision. Provide adaptability to the user's pace.
Perceptible information(#4)	No device to acquire scooter riding information
Tolerance for error (#5)	Require sustained physical effort Need effort to achieve riding skill Scooter without safety protection itself No information device to prevent crash
Low physical effort(#6)	Require sustained physical effort Need effort to achieve riding skill Scooter require rider's skill to keep vehicle balance
Size and space for approach and use(#7)	Provide adequate space for the use of assistive devices or personal assistance Provide a clear line of sight to important elements for any seated or standing user.

In the view of universal design related with driving features. Watanabe N. (2005) indicates the aging attributes related with the driving features base on the development of next generation vehicle as summarized in Table 2.12. The physical aging attributes such as vision ability, reaction, driving posture have correlations with controlling vehicles, and hard attributes such as the body structure, accessibility, control space and vehicle information services have effects on the elderly driver's reaction.

Table 2.12 Driving factors of the elderly aging symptoms

Related driving features	Physical attributes of the elderly
Effective view field	Neck and shoulder stiffness Short vision field
Driving reaction ability Vehicle structure	Vision ability declined
Accessibility in/ off vehicle	Joint flexibility decreasing Muscle activity decline
Widely control space	Neck and shoulder stiffness Joint flexibility decreasing
Driving posture	Joint flexibility decreasing Short vision field
Control ability Control vehicle	Cognition declined Joint flexibility decreasing
Visual measurement capability Information	Cataract or presbyopia Text and color recognized barrier Cognition declined

Source: Watanabe N. (2005), Research of the intelligent personal mobility in community

As the results, the elderly mobility barriers on scooter riding are summarized in aspect of UD (Universal Design) including evolutions considering whole age levels. The author analysis the scooter riding barrier experiences in three aspects: ①Vision and hearing – vision field, glare recovery, near and far acuity, sensitive to light and depth perception; ②Reaction – joint flexibility, strength, reaction time, aging body posture, balance disorder, neck and shoulder stiffness; and ③Cognition – divided and selective attention, processing speed on behavior, and long term memory. Those aging symptoms might bring riding barriers such as night riding, vehicle collision, take efforts on turning, fatigue, lost direction, nervous , and S-turn riding and they are summarized in Table 2.13 as followed:

Table 2.13 Aging symptoms related to riding barriers

Aging symptoms	Scooter riding barriers
Vision& Hearing ● Short vision field ● Glare recovery ● Near& far acuity ● Sensitive to light ● Depth perception	Night riding Vehicle collision
Reaction ● Joint flexibility decreasing ● Strength Muscle activity decline Grasp force declining ● Reaction time ● Posture change while aging ● Balance disorder ● Neck and shoulder stiffness	Take efforts on turning Keep vehicle balance Fatigue Vehicle collision
Cognition ● Divided attention ● Selective attention ● Processing speed ● Long-term memory	S-turn Lost direction Nervous and anxiety Vehicle collision

2.8 Chapter Summary

Base of the literature review, it indicates scooter itself has cause the risk of the elderly traffic accident, but lack of interventions to stop the raising accident rate. Therefore, this research make position base on the literature review by following four points:

1. The age level of the society is changing year by year, and increasing elderly will be a future target group. This research will focus on the pre-elderly since age 50 and elderly as study subjects since this population is under the pace of the huge Baby Boom generation (born between 1946 and 1964) and will step into the ranks of senior citizens in next decades.
2. The vehicle environment in Taiwan is different with other countries, one of the best examples is the scooter which provide in all around Taiwan traffic environment. The pre-elderly and elderly in Taiwan also count on the scooter very much in their daily life tours since they have applied scooter through their younger age along with the eruption of scooter development in Taiwan.
3. Scooter fatality death rates of elderly and pre-elderly create another statistic summit among whole populations which is not lower than younger generation (age 15 to 24). Most of the elderly injured body parts are located on head, feet, and synthetic events. Lin F.(2005) has mentioned that present elderly drivers has a “danger avoidance” characteristic due to their long term experiences on driving and recognizing traffic environment, and it helps them avoid involving into unwell traffic situation and accidents. However, it is inevitable the elderly’s fatality death hazard rate is three to four times higher than younger’s. If related sectors are not starting concern the elderly mobility issues, more future elderly will face higher fatality death hazards especially it comes with more elderly on 2015 by emerging huge aging Baby Boomer generation.
4. Scooter is under indistinct vehicle position for the elderly personal transportation that raises raising traffic accident rate due to its design direction

exclude elderly degrading situation after examine in aspect of UD (Universal Design). Moreover, visual, reaction, and cognitive abilities declining reflect that scooter has fallen short of protection for the elder riders, and brings them riding barrier experiences such as inconvenient night riding, balance disorder with vehicle, fatigue, and nervous.

5. Limited researches indicate elderly facing the barriers on scooter riding; Shen T. (2003) indicates events when elderly riding faced: Sideswiping by vehicle, slower reaction with sudden events, balance disorientation and road roughness. Lin F. (2005) indicates the elderly drivers have danger avoidance characteristic to reduce driving in danger circumstance. However, the attributes which cause these scooter barriers remain stay in unknown statues. Therefore, based on the reaction and cognition review, the author formulizes the degrading symptoms effecting riding barriers by six points: ①vision impairment; ②hearing impairment; ③memory impairment; ④balance declining; ⑤ posture and ⑥disorientation.
6. Researches might find answers to the common disease of old age. But beyond curing specific disease, researchers are also looking at interventions that could delay or actually reverse the process of aging. Therefore, this study continues finding attributes finding behind the elder group riding barriers for future study on elderly scooter riding.
7. Consider and implement design development through each age level user's view instead of product maker's is original point of UD (Universal Design). In the other hand, scooter is applied with diverse usages for the all kinds of age level in present Taiwan traffic environments and it's different with its original design for specific target groups – women users. In consider safety and usage for increasing riders – the elder group, this study use descriptive questionnaire to survey the elder groups' opinions in firsthand.

Chapter3. Methodology

The questionnaires survey is held to explore the interviewee's opinions and barriers with the scooters after reviewing the literature. With the results of the questionnaires, it helps to reveal important opinions of unspeaking elder groups, and the government and academic could make improvement for future elderly society development as well.

3.1 Questionnaires method

The function of research is to help obtaining clear answer to meaningful problems. It is possible to make a board distinction between two types of survey: (1) the descriptive, enumerative, census type of survey; (2) the analytic, relational type of survey. The purpose of descriptive survey is to count. When it cannot count everyone, it counts a representative sample and then makes inferences about the population as a whole. The important point to realize is that such surveys tell us how many members of population have certain characteristic or how often certain events occur. The job of such surveys provide essentially fact-finding and actuarial, the collected result are often to use to make predictions, for instance by comparing the results of surveys at different times and producing a trend (A.N. Oppenheim). As a result, we can conclude that this pilot questionnaires study is executed in the way of response distribution analysis.

3.2 Questionnaire process

In the aspect of exploring the elder groups' opinions with scooter and restricted research resource, these interviewees of the questionnaire survey are random sampling from elderly in Taichung urban area. The content of questionnaires is divided in four parts: ①interviewees' basic information; ② scooter riding frequency and usage; ③barriers when riding scooter, and ④attitudes if continue riding scooter in the future. SPSS and Microsoft Excel are applied to make statistic analysis to show to response

distribution, and the total process in shown as following Figure 3.1.

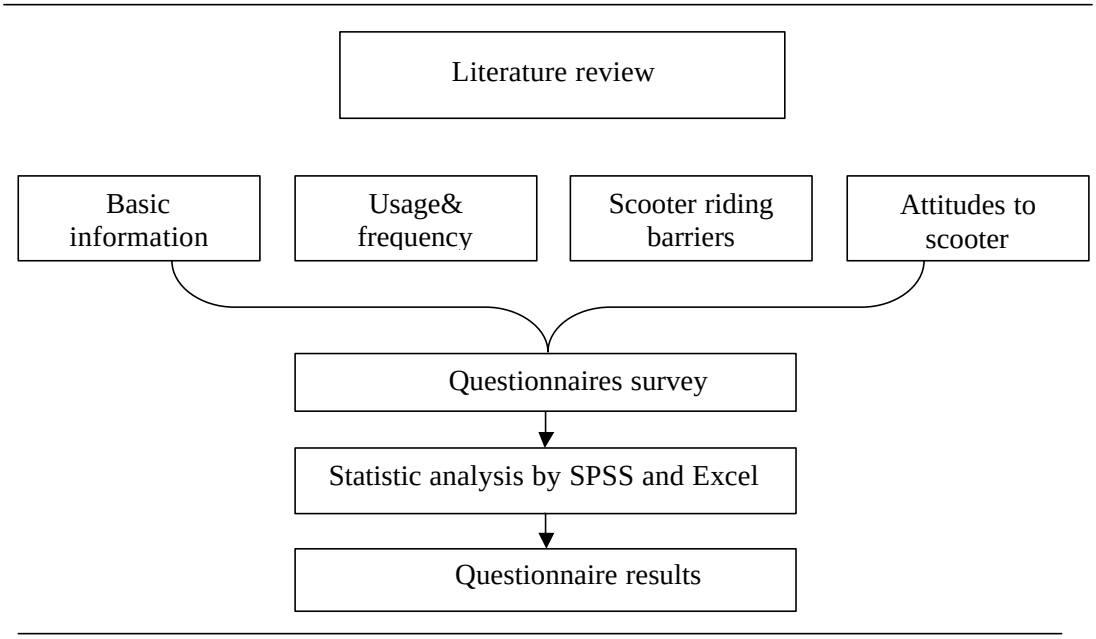

Figure 3.1 Questionnaire survey process

3.3 Questionnaire structure

Based on review of the literature and personal observation, questionnaire survey is divided in four parts by 26 questions. From the questionnaire, Q1 to Q11 are questions about population basic information, Q12 to Q20 are frequency and usage of riding scooter, Q21 is survey the barriers when riding scooter divided by 10 sub questions, and Q22 to Q26 are attitudes and opinions survey with scooter. Tables 3.1 concluded the contents and structure questionnaire as follows:

Table 3.1 Questionnaire structure

Questionnaire structure	Item	Objective
Population basic information(Q1-Q11)	Age, gender, marriage, education, and income	To know the elder group scooter riding habit and basic feature
Frequency and usage of riding scooter(Q12-Q20)	Frequency riding scooter Average riding time Average riding kilometers	Exploring how the elder groups applying the scooter
Barriers when riding scooter(Q21 divided by ten sub-events)	①make turning while riding, ②recognize signals, ③night riding, ④vehicle balance control, ⑤scooter bumping experiences, ⑥anxiety and nervous, ⑦fatigue, ⑧S-turn, ⑨lost direction	Exploring aging effects on the riding behaviors and search the exactly obstacle
Attitudes to replace scooter instead in the future(Q22-Q26)	The opinions of choosing transportation in the future	Exploring the elder group willing continue riding scooter

3.4 Implement of the questionnaire survey

3.4.1 Population and spot interview

The questionnaire survey interviewee's age is located the elder group from 50 years old as mention in chapter 2, and the survey area locates on the Taichung urban area due to limited research resource. In the other hand, limited area interviewees can make further cluster and cross analysis as well. The questionnaire the implemented by

random sampling to each elderly and pre-elderly by oral interview if the elder group confused with the content due to education level or handicapped , interviewer will help them explain the content to writing the questionnaire.

3.4.2 Timeline execute questionnaire

Survey time: From 2006 April 1st to May 1st

Questionnaire numbers: 62

Effective questionnaire subjects: 42

62 subjects are involved in this questionnaire, 42 effective samples continue riding scooters, 9 illegible subjects, and 11 subjects not continue riding but include their age to know the state of the riding situation from age group distribution.

Chapter4. Review of Questionnaire Results

This questionnaire is held as a pilot study for explore the elderly riding behavior and more further for their riding scooter obstacle experiences. Therefore, the results were carried out by the response distribution analysis and cross analysis with the Excel and SPSS statistics analysis software, and Figure 4.1 shows the structure of chapter 4 to explain content of each section.

4.1 Population characteristics	Basic information Motivation purchasing scooter and usage for scooter Riding characteristics per day and per week
4.2 Scooter riding barriers	10 scooter riding barriers on the elder group
4.3 Self-assessments	Traffic safety awareness self-assessment Attitudes to replace scooter in the future
4.4 - 4.5Cross& cluster analysis	Cross analysis by gender and age level Cluster analysis from the attitude to replace scooter

Figure 4.1 Structure of chapter 4 - Review of Questionnaire Results

4.1 Population characteristics

The results of questionnaire basic information are divided into three parts to discuss: ①basic scooter riding data, ②motivation purchasing scooter and usage for scooter, and ③riding characteristic per day and per week, the subjects characteristics are addressed in following section.

4.1.1 Basic information of subject

Table 4.1 summarized the basic characteristic of the subjects as follows:

1. Male and female subjects are about half and half; the survey shows the percentage of people who riding scooter is getting less with aging, 80.9% subjects are under 60 years old, and 19% is over 60 years old.
2. Most of subjects have an educational background of high school graduates (33.3%), and the second are elementary (23.8%).
3. 91.9% of the subjects own their personal vehicle license, represents most of them are qualified in law to riding the 50 c.c. scooter as well.
4. Half of the subjects (50.8%) have their own scooters, 28.6% of them own their passenger car.

Table 4.1 Basic scooter riding data of subjects

Event	Variable	Subjects (unit: person)	Percentage
Gender (Q1)	Male	20	47.6%
	Female	22	52.4%
Age (Q2)	51-55	20	47.6%
	56-60	14	33.3%
	61-65	5	11.9%
	Over65	3	7.1%
Education level (Q4)	Elementary or below	10	23.8%
	Junior	3	7.1%
	Senior	14	33.3%
	College	7	16.7%
	University	7	16.7%
	Graduate or above	1	2.4%
Vehicle license (Q9)	None	5	8.1%
	50 c.c. scooter	11	17.7%
	90 c.c. scooter	23	37.1%
	250 c.c. motorcycle	1	1.6%
	Passenger car	22	35.5%
Own vehicle (Q10)	None	2	3.2%
	Scooter	32	50.8%
	Passenger car	18	28.6%
	Bike	11	17.5%

4.1.2 Motivation purchasing scooter and usage for scooter

Investigating the motivation and usage why the elder group riding scooter in their daily life, the results are as shown in Table 4.2.

1. Motivation: 61.9% of the subjects purchasing the scooter as the short distance transportation tool are the highest percentage, second highest are for commute (16.7%) and to pick someone up (16.7%).
2. Usage: for shopping is the main usage in 40.5% among entire questionnaire samples.
3. Passenger capacity: 83.3% of the subjects only with one passenger, it means the elderly riding the scooter only themselves alone frequently.

Table 4.2 Motivation and usage why subjects applying the scooter

Event	Variable	Subjects (unit: person)	Percentage
Motivation buying scooter (Q12)	Short distance Transportation	26	61.9%
	Deliver goods	1	2.4%
	To commute	7	16.7%
	To pick someone up	7	16.7%
	Else	1	2.4%
Usage (Q13)	Visiting friends	3	7.1%
	Shopping	17	40.5%
	To pick someone up	6	14.3%
	Go Exercising	1	2.4%
	To commute	15	35.7%
Passenger capacity (Q14)	1	35	83.3%
	2	6	14.3%
	Over 3	1	2.4%

4.1.3 Riding characteristics per day and per week

Table 4-3 summarized frequency and scooter riding conditions per day, the result divides in four parts:

1. Riding time per day: the results shows subjects take scooter in short time riding, the order of results fall on ①10-20 minutes (38%) and ②less than 10 minutes (29%).
2. Riding frequency per day: the subjects take few runs ridings per day, the order of results are ①two times (38%) per day and ②one time (35%).
3. Riding distance per day: 50% of all subjects take riding less than two kilometers per day; others are ②2-4 km (24%) and ③4-6 km (17%).
4. Average riding time in one turn: 50% of subjects take under 10 minutes using scooter in average per run, 10-20 min (36%) by the second.

Table 4.3 Frequency and times of scooter riding per day

Event	Variable	Subjects (unit: person)	Percentage
Riding time everyday (unit: min; Q15(1))	Under 10	12	29%
	10– 20	16	38%
	20- 30	8	19%
	30- 40	1	2%
	40- 50	1	2%
	50- 60	3	7%
	60-70	1	2.4%
Riding frequency everyday (unit: times; Q15(2))	0	3	7%
	1	10	24%
	2	18	43%
	3	9	21%
	4	2	5%
Riding distance everyday (unit: km.; Q16)	0-2	21	50%
	2-4	10	24%
	4-6	7	17%
	6-8	3	7%
	More than 8	1	2%
Average riding time in one turn (unit: min; Q17)	Under 10	21	50%
	10-20	15	36%
	20-30	4	10%
	30-40	1	2%
	50-60	1	2%

Table 4.4 summarized frequency and scooter riding conditions per week, the results divide in three parts:

1. Days riding scooter per week: the subjects are high scooter using rate group, and each percentage of riding days by order is as follows: ①everyday (38%), ②6 days (14%).
2. Riding frequency per day: ①occasionally (41%), ②often (26%), ③Seldom (19%), ③ seldom (19%), ④ always (10%) and ⑤ never (5%).
3. Riding distance per week: there are two summits among event variables, the order is as follows: ①over 8 km (33%) ②0-2 km (29%), and ③2-4 (24%). By checking the source data of subjects who choose over 8 km, it is found that most of them are using scooter for commuting or delivering goods as main usage.

Table 4.4 Frequency using scooter per week:

Event	Variable	Subjects (unit: person)	Percentage
Days riding scooter by week (unit: day; Q15(3))	0	2	5%
	1	2	5%
	2	5	12%
	3	5	12%
	4	6	5%
	5	4	10%
	6	6	14%
	Everyday	16	38%
Riding frequency per week (Q15(4))	Never	2	5%
	Seldom	8	19%
	Occasionally	17	41%
	Often	11	26%
	Always	4	10%
Riding distance per week (unit: km.; Q19)	0-2	12	29%
	2-4	10	24%
	4-6	2	5%
	6-8	4	10%
	Over 8	14	33%

Compare each elderly total riding distance per week, Figure 4.2 summarized each response and calculate the main riding distance as shown follows; it could divided into two groups, short distance and long distance riders. The short distance rider is the most

of the questionnaires. Percentage of the elderly riding distance from 0 under 4 km is 53% (N=22), it indicates that more than half of the elderly take scooter as short distance transportation.

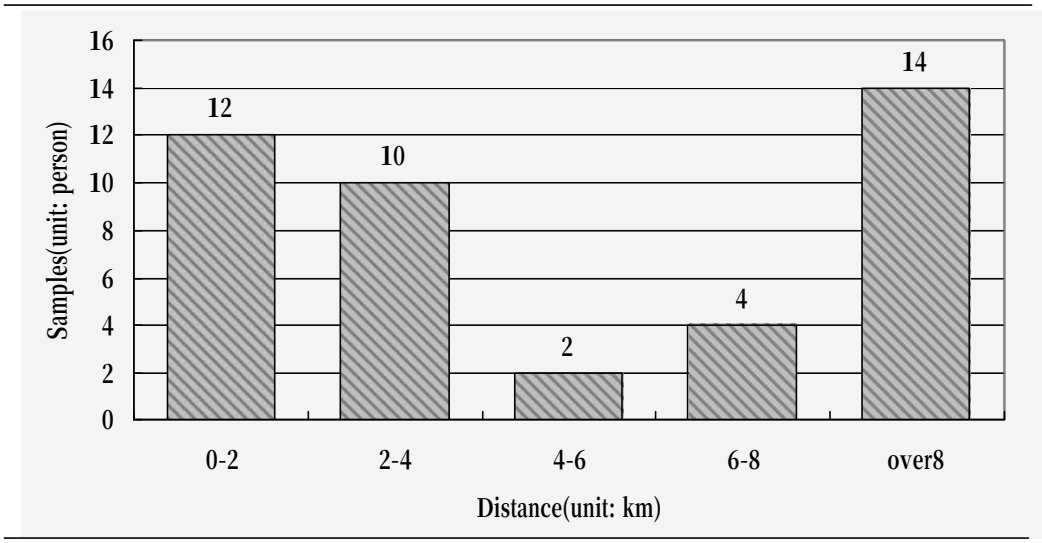

Figure 4.2 Average riding distance per week

Another part in the questionnaire investigates the subjects if they ever have car accidents in the last one year, 78.6% (N==33) of the subjects have negative answer, while they have risk avoidance characteristics as literatures shown. In the other words, there has 22.4% (N=11) of the subjects did have accidents or collision in the last year. Table 4.5 summarized the result and conclude questionnaire events as follows ：

1. Accident type: main accident type is collision which bumped by vehicles by 9.6% of whole subjects; 4.8% (N=2) of subjects have experiences be bumped by scooter, while 4.8% were bumped by car.
2. Accident place and time: Main accident places focus on roadway, lane and intersection; accident time section mainly falls on afternoon (9.5%, N=4) and morning (7.6%, N=3).

Table 4.5 Frequency distribution of accidents in this year

Event	Variable	Subjects (unit: person)	Percentages
Have any accident experiences in 2005(Q20)	Bumped by car	2	4.8%
	Bump on someone's scooter	1	2.4%
	Bumped by scooter	2	4.8%
	Hit object on road	1	2.4%
	Else	3	7.1%
	Never have accidents in last year	33	78.6%
Place accident happens(Q20)	Roadway	3	7.1%
	Lane	3	7.1%
	Intersection	3	7.1%
Time section(Q20)	Daybreak	1	2.4%
	Morning	3	7.1%
	Midday	1	2.4%
	Afternoon	4	9.5%

4.2 Experiences of riding scooter barrier

Each questionnaire events are calculated into response distributions and pick up high frequency events to make deep result research by cross analysis and cluster analysis to explore the correlations between scooter barrier experiences and effecting attributes which the summarized procedure as following Figure 4.3.

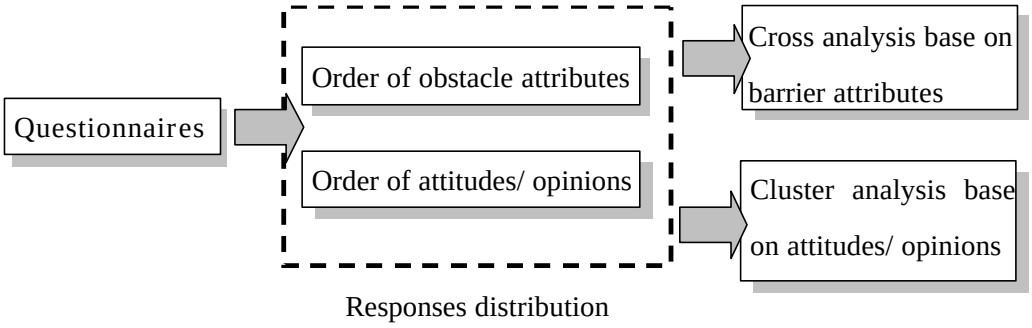

Figure 4.3 Procedure of questionnaire analysis

Figure 4.4 summarized the response distributions of scooter riding barrier experiences by following nine points by order of frequency: ①Nervous; ②Control

vehicle balance; ③Night riding; ④Turning; ⑤"Recognize signal" and "Fatigue" at the same phase; ⑥Be bumped by vehicle; ⑦Bump on object; ⑧Lost direction when riding; and ⑨S-turn.

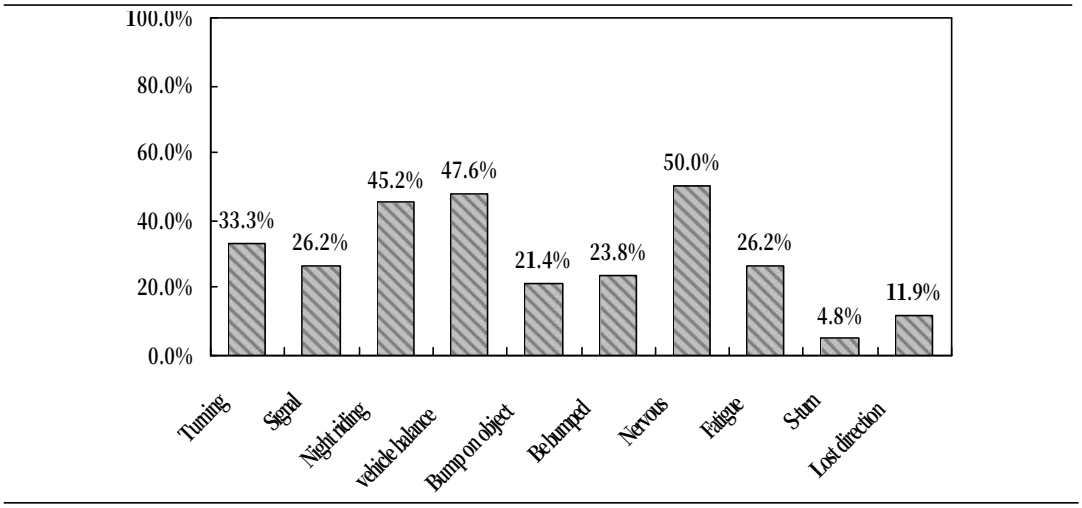

Figure 4.4 Percentage of having scooter riding barriers

Further details are addressed as follow sections by the order of each scooter riding barriers event in the questionnaire Q21:

1. Attributes cause nervous situation when riding scooter: the event of nervous has the most higher percentage in the questionnaire by 50%; "slower reaction time" cause the riding obstacle most often, the order of each attribute is as follows: ①Slower reaction time, ②inattention, ③else, ④vision degrading and strength and grasp force degrading, ⑤disorientation. Figure 4.5 summarized the percentage of each attributes.

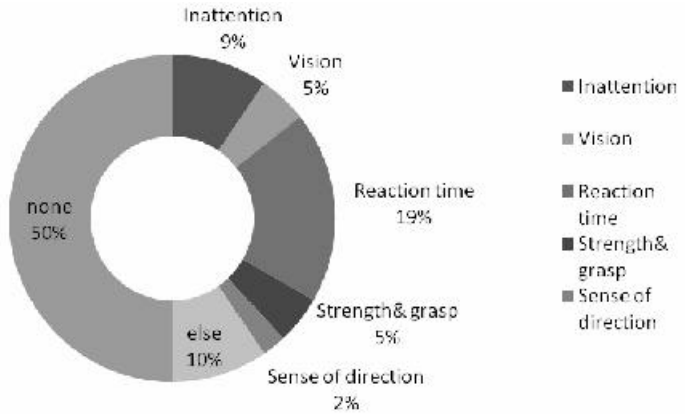

Figure 4.5 Attributes cause nervous when riding scooter

2. Attributes cause obstacle of control vehicle balance when riding scooter: 48% subjects have riding experiences with control vehicle balance obstacle by the second high place among the questionnaire events. “Balance disorder” is the higher attribute by 20% among whole subjects. Figure 4.6 summarized the attributes as follows: ①balance disorder, ②slower reaction time, ③inattention, ④vision degrading, and rachis disease and else.

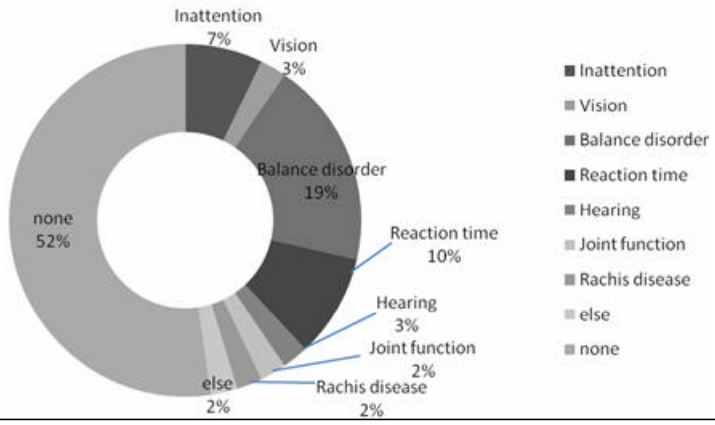

Figure 4.6 Attributes cause control vehicle balance barrier

3. Attributes cause night riding barrier: 45% of elderly have night riding obstacle as the third place among all. Vision degrading effect by 21% among this event. Figure 4.7 summarized the result and shows the attributes as follows: ①vision

degrading, ②else, ③inattention and slower reaction time, ④balance disorder, hearing degrading and joint function decline.

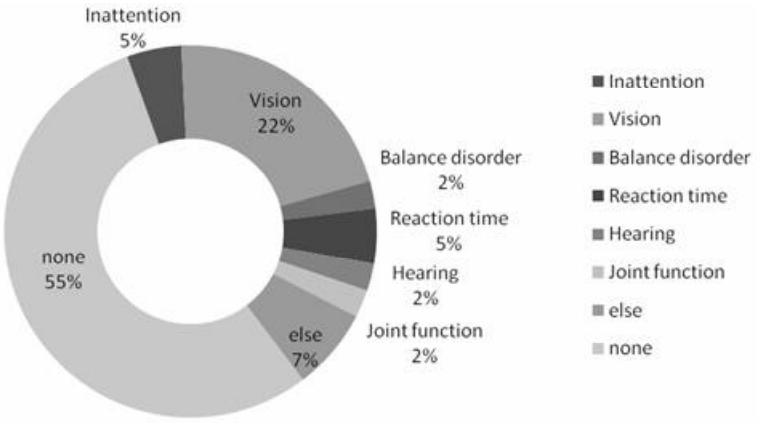

Figure 4.7 Attributes cause night riding barrier

4. Attributes cause waste efforts on turning: 33% of elderly have barriers on waste efforts on turning scooter in intersection, the order of attributes are counted as follows: ①slower reaction time, ②inattention, ③balance disorder and ④vision degrading; Figure 4.8 summarized the result.

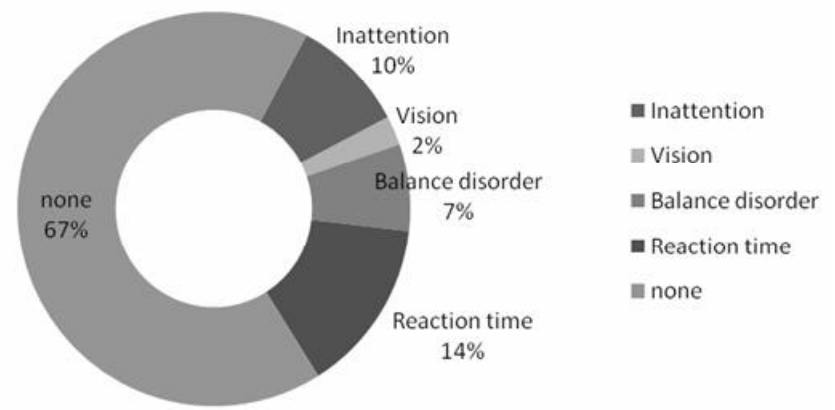

Figure 4.8 Attributes cause waste efforts on turning

5. (1) Attributes cause recognize the signals obstacle: 26% of the elderly have experience with recognize the signals when riding scooter, and the result as

conclude as follows and summarized in Figure 4.9: ①vision degrading, ②inattention, ③reaction time and else.

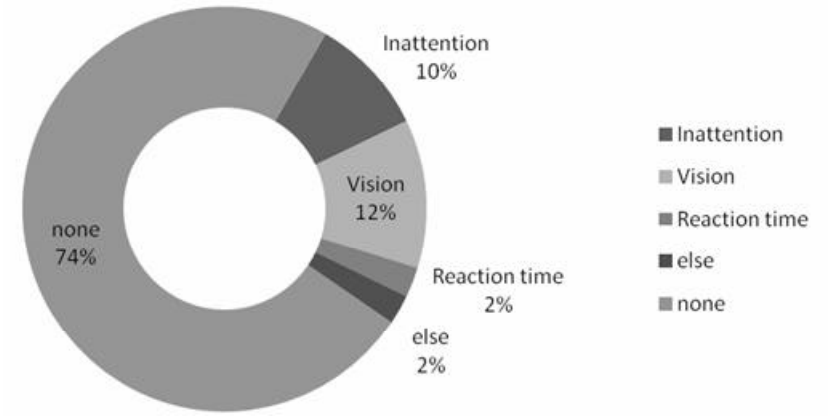

Figure 4.9 Attributes of barrier experience of recognize the signals

(2)Attributes cause fatigue while riding scooter: There are many attributes involve in, while 8% subjects have strength and grasp force degrading as first place in this event. 26% of the subjects indicate that ever had fatigue experience while ring scooter, and conclude as follows in Figure 4.10: ①strength and grasp force degrading (8%), ②rachis disease (7%), ③inattention (2%), vision degrading (2%), and slower reaction time (2%).

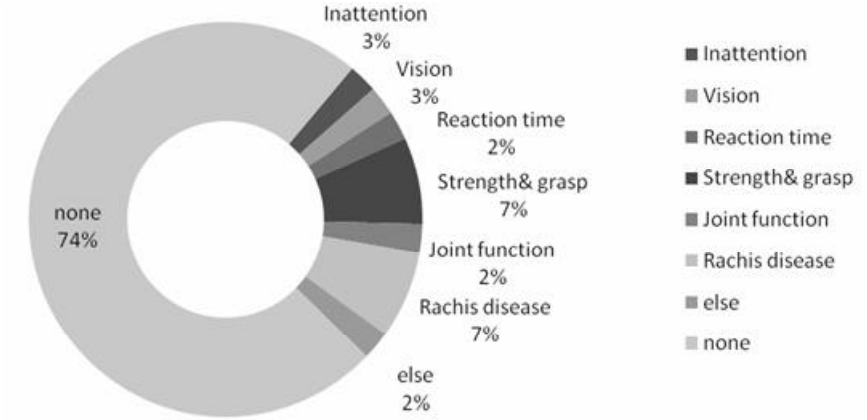

Figure 4.10 Attributes cause fatigue while riding scooter

6. Attributes of be bumped by vehicle: 24% subjects have experiences with

bumper by vehicle. There are three attributes involve, the order is as follows: ①inattention (14%) ②slower reaction time (5%) and else (5%) as shown in following Figure 4.11.

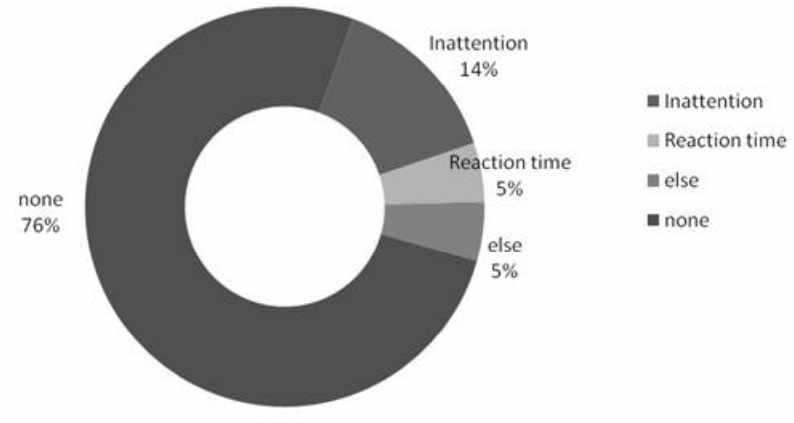

Figure 4.11 Attributes of be bumped by vehicles

7. Attributes cause bump on object: 22% subjects have experiences bumping on object, the order of attributes is as follows and summarized in Figure 4.12: ①slower reaction time (12%), ②inattention (5%) and else (5%).

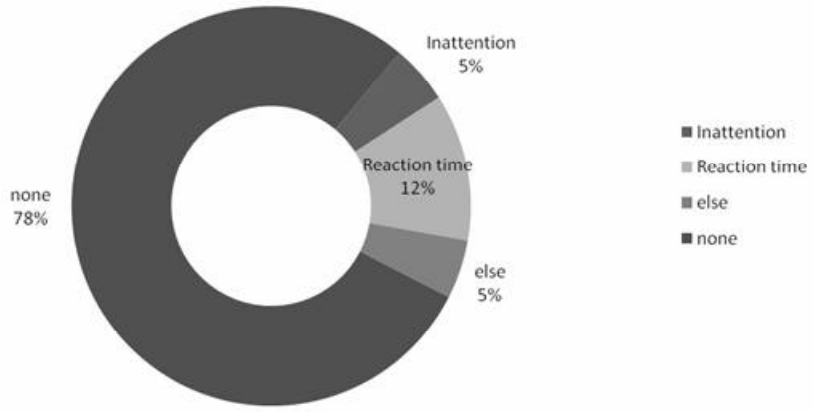

Figure 4.12 Attributes cause bump on object

8. Attributes cause lost direction while riding: The order of the cause attributes are ① memory deficits and ②inattention. 12% of the subjects have lost

direction experiences while riding by last second place among questionnaire events.

9. Attributes cause S-turn: Only 4% subjects have S-turn experiences by last place among all events, the order of attributes is as follows: ① lost direction (2%), ②else (2%).

Table 4.6 concludes the relationship of ten events and main effecting attributes which selected by each percentage; Furthermore, Figure 4.13 (page 53) concludes the percentages of each attributes distribution among all events; it indicates there are four major attributes with significant percentage among each event as well, the order of four attributes as follows: inattention, slower reaction time, vision degrading and sense of balance.

1. Inattention: Inattention has high percentages in the four events - turning, recognize signal, nervous and be bumped. Be bumped by vehicles is the first place among whole events by 14%, and following are turning, recognize signal, and nervous each in 10%.
2. Vision degrading: recognize signal obstacle and avoid night riding are first place among all. In the category of avoid night riding, vision degrading Attributes has 21% among whole elderly as the highest in the single category. Recognize signal obstacle is the second highest in this category after vision factor by 12%.
3. Slower reaction time: slower reaction time has effect on many questionnaire categories, the order is as follows: ①cause nervous (19%), ②cause turning obstacle (14%), ③cause bumper on object (12%), and ④night riding obstacle (11%).
4. Sense of balance obstacle: sense of balance effect higher in control vehicle balance by 19% among whole samples.

Table 4.6 List of attributes effect on each event

Event	Attributes
Nervous	Slower reaction time, inattention
Control scooter balance	Balance disorder, slower reaction time
Night riding	Vision degrading
Waste efforts on turning	Slower reaction time, inattention
Recognize the signals	Vision degrading
Fatigue	Strength and grasp force degrading, rachis disease
Be bumped	Inattention
Bump on object	Slower reaction time
Lost direction	Memory deficits
S-turn	Disorientation

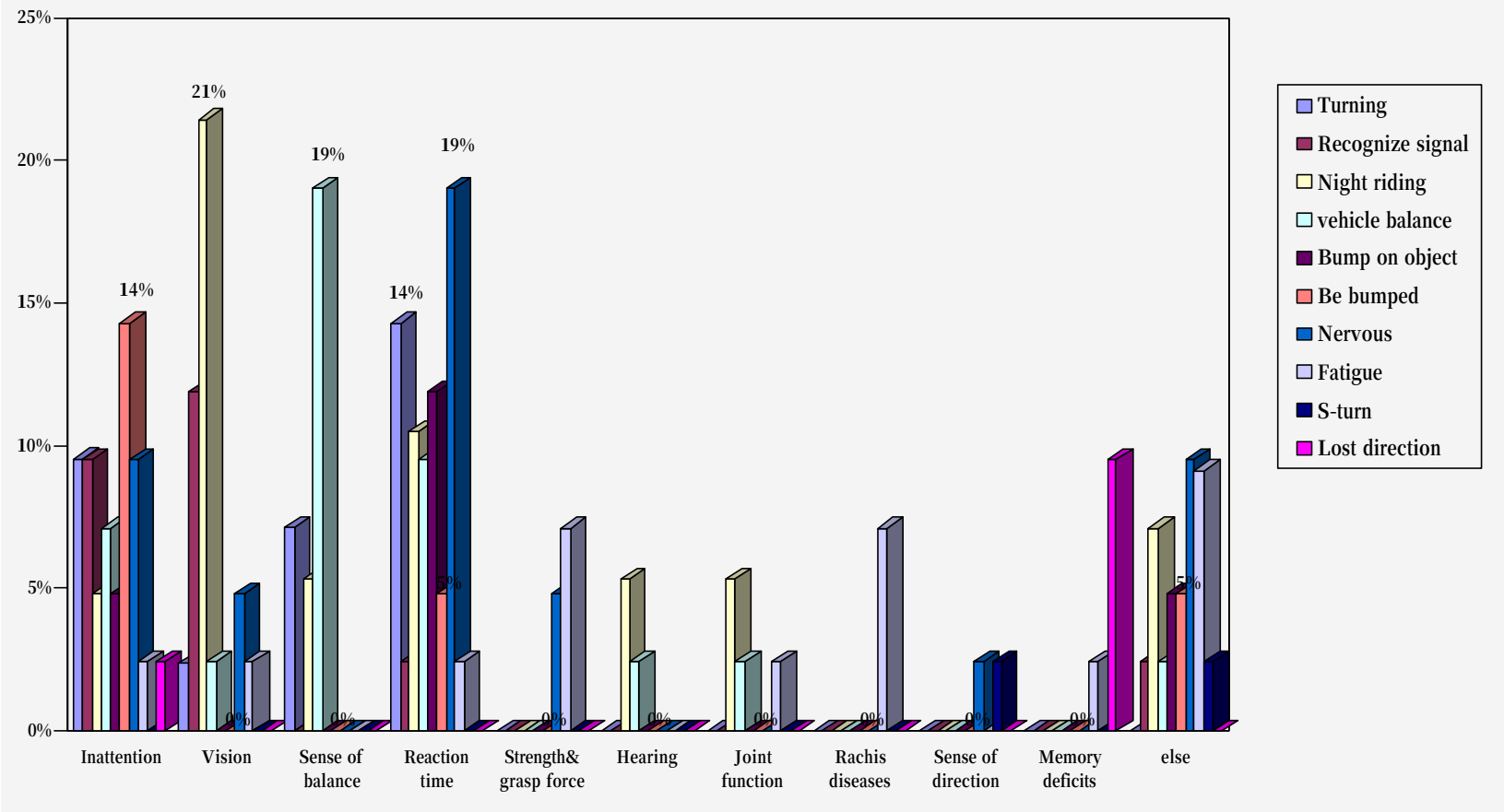

Figure 4.13Comparison of percentage of attributes within each questionnaire event

4.3 Self-assessment and attitudes with scooter

This part of questionnaire events is designed for investigate the respondent's riding behavior and opinions for scooter. Likert scale is applied on this questionnaire to measure the frequency of subjects riding behaviors; the five descriptive substantives of rating scale are as follows: Never, Seldom, Occasionally, Frequently, and Always.

4.3.1 Traffic safety awareness self-assessment

This section explains the elder rider's riding self-assessments content by following five points: ①Frequency watching rear mirror while riding; ②Frequency wear helmet when riding scooter and self-assessment of personal riding safety; ③People's concern for the respondent riding behavior; ④Attributes cause brake emergently while riding scooter; ⑤Scooter riding habits crossing intersection.

1. Frequency watching rear mirror while riding (Q22 (1)): The result indicates that subjects have different cognition on watching rear mirror. The response distribution is as follows: Frequently (40%), seldom (24%), occasionally (19%), never (10%), and always (7%) as shown in following Figure 4.14 .

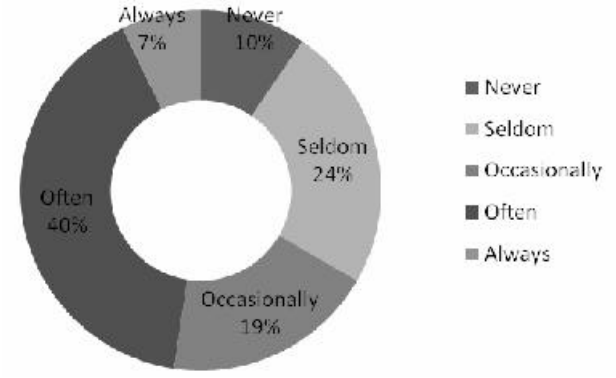

Figure 4.14 Frequency watching rear mirror while riding

2. Frequency wear helmet when riding scooter and self-assessment of personal riding safety (Q22 (2)-(4)): Taiwan traffic regulations declare that every scooter rider has to wear helmet while riding scooter. Figure 4.15 summarized

the elderly riding behavior frequency; the results indicate that subjects are used to wear helmet before riding on road. In the other hand, conflicts of elder groups' safety awareness might observed from following Figure 4.15 and 4.16; over half of subjects believe their own helmet provide enough safety, but the helmets they everyday wear are unsafely semi type ones. The results might remind the elder groups to enhance their safe riding consciousness .

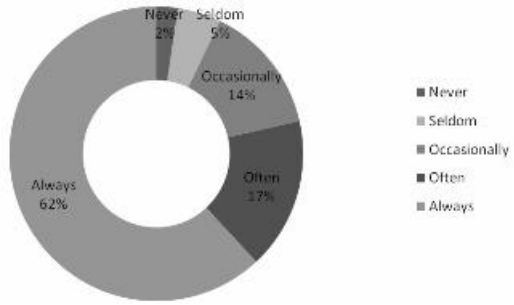

Figure 4.15 Frequency wear helmet while riding scooter

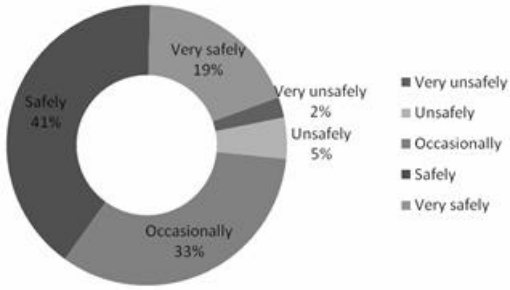

Figure 4.16 Self- assessments for their own helmet safety

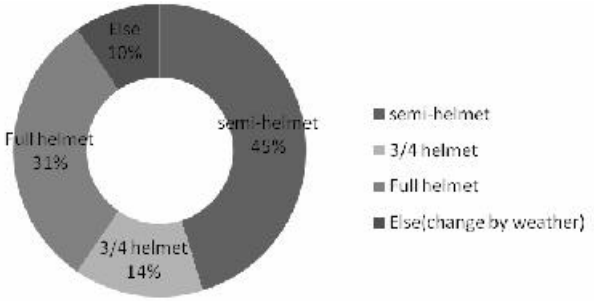

Figure 4.17 Percentages of wearing helmet categories

3. People's concern for the respondent riding behavior (Q22 (5)&(6)): this even is set to investigate how much the respondent's friends or family members concerned about their riding behavior. Figure 4.18 summarized the frequency of reminders tell the elderly watch out their riding, seldom(33%), occasionally(29%), and frequently(21%); Only 2% subjects of all have suggestion to quit riding scooter from family doctor or medical institution.

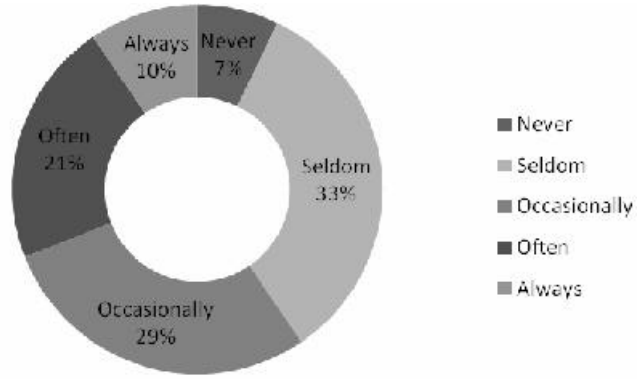

Figure 4.18 Percentages of how friends and family of the elderly concerning about their scooter riding behavior

4. Attributes cause brake emergently while riding scooter (Q23 (1)): 64%(N=27) of the subjects have indicate several factors from the questionnaire, and Figure 4.19 conclude the attributes as follows:①Not notice front vehicle situation (33%), ②not notice traffic signal (30%), ③slower reaction time (26%), and ④else (11%).

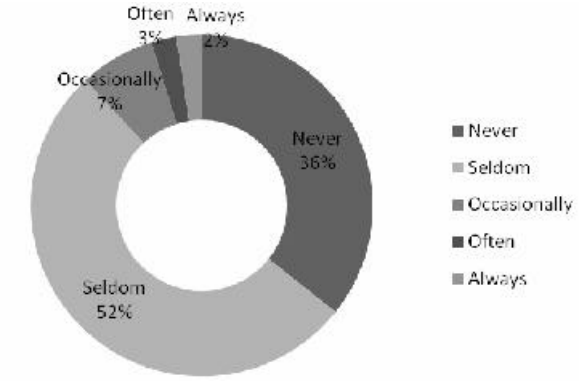

Figure 4.19 Attributes will cause brake emergently while riding scooter

5. Scooter riding habits crossing intersection(Q23): Questionnaires investigated the subjects' scooter riding behaviors via following events: ①Speed cross roadway intersection, ②Frequency making left turn on the red traffic light, ③Indirect left-turning at T-intersection, and④Frequency of using scooter traffic indicator, and it's summarized in following Table 4.6

Table 4.7 Riding habits of the subjects

Event	Variable	Subjects (unit: person)	Percentage
Speed cross intersection(Q23 (2))	0-10	10	24%
	10-20	16	38%
	20-30	8	19%
	30-40	7	18%
	40-50	1	2%
Make right turn while red light (Q23 (3))	Never	12	29%
	Seldom	20	48%
	Occasionally	4	10%
	Often	5	12%
	Always	1	2%
Indirect left-turning at T-intersections (Q23 (4))	Never	2	5%
	Seldom	11	26%
	Occasionally	10	24%
	Often	12	29%
	Always	7	17%
Frequency using scooter traffic indicator(Q23 (5))	Seldom	2	5%
	Occasionally	2	5%
	Often	18	43%
	Always	20	47%

How long of the riding time will cause fatigue: Long time riding will cause physical fatigue, but riding time scooter rider can bear comes shorter while aging. As shown in Figure 4.20, the summit group of scooter riding fatigue falls on 20-30 min by 12 subjects, and consider if another transportation instead.52% of the subjects attribute the factor of scooter riding fatigue to uncomfortable riding posture, and 17% attribute the factor of fatigue to inattention as shown in Figure 4.21.

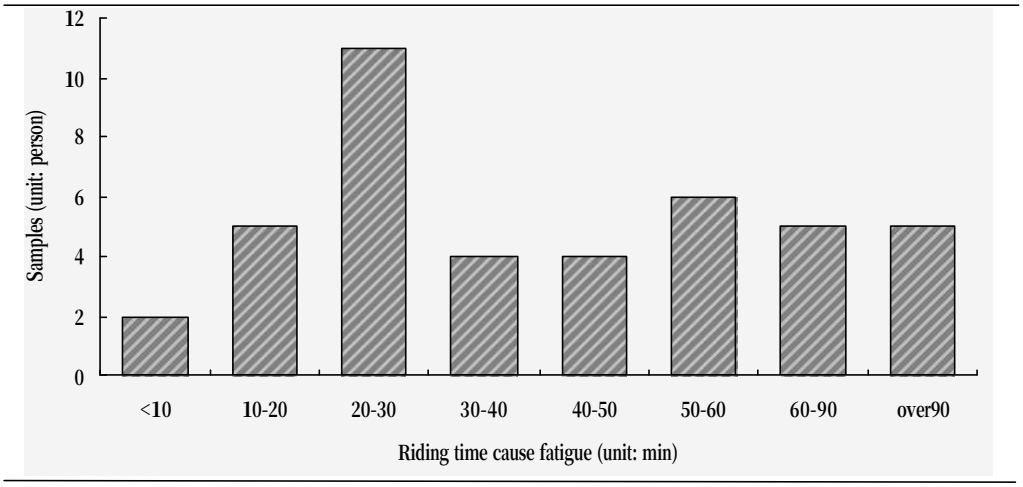

Figure 4.20 How long of the riding time cause fatigue

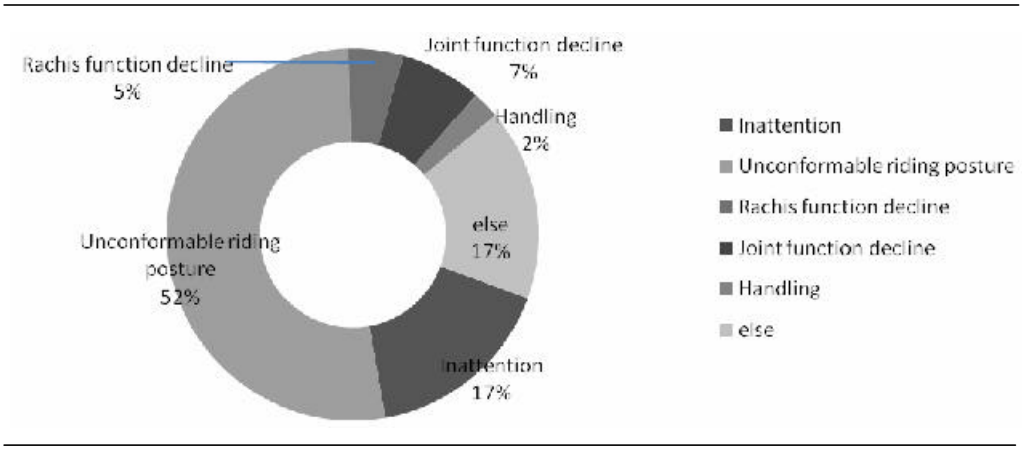

Figure 4.21 Attributes cause long time riding fatigue

The elderly indicates there are two scooter riding danger circumstances from the survey; one is alley (46%), and the other as roadway which conclude the opinions in following Figure 4.22.

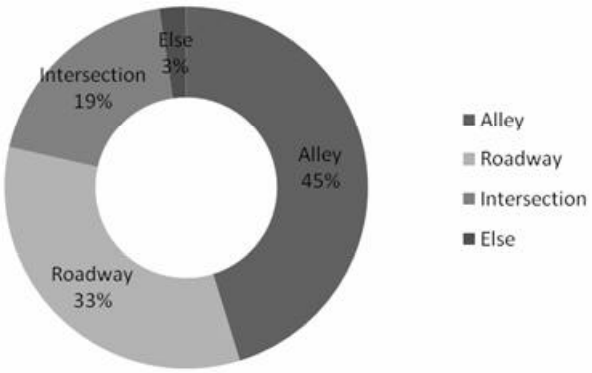

Figure 4.22 Dangerous circumstances when riding voted by the elderly

4.3.2 Attitudes to replace scooter in the future

Ever concern if reduce using scooter in the future (Q25&26): In the event of self-assessment if use optional transportation instead of current scooter, the attitudes of the subjects are divided as followed which referred to Figure 4.23:

1. Continue riding: 55% (N=23) of the subjects consider they will reduce using scooter.
2. Consider replace scooter with other transportation: 36% (N=15). Most subjects in this group intend to walk or take public transportation instead; Figure 4.22 indicates the percentage of their option transportation choices.
3. Wait-and-see: 10% (N=4) with wait-and-see attitude cannot imagine their future with scooter.

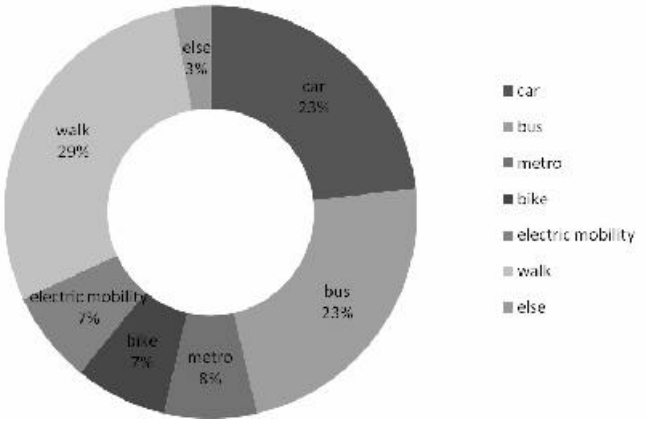

Figure 4.23 Replace options from replace scooter group

Explore the opinions of respondent keep riding scooter, the main reason of theirs are divided into three parts as follows and shown in Figure 4.24

1. Insufficient mobility (51%)
2. No vehicle fit the environment except scooter or concern vehicle size (21%)
3. Disease or eco directed (14%)

Most of them are concerned about this vehicle mobility as short distance tool to help the elder group moving around their neighborhood area.

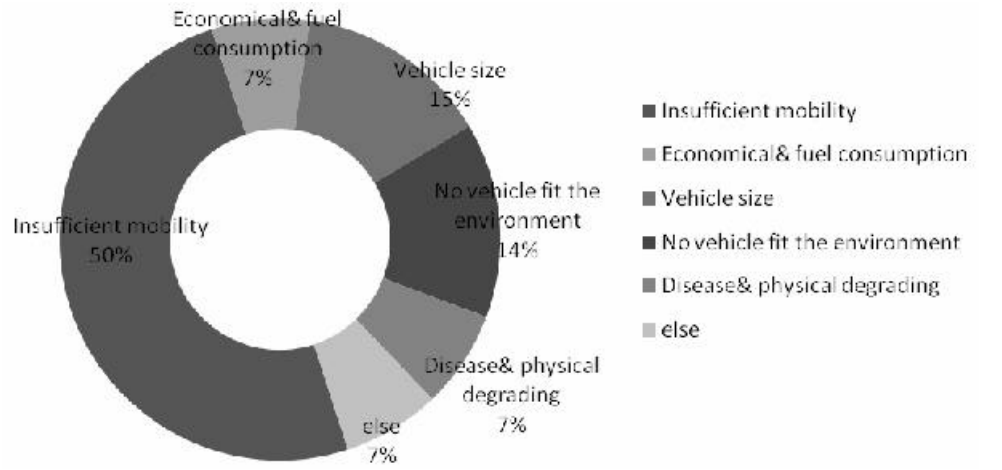

Figure 4.24 Attributes effect them continue using scooter

4.4 Cross analysis

As mentioned in the front section of scooter riding, the cross analysis is implemented to get further characteristic of the subjects base of their gender and age level. Top four riding obstacle events in the questionnaires are choosing to discuss as followed: ① avoid night riding, ② nervous, ③ to keep vehicle balance, ④ waste efforts on turning.

4.4.1 Cross analysis base by gender

This part of cross analysis is base on subjects' age level as following, based on the

analysis result as shown in Table 4.7 and 4.8:

1. Avoid night riding: vision degrading is the main attribute which male by 50% and female by 44% among vision grading group; “Else” (33%) is the second place in the female part which they indicate the reasons are their early daily living activities and afraid of public security of Taichung city in the night.
2. Nervous: sense of balance disorder is the main attribute which male by 50% and female by 31% among this nervous group. There is a decentralized results distribution in this analysis. The attribute “Else” with higher percentage in this event, and the subjects refer to the cause of Taiwan inconvenient and dangerous traffic environment by review of each questionnaire. The second effecting attribute for the female is inattention.
3. To keep vehicle balance: sense of balance disorder is the main attribute in this event which male by 38% and female by 42%, and secondary attribute is slower reaction time.
4. Waste efforts on turning: slower reaction time is the main attribute, secondary attribute is sense of balance disorder。

Table 4.8 Cross analysis of avoid night riding by gender

Avoid night riding								
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Hearing obstacle	Joint function declining	Else	Total
Male	2	5	0	2	1	0	0	10
Percentage	20%	50%	0%	20%	10%	0%	0%	100%
Female	0	4	1	0	0	1	3	9
Percentage	0%	44%	11%	0%	0%	11%	33%	100%
							p-value= 0.121	

Table 4.9 Cross analysis of nervous by gender

Nervous							
	Inattention	Vision degrading	Sense of balance disorder	Strength& grasp force degrading	Sense of direction	Else	Total
Male	1	1	4	0	0	2	8
Percentage	13%	13%	50%	0%	0%	25%	100%
Female	3	1	4	2	1	2	13
Percentage	23%	8%	31%	15%	8%	15%	100%
						p-value= 0.703	

Table 4.10 Cross analysis of keep vehicle balance by gender

To keep vehicle balance									
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Hearing obstacle	Joint function declining	Rachis disease	Else	Total
Male	1	0	3	2	1	0	1	0	8
Percentage	13%	0%	38%	25%	13%	0%	13%	0%	100%
Female	2	1	5	2	0	1	0	1	12
Percentage	17%	8%	42%	17%	0%	8%	0%	8%	100%
								p-value= 0.630	

Table 4.11 Cross analysis of waste efforts on turning by gender

Waste efforts on turning					
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Total
Male	3	0	1	3	7
Percentage	43%	0%	14%	43%	100%
Female	1	1	2	3	7
Percentage	14%	14%	29%	43%	100%
				p-value=0.506	

4.4.2 Cross analysis base by age level

The part of cross analysis is held by the subjects' age level every ten years instead of five years level because of limited population size in the older age over 65 years old. Therefore, the age levels are divided by 50 to 59 years old and 60 years old above. In the end, this part of analysis targets on the pre-elderly 50 to 59 but disregard age 60 above due to insufficient population numbers. The results of main four barriers (Q21(1), (3), (4), and (7))are shown as follows:

1. Avoid night riding: vision degrading has slightly significant influence on these two age levels. Most subjects who's age 51 to 59 years old indicate the main attribute cause them reduce nigh riding is vision degrading; But the opinions of subjects age above 60 years old are different and have a decentralized results distribution, such as inattention, vision degrading, slower reaction time, joint function declining. From those features, we might conclude the totally aging on the physical and cognition cause various aging symptoms while age growing up. Therefore, synthetic aging symptoms make the elderly face severe riding fatality hazards while age rising.
2. Nervous: Sense of balance disorder (44%) is the first place attribute in 51 to 59 years old age level. In the age level 51 to 59 years old, else (19%) is the second place attributes which they refer to be influenced scooter riding by severe traffic environment.
3. To keep vehicle balance: Sense of balance(44%) is the first place attribute in 51 to 59 years old age level while slower reaction time in 60 years old above.
4. Waste efforts on turning: slower reaction time (45%) is the main attribute affecting the subjects while make turning, and inattention (27%) by the secondary attribute. Age level that 60 years old above has a decentralized results distribution, and the attributes are shown as follows: slower reaction time, sense of balance disorder, and inattention.

Table 4.12 Cross analysis of avoid night riding by age level

Avoid night riding								
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Hearing obstacle	Joint function declining	Else	Total
51-59	1	8	1	0	1	0	2	13
Percentage	8%	62%	8%	0%	8%	0%	15%	100%
60 above	1	1	0	2	0	1	1	6
Percentage	17%	17%	0%	33%	0%	17%	17%	100%
							p-value=0.148	

Table 4.13 Cross analysis of nervous by age level

Nervous							
	Inattention	Vision degrading	Sense of balance disorder	Strength& grasp force degrading	Sense of direction	Else	Total
51-59	2	1	7	2	1	3	16
Percentage	13%	6%	44%	13%	6%	19%	100%
60 above	2	1	1	0	0	1	5
Percentage	40%	20%	20%	0%	0%	20%	100%
							p-value=0.582

Table 4.14 Cross analysis of keep vehicle balance by age level

To keep vehicle balance									
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Hearing obstacle	Joint function declining	Rachis disease	else	Total
51-59	3	1	7	2	1	1	0	1	16
Percentage	19%	6%	44%	13%	6%	6%	0%	6%	100%
60 above	0	0	1	2	0	0	1	0	4
Percentage	0%	0%	25%	50%	0%	0%	25%	0%	100%
								p-value=0.308	

Table 4.15 Cross analysis of waste efforts on turning by age level

Waste efforts on turning					
	Inattention	Vision degrading	Sense of balance disorder	Slower reaction time	Total
51-59	3	1	2	5	11
Percentage	27%	9%	18%	45%	100%
60 above	1	0	1	1	3
Percentage	33%	0%	33%	33%	100%
				p-value=0.888	

4.5 Cluster Analysis

This part of the section is to describe the cluster analysis base of the questionnaire event (Q26 refer to appendix 1) which investigates their attitude for scooter in their future and is concluded in Table 4.16. we also discuss three clusters as follows referred to their riding barrier collected in Table 4.17 :

1. Replace scooter in the future: 64 % (N=28) of all the subjects are referred to this cluster and it indicates they are the group that despairing using the scooter in the future. The percentages of their obstacle experiences are higher than other clusters. Table 4.17 indicates the experiences they have met while riding are as follows: ①feel nervous when riding (54%), ②avoid night riding (50%) and ③keep vehicle balance (50%).
2. Mobility and economic directed: 24% (N=10) of all the subjects are referred to this cluster and it indicated they are the group that willing keep using scooter in their elderly life. To get more advanced mobility and save fuel consumption are the characteristics by comparing the referred attributes. The referred attributes of this cluster are concluded as follows: ①High mobility (N=7), ② tinny vehicle size (N=2), and ③ economical and low fuel consumption (N=1).
3. Conservative: the subjects refused accepting any other vehicles instead, due to some reasons although they have obstacle on scooter riding. The reason that they cannot give up scooter riding may cause of their personal disease that force them using scooter as transportation, or still take scooter for certain usage such as delivering goods and taking children. The referred attributes from Q26 are concluded as follows: ①personal disease (N=2), ②take scooter as special usability tool (N=1) and refuse any other vehicles instead (N=1).

Table 4.16 Cluster categories

Cluster (from Q26)	Referred attributes	Subjects (Unit: person)
Replace scooter in the future (Q26(1))	Replace scooter in the future	28
Mobility& economic (Q26(2))	High mobility	7
	Economical and low fuel consumption	1
	Tinny vehicle size	2
Conservative (Q26(2))	personal disease	1
	take scooter as special usability tool	2
	refuse any other vehicles instead	1

Table 4.17 Features of each cluster from questionnaire

Cluster / Population		Replace in the future		Mobility& economic		Conservative	
		Subjects	Percentage of cluster	Subjects	Percentage of cluster	Subjects	Percentage of cluster
Age level	51-55	12	43%	6	60%	2	50%
	56-60	10	36%	3	30%	1	25%
	60-65	3	11%	1	10%	1	25%
	over 65	3	11%				
Gender	Male	14	50%	5	50%	1	25%
	Female	14	50%	5	50%	3	75%
Obstacle experiences							
Turning		9	32%	2	20%	3	75%
Recognize Signal		8	29%	2	20%	2	50%
Night riding		14	50%	4	40%	1	25%
Keep vehicle balance		14	50%	3	30%	3	75%
Bumped on object		6	21%	2	20%	2	50%
Be bumped by others		7	25%	3	30%	1	25%
Nervous		15	54%	3	30%	3	75%
Fatigue		7	25%	2	20%	2	50%
Lost direction		3	11%	1	10%	2	50%

4.6 Chapter Summary

4.6.1 Results of questionnaire survey

Base of the statistic results review and analysis, the summary of this chapter is concluded as follows:

1. Characteristic of subjects: male and female subjects are about half and half, 91.9% of them owe their scooter license which represent they are qualified in law to riding scooter. The elder groups are belonging to high frequency applying scooter users; the scooter purchasing motivation is for short distance transportation and main usages are shopping in first place, the second is commuting to work.
2. Safety awareness: Elder groups' safety consciousness difference is found from the questionnaire event results of wearing helmet; half of them believe their helmets provide with sufficient protection, but somehow the helmet they wear are semi type helmet. The results might indicate the elder groups need to enhance their safety awareness to keep safety riding after all.
3. Fatigue durability of the elder groups' riding is located within 30 minutes; the main reasons which they attribute to uncomfortable riding posture and their inattention of riding consciousness.
4. Scooter riding barriers experience: ①nervous, ②control vehicle balance, ③avoid night riding, and ④waste efforts on turning are main barriers that the elder groups meet in their scooter riding experience.
5. Attributes cause riding barrier in behind: ①inattention, ②vision degrading, ③slower reaction time, and ④sense of balance disorder is the major attributes that happen with high frequency among obstacle experiences.
6. Cross analysis by gender: Gender has no widely differences with results of the scooter riding barriers (p-value >0.05); vision degrading and sense of balance disorder are the main attributes that pre-elderly indicated from their riding barriers.

7. Cross analysis by age level: Age level has no widely differences with the results of scooter riding barriers ($p>0.05$), and it also shows a decentralized distribution while age level rising on age 60 above. The reasons might be the entirely physical and cognitive aging of the elder groups themselves. Moreover, these three attributes – "vision degrading", "senses of balance disorder" and "slower reaction time" have affects on riding for pre-elderly from age cross analysis.
8. Cluster analysis: It is divided the subjects into three groups based on their attitudes on scooter based on questionnaire event #26 and described as followed: ①replace scooter in the future; ②mobility and economic directed and ③ conservative. Most of subjects (64%) belong to the cluster of "replace scooter in the future" and with negative attitudes on the future applying scooter.

4.6.2 Results comparison with literature

This session is addressed to compare with the literature review and check the status of the study, and list as below:

1. Compare with previous survey summary, similar results happen in barriers experiences such as "control vehicle balance" and major attributes related to riding barriers such as "slower reaction time", and "sense of balance disorder". Shen T.(2003) indicates four events that the elderly facing in primary: ①Sideswiping by vehicle; ②Slower reaction with sudden events; ③Balance disorientation and ④Road roughness.
2. Compare with previous literature review, the questionnaire survey provides extend results beyond researches. Therefore, direct opinions and person experiences provide conclusive evidences that current elderly and pre-elderly involved within riding barrier experiences through this pilot study.

Chapter5. Conclusions

As the elderly population grows more numerous and changed the society structure, the public and private sectors should take efforts to study the elderly topics in hence it brings negative impact to society. But there are few researches on the issues with the elderly driving safety in Taiwan. Therefore, this pilot study explores the traffic fatalities with the elderly and investigates the elder group's options through questionnaires survey. Moreover, the study gave a sketch of this issue through the elder rider's opinions, and expects to show scooter riding difficulties of the elder group (include pre-elderly and elderly) that present literatures lack of.

5.1 Discussion

From previous questionnaire survey and literature, the following section is addressed to discuss the scooter riding issues in aspect of safety by following three points:

1. Safety awareness: From the results of questionnaire survey, we can conclude that some of the elder groups lack of safety protection by themselves and under-estimate their safety consciousness, such as misunderstanding the safety on semi-helmet and disobey traffic rules occasionally. Therefore, we also indicate improving the safety not only include the refinement of scooter itself, but also consider to upgrade their safety awareness through post-training. Riding skill examination and tutorials of safety riding behavior might be a considerable idea to implement as a short term solution; for example, to avoid take efforts on turning by take indirect left turn at cross section and keep distance with nearby vehicles. However, the scooter riding license renewing in Taiwan only restricts on document examination without personal riding skill and physical condition assessment. It might be lead the elder groups keep riding even one day happen with vehicle accidents or be suggested stop riding by medical center. Although Lin F. (2005) indicates the elderly has the characteristic of danger avoidance; Moreover, we suggest if the elder groups understand their physical condition

limits might lead them obey safety riding behaviors in all riding environment. In the aspect of raising their safety awareness, we address strongly the relative sectors evaluate the impact of their safety protection while pre-elderly in 2004 will step into elderly by 2015.

2. Scooter development for the elder groups: The results of questionnaire survey indicate the elder groups take scooter as daily transportation as well. Similar distribution results with previous literatures, more than half of the elder groups continue applying scooter as a short distance transportation. However, scooter itself belongs to a skilled transportation that need efforts to keep it in balance, and brings the inconvenience for the elder groups; for example, the elder groups indicate they cannot tolerate long time (less than 30 minutes) riding due to their aging posture and vehicle vibration. Therefore, we also suggest future scooter design development consider the elderly ergonomics included; for example, refinements on hip position height base on different age levels, or add in optional back support on the seat in short term solution.
3. Scooter riding barrier: From the literature review and questionnaire survey result, we conclude scooter riding protect direction from following four riding barrier ①avoid night riding, ②nervous, ③keep vehicle balance and ④waste efforts on turning and addressed as followed:
   (1) Avoid night riding: we suggest the elder groups riding in the route with sufficient light intensity instead of dark riding route. Slower glare recovery, sensitive to light, short vision field might affect them on judgment and cognition while riding under insufficient light intensity and facing light glare. In the other hand, the way of passive protection is considerable as well though visible vehicle paint and bright dress color instead that will help vehicle driver notice them riding on the road. In the end, we suggest the elder groups trace their medical eye ability examination in the medical center in routine, it will provide examinations on eye field, eye ball tracing ability and glare recover by effective experiment might help them knowing personal degrading .

(2) Nervous and waste efforts on turning: slower reaction time is the main attribute of these barrier experiences. To prevent those barriers, we also suggest the elder groups adjust their riding behavior and understanding their physical limits such as reaction time, eye and hearing abilities.

(3) Keep vehicle balance: The elder groups have low attempts applying electric mobility instead of scooter because of the image of it closed to handicapped tool. On the other hand, the development scooter body structure belongs to long term modification that might not on the market in latter stage. Therefore, based on aging symptoms of the inattentions and balance disorder, we suggested the elder groups keep enough riding brake distance in crowding circumstances; avoid riding in behind cars and bus on the intersection helps them in safety visual field for each riders and drivers; Make indirect left turn on intersection also help them keep in safety and avoid riding in anxiety. Theses safety riding behaviors should be promote and are executed carefully on regulations.

5.2 Suggestion

From previous discussion on phenomenon of elder groups, we observe from this pilot study and concluded suggestions by following four points:

1. The review of scooter riding barriers: Although pre-elderly are healthier than past decades, but they are stepping into facing the scooter riding barriers gradually. Therefore, this study intends to investigate the barrier experiences for the further elder groups through questionnaire survey, and contribute the results of this pilot study as a reference for further vehicle and elderly society study. Several riding barriers are found in this research, and concluded as follows: ①avoid night riding, ②nervous, ③keep vehicle balance and ④waste efforts on turning, Table 5.1 explain the attributes of riding barriers and directions based on observing the result of questionnaire survey and author’s opinion:

Table 5.1 Attributes of riding barriers and predicted solutions

Riding barriers	Attributes	Short term solution	Long term direction
Avoid night riding	Vision degrading	● high mount lamp ● Bright color vehicle body paint ● Extra warning light and indicators ● Riding information assistance ● Traffic signals enhancement ● Warring signs in elderly neighborhood	● Night vision enhancement ● Advance Light technology
Keep vehicle balance	Sense of balance disorder	● Vehicle balance enhancement ● Raise the rider's comfort ● Anti-roll bars ● Post training of scooter rider	● vehicle stability ● Safety directed vehicle
Nervous Waste efforts on turning	Slower reaction time	● Rebuild scooter dimension in aspect of universal design ● Pre-bump and post-bump protection ● Significant warning indicators ● Post training of the elder scooter rider	● Safety directed vehicle ● Intelligent riding supporting system

2. In aspect of interaction among user, scooter and environment: current elder groups belong to unspeaking user which lacked of safety awareness while facing aging impact. In the other hand, simplified functional scooter provides insufficient support for elder riders observing from this study and literatures. Honda has succeeded in developing the world's first production motorcycle airbag system, to be made available in 2006 as shown in Figure 5.1 below. YAMAHA also introduce their crotch air bag system on motorcycle at the 2006 JSAE Automotive Engineering Exposition to hold the lumbar section of the rider

in place and mitigate the impact of a collision as shown in following Figure 5.2. TOYOTA introduced the concept vehicle “i-swing” to promote the issue of personal mobility. Watanabe N. (2005) promotes the concept of IPM (Intelligent Person Mobility) in the view of universal design, intelligent transportation systems, and Taiwan elderly lifestyles and Figure 5.2 collects mentioned personal mobility concepts as following.

Figure 5.1 Honda motorcycle airbag system

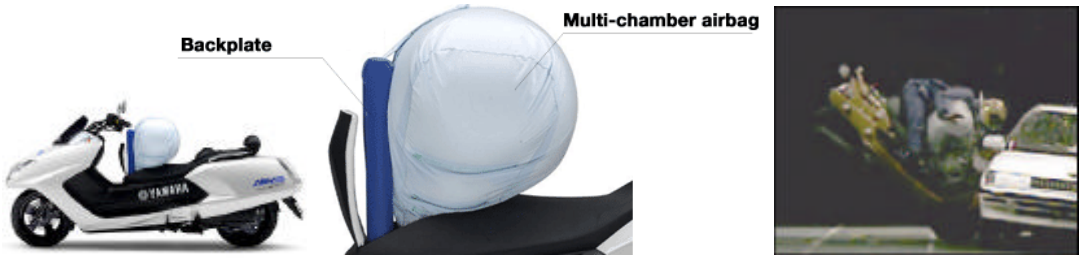

Figure 5.2 YAMAHA motorcycle airbag system

Figure 5.3 Concepts of Intelligent Personal Mobility (IPM)

From the previous motorcycle safety technology and new concept vehicle, the tendency of personal safety mobility is be revealed and evaluate practicable possibility by vehicle makers. Therefore, the author promotes five scooter improvement directions in synthetic aspect: ①Raise personal safety awareness; ②Safety protection; ③Scooter accident rescue; ④Scooter riding assistance and ⑤Danger riding condition exclusion, the contents of directions are summarized in Table 5.2 as followed:

Table 5.2 Suggestions divided by subjects

Suggestions		Participator
Events	Content	
Raise personal safety awareness	● Develop safety riding skills ● Awareness of safety, and know self-condition are allowed to riding	● Elder drivers
Safety protection	● Vehicle airbag protection ● Safety accessory items for scooter riders ● Advance technology or mobility vehicle to exclude the riding barriers	● Scooter industry
Scooter accident rescue	● Scooter rescue system after crash ● Position sensors install on scooter	● Scooter industry and government
Scooter riding assistance	● Scooter riding navigation system ● Pre-bump warning on car and scooter ● Traffic signals enhancement ● Scooter balance enhance devices	● Scooter industry and government
Danger riding condition exclusion	● License examining for the elder group via their physical evaluation ● The elder group's riding skill examination ● Tutorial of keep riding scooter safety ● Self-evaluated principles of aged riding condition	● Government

3. Responsibility for future scooter users: Taiwan scooter industry should take the responsibility to improve the elderly scooter riding safety; due to the elder citizen will be high frequency scooter users and facing with hazard.
4. Safety awareness of the elder scooter users and correlation on accident death:
   Elder drivers generally perceive their driving ability to be better than or equal to that of their peers; therefore, The implement of measurement experiment will help reach more tangible data to determine correlation behind the elderly riding and driving behaviors, and post training in the elderly latter life will be a future topic in Taiwan society development. There are several subjects will be related which found in the study and concluded as follows:
   (1) Post training of the elderly scooter aids;
   (2) Post training help the elderly aware how their physical decline situations affect them on riding scooter or driving vehicles, avoid danger or hazard traffic circumstances, and keep their mobility ability while aging gracefully.

5.2 Suggestions for future studies

From this pilot study, it is indicated the preelderly whose age from 50 to 64 years old are starting involved with the physical and mental degrading and effect them on their vehicle control ability; therefore, in the aspect of design view, several directions are promoted from observing the pilot study, and concluded as follows:

1. Upgrade the safety of the scooter in the aspect of excluding riding barriers:
   The aim of this pilot study is to survey feasibility the improvement of scooter, and prove that the elder groups indeed facing the riding barriers cause by scooter as well. Therefore, it provide a foundation for the future studies evaluating scooter and searching solutions to eliminate present scooter riding barriers with the elder groups. For the safety issues, future studies might consider not only the new safety technologies and vehicle structure design, but also develop the long term consciousness observing correlation among human, transportation and traffic environment.

2. Refinement of scooter for future users in aspect of universal design:

   There is a great amount of populations applying scooter in different age level, the transportation position of scooter should consider for all applying age level by aspect of universal design, instead of defining it only for limited user groups such as younger and woman. Moreover, the author believes that the elder groups stand in a important position in the future scooter development. If the scooter industry would like to enlarge the applying usages of scooter, it is recommended that consider in the view of universal design to obtain each users' opinion instead of technology directed performance.

3. Develop new type vehicle in between cars and scooter, which more suitable for short distance commute:

   The transportation development in Taiwan is lack of concept vehicle project to inspire new consciousness between human and vehicle compare with automobile countries. There is a huge amount of scooter riding populations in Taiwan, which it means we have the opportunities to study the scooter riding behaviors with plenty of populations than other competitors. Moreover, the symptoms of huge amount of scooter riders might represent that they have potential needs rely on high mobility of scooter. In the view of personal mobility need and background of riders' population, the author suggest the direction of develop the concept personal vehicle for Taiwan is practicable for future studies.

4. Accuracy of experiment and discover the correct respondent attitude:

   Instead of descriptive questionnaire research, the author suggests to the attributes finding of specific barrier experience (such as nervous or avoid night riding) through measuring by instrument. The elderly might underestimate their physical and riding abilities that affecting the accuracy of descriptive questionnaire survey. Therefore, the scooter industry and government are suggested to take obligations and investigate this group lifestyles and scooter riding behaviors, and collaboration of government and research institute also is suggest to achieve deeply scooter riding barrier attributes search due to sufficient accidents and fatalities database.

References

A.N. Oppenheim (1996), *Questionnaire design and attitude measurement*, Basic books, INC., New York, p7-9

Benekohal, R.F. et al (January 1994), "Highway Design and Traffic Operation, Needs of Older Drivers", *Transportation Research Board*, 73rd , Annual Meeting, Washington, D.C.

Chen W. (2004), "An analysis traffic accident injury and medical cost on the elderly", Committee of Road Safety and Traffic Injury Prevention, ROC. (**陳菀蕙**, 2004, "**高齡者道路交通事故受傷嚴重性與醫療成本分析**",**道路安全與交通事故傷害防制研討會**)

Chen Y. (2006), *Literature Review of Motorcycle Riding Behavior, Accident Risk, and Countermeasures for Adolescents*, Institute of Transportation, Ministry of Transportation And Communications, ROC. (**陳一昌**, 2006, "**青少年機車駕駛人行為特性、事故風險與管理對策之文獻探討**",**交通部運輸研究所**)

Department of Statistics, MOI (Ministry of Interior) (1999), "Bulletin of interior statistics", ROC (**戶籍登記人口統計報告書**(1999),**內政統計通報**, **內政部統計部**)

Dept. of Human Resources, Council for Economic Planning and Development (2002), *Projections of the population of the Taiwan area , Republic of China 2002 to 2051*, Taipei, ROC. (**行政院經濟建設委員會人力規劃處**, 2002, ***中華民國台灣地區民國 91 年至 140 年人口推計***, **台北**)

Dept. of Statistics, MOTC (2004), *Investigation the scooter use in Taiwan area*, Taipei, ROC. (**交通部統計處**, 2004, ***機車使用狀況調查報告***, **台北**)

Eby, D.W., Shope, J.T., Molnar, L.J. and Vivoda, J.M. (2000). Improvement of the older driver safety through self-evaluation: The development of a self-evaluation instrument (Report No. UMTRI-2000-04). Ann Arbor, MI: University of Michigan Transportation Research Institute.

EICP (2004), Research on Mature Age Generation Lifestyles, Taipei, ROC. (**東方線上生活型態研究小組**, 2004, **熟年世代生活型態族群研究**, **台北**)

Forrest, K.T.Z., Bunker, C.H., Songer, T.J., Cohen, J.H., Cauley, J.A., "Driving patterns and medical conditions in older women", *Journal of the American Geriatric Society 45*, p1214-1218, 1997

Groeger, J.A., Brown, I.D., "Assessing one's own and others' driving ability: the influences of sex, age and experience", *Accident Analysis and Prevention*, 21(2), p155-168, 1989.

Hakamies-Blomqvist, L. and Wahlstöm, B (1998), "Why do older drivers give up driving?", *Accident Analysis and Prevention*, 30, p305-312

Havighurst, Cavan, Burgess & Goldgammer (1949), "Personal adjustment in old age", *Science Research Associates*, Chicago

Holland, C.A.(1993), "Self-bias in older drivers' judgments of accident likelihood", *Accident Analysis and Prevention*, 25(4), p431-441

International Road Foundation (2003), World Road Statistics (Data 1997 to 2001).

Kara E., MacLeod, et al, "The Association between Health Problems and Driver Status among Older Adults", U.C. Berkeley Traffic Safety Center, 2004.

Lim F.(2005), *Traffic crash involved elderly people*, Institute of Transportation, Ministry of Transportation And Communications, ROC. (**林豐福**, ***高齡者道路交通事故特性研究***, **交通部運輸研究所**, 2005)

Lin F.(2004), "Review of occupational driver's license examination and certification by limited terms", International committee of road traffic safety and law enforcement (**林豐福**, "**我國職業駕駛執照考領及持用有效條件管理之探討**", **道路交通安全與執法國際研討會**, 2004)

Marottoli, R.A., Cooney, L.M., Wagner, D.R., Doucette, J., Tinetti, M.E. (1993), "Predictors of automobile crashes and moving violations among elderly drivers ", *Annals of Internal Medicine*, 846(121), p842

Marottoli, R.A., Richardson, E.D.(1998), "Confidence in ,and self-rating of , driving ability among older drivers", *Accident Analysis and Prevention*, 30(3), p331-336

Owsley, C., McGwin Jr., G., Phillips, J.M., McNeal, S.F. and Stalvey, B.T. (2004), "Impact of an educational program on the safety of high-risk, visual impaired, older drivers", *American Journal of Preventive Medicine*, 26, p222-229.

Pitts, D.G. (1982), "The Effects of Aging on Selected Visual Functions: Dark Adaptation, Visual Acuity, Stereopsis, and Brightness Contrast." In: Sekuler, R., Kline, D., and Dismukes, K. (Eds.), *Aging and Human Visual Function*. Liss: NY.

Rosenbloom S. (1993), "Transportation needs of the elderly population", *Drachman Institute of Land and Regional Development Studies*, University of Arizona, USA

Shen, T.(2003), *Application of ITS Technology for the Aging Society*, Institute of Transportation, Ministry of Transportation And Communications, ROC. (**沈添財**,

2003, “**智慧型運輸系統技術於高齡化社會之應用研究**”, **交通部運輸研究所**)

Stutts, J.C.(1998), “Do older drivers with visual and cognitive impairment drive less?”, *Journal of the American Geriatric Society,* 46, p854-861.

Waller, J.A.(1992), “Research and other issues concerning effects of medical condition on elderly drivers”, Human Factors

Watanabe N. (2005), “Research of the intelligent personal mobility in community”, Project Report of National Science Council. (**渡部紀綱**, 2005, “**地域社會中智慧型個人移動工具之研究**”, **行政院國家科學委員會? 題研究計畫成果報告**)

Yanik, A.J. (1989). Factors to consider when designing vehicles for older drivers.

Zhu J. (1998), *The driving maneuver responses to traffic conflicts for motorcyclists*, Master Thesis, Graduate Institute of Transportation Technology and Management, Chiao-Tung Univ., Taiwan, ROC. (**朱建全**, 1998, ***機車駕駛者面臨交通衝突之行為反應研究***, **交通大學運輸工程與管理研究所碩士論文**)

網頁文獻

Council of Labor Affairs(**行政院勞工委員會**)
http://www.cla.gov.tw/

Driving safety while aging gracefully,
http://www.nhtsa.dot.gov/people/injury/olddrive/Driving%20Safely%20Aging%20Web/index.html

Employment Services Law(**就業服務法**)
http://www.ncu.edu.tw/~ncu7262/law/11.htm

Fukuda R., (2006), Course content of environment design for the elderly, Keio

University, http://gc.sfc.keio.ac.jp/cgi/class/class_top.cgi?2005_21094 (**福田亮子**, 2006, **高齡者環境設計論課程資料**, **慶應義塾大?**).

Mace, R. 1997. "What is the universal design? Universal design principles". http://www.design.ncsu.edu/cud/about_ud/udprincipleshtmlformat.html#top

NHTSA injury prevention for older road user, http://www.nhtsa.dot.gov/people/injury/olddrive/

Official website of KYMCO, (2006), http://www.yamaha-motor.com.tw/index.htm

Official website of Sym, (2006), http://www.sym.com.tw/

Official website of YAMAHA, (2006), http://www.yamaha-motor.com.tw/index.htm

Scooter (motorcycle), Wikipedia, http://en.wikipedia.org/wiki/Scooter_(motorcycle)

Scooter development in Taiwan (**台灣機車史**) http://www.carsafety.org.tw/motolook1.asp

The Washington state patrol, RCW 46.04.304, http://apps.leg.wa.gov/RCW/default.aspx?cite=46.04.304

TRB, Transportation Research Board, http://www.trb.org/

Zhang H., (2004), "Is evasion reasonable while driving?", PCR, http://www.pcr.com.tw/pviewitem3.asp?sn=716&area=41&cat=143 (**張漢威**, 2004, "**閃避有理否**", **人車路資訊網**)

Appendix 1
Questionnaire

【 高齡化對騎乘機車行為的影響 】

您好：

本份問卷目的為探討高齡化對熟年世代族群（50~64 歲）及健康型高齡者（65 歲以上），探討機車於此族群間所遭遇使用上之問題。並藉由此問卷探討現行機車使用方面是否符合熟年世代及健康高齡者需求；因此，你的意見對此研究非常重要，望您能撥冗填寫以下問題。本問卷採無記名方式回答，在此感謝您的協助與配合。

私立東海大學工業設計所研究生 洪麒鈞 敬上

＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝＝

★ 高齡者基本資料

1. 年齡

□51　55　　□56　60　　□61　65　　□65 以上 ___ 歲

2. 性別　　□男　　□女

3. 婚姻　　□已婚　　□未婚

4. 教育程度：

□國小及以下　□國（初）中　□高中職

□專科　□大學　□研究所及以上

5. 職業：

□（1）有就業：□農林漁牧　□工　□商　□服務業

□軍公教　□其他 _____

□（2）無就業：□家庭管理　□退休　□其他_____

6. 您平均每個月的個人所得（含津貼，不包括其他成員所得）：

□未滿 5 千　□5 千　未滿 1 萬　□1 萬　未滿 2 萬

□2 萬　未滿 3 萬　□3 萬　未滿 4 萬　□4 萬　未滿 5 萬

□5 萬　未滿 6 萬　□6 萬　未滿 7 萬　□7 萬以上

7. 是否為機車車主本人：　□是　□否

8. 請問您這三個月內是否有騎過機車的經驗：　□是　□否

9. 是否擁有駕照（複選）：

□無　□輕型機車（50cc 以下）　□普通重型機車

□大型重型機車　　□小型汽車

□大型汽車（含大客車、貨車及聯結車）

10．個人擁有車輛(複選)

□無　　□機車（____cc）　　□小客車（_____cc）

□腳踏車　　□電動車　　□其他

11．平均每日活動最大範圍距離（包含使用各種運具）

□0　未滿 2 公里　　□2　未滿 4 公里　　□4　未滿 6 公里

□6　未滿 8 公里　　□8　未滿 10 公里　　□10 公里以上____

★　主要使用機車用途

12．您購買機車的主要動機為（單選）：

□短程代步用　　□運送貨物　　□通勤使用

□載人　　□收藏品　　□休閒競技

□其他_____

13．使用機車次數最頻繁的目的為（單選）：

□訪友　　□購物　　□進修　　□接送小孩

□運動　　□其他

14．您使用機車時通常的乘載數量為（單選）：

□單人　　□2 人　　□3 人　　□3 人以上 _____人

15．使用機車頻率/每天/每週

(1)「每天」騎乘機車使用時間：

□未滿 10 分　　□10　未滿 20 分　　□20　未滿 30 分

□30　未滿 40 分　　□40　未滿 50 分　　□50　未滿 60 分

□60　未滿 75 分　　□90 分以上

(2)「每天」使用機車次數：

□無　　□1 次　　□2 次　　□3 次

□4 次　　□5 次　　□6 次　　□7 次以上（_____）次

(3)「每週」使用機車天數

□無　　□一天　　□二天　　□三天

□四天　　□五天　　□六天　　□每天

(4)「每週」使用頻率

□無　□很少　□一般　□頻繁

□非常頻繁

16．每日平均騎乘的單趟距離：

□0　未滿 2 公里　□2　未滿 4 公里　□4　未滿 6 公里

□6　未滿 8 公里　□10 公里以上

17．每次平均騎乘單趟的時間：

□未滿 10 分　□10　未滿 20 分　□20　未滿 30 分

□30　未滿 40 分　□40　未滿 50 分　□50　未滿 60 分

□60　未滿 75 分　□90 分以上

18．主要使用機車轉乘其他交通工具情形（限單選）

□小客車　□市區公車　□客運車（如國光及統聯）

□火車　□無　□其他_____

19．每星期平均來回騎乘行駛公里數

□0　未滿 2 公里　□2　未滿 4 公里　□4　未滿 6 公里

□6　未滿 8 公里　□10 公里以上 _____

20．去年整年是否有發生過交通事故（若是請詳述原因）

□ 是，發生次數_____，其中入醫院次數有 ____次

主要事故類型：□追撞對方汽車　□被對方汽車追撞

□追撞對方機車　□被對方機車追撞

□撞到行人　□撞到路上物體　□其他 _____

發生路段：□大型路段　□巷道間　□十字交叉路口

□停（候）車處　□其他 _____

發生時間：□凌晨　□上午　□中午　□夜間　□午夜以後

□ 否

★機車使用所遭遇問題

21．您在騎乘機車時是否有經驗過以下幾種狀況：

(1) 騎機車時是否有轉彎吃力的經驗？（如雙腳貼近地面協助轉彎）

□ 是（請承下）　　□ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　　□視力退化　　□平衡感失調

□反應時間的遲緩　　□聽力退化　　□肌握力衰退

□關節機動性衰退　　□記憶力衰退　　□方向感喪失

□脊椎的退化　　□其他_____

(2) 騎機車時是否有號誌難以辨認之經驗？

□ 是（請承下）　　□ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　　□視力退化　　□平衡感失調

□反應時間的遲緩　　□聽力退化　　□肌握力衰退

□關節機動性衰退　　□記憶力衰退　　□方向感喪失

□脊椎的退化　　□其他_____

(3) 是否有過因夜間騎乘機車的困擾(如難以辨識標誌或分隔線)？

□ 是（請承下）　　□ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　　□視力退化　　□平衡感失調

□反應時間的遲緩　　□聽力退化　　□肌握力衰退

□關節機動性衰退　　□記憶力衰退　　□方向感喪失

□脊椎的退化　　□其他_____

(4) 騎乘機車是否遇過難以控制車身平衡的經驗？

□ 是（請承下）　　□ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　　□視力退化　　□平衡感失調

□反應時間的遲緩　　□聽力退化　　□肌握力衰退

□關節機動性衰退　　□記憶力衰退　　□方向感喪失

□脊椎的退化　　□其他_____

(5) 騎機車是否遇過追撞過其他車輛的經驗

□ 是（請承下） □ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中 □視力退化 □平衡感失調

□反應時間的遲緩 □聽力退化 □肌握力衰退

□關節機動性衰退 □記憶力衰退 □方向感喪失

□脊椎的退化 □其他_____

(6) 騎乘機車是否有被其他車輛追撞過的經驗

□ 是（請承下） □ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中 □視力退化 □平衡感失調

□反應時間的遲緩 □聽力退化 □肌握力衰退

□關節機動性衰退 □記憶力衰退 □方向感喪失

□脊椎的退化 □其他_____

(7) 是否有騎乘機車造成緊張的經驗

□ 是（請承下） □ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中 □視力退化 □平衡感失調

□反應時間的遲緩 □聽力退化 □肌握力衰退

□關節機動性衰退 □記憶力衰退 □方向感喪失

□脊椎的退化 □其他_____

(8) 是否有騎乘機車容易疲勞的經驗

□ 是（請承下） □ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中 □視力退化 □平衡感失調

□反應時間的遲緩 □聽力退化 □肌握力衰退

□關節機動性衰退 □記憶力衰退 □方向感喪失

□脊椎的退化 □其他_____

(9)是否有騎乘機車蛇行的經驗

□ 是（請承下） □ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　□視力退化　□平衡感失調

□反應時間的遲緩　□聽力退化　□肌握力衰退

□關節機動性衰退　□記憶力衰退　□方向感喪失

□脊椎的退化　□其他_____

(10)是否有行走熟悉道路但經常迷路的經驗

□ 是（請承下）　□ 否（請至下一題）

若是，主要為以下何種因素為主因（單選）

□注意力不集中　□視力退化　□平衡感失調

□反應時間的遲緩　□聽力退化　□肌握力衰退

□關節機動性衰退　□記憶力衰退　□方向感喪失

□脊椎的退化　□其他_____

22．騎乘行為與意見調查

(1) 請問您觀看後視鏡的頻率：

□無　□偶而　□普通　□頻繁　□非常頻繁

(2)請問您出門戴安全帽的頻率：

□無　□偶而　□普通　□頻繁　□非常頻繁

(3)請問您認為你使用的安全帽安全度足夠嗎？

□非常不安全　□不安全　□普通　□安全　□非常安全

(4) 請問您所配戴的安全帽種類為：

□半罩式　□3/4 罩　□全罩　□其他 _____

(5) 是否有家人或友人曾提醒或關心您的騎乘行為

□無　□偶而　□普通　□頻繁　□非常頻繁

(6) 是否有醫生或健康諮詢機構建議您停止騎乘機車

□ 是　□ 否

23．十字路口之騎乘行為

(1)經過十字路口時，是否常發生煞車不及或緊急煞車的狀況

□無　□偶而　□普通　□頻繁　□非常頻繁

其中影響的主因為（單選）：

□沒注意號誌　□沒注意前方車況　□反應時間太慢

□看不懂號誌　□其他_____

(2)您平常騎車經過十字路口時速約為？

□0　未滿 10　□10　未滿 20　□20　未滿 30

□30　未滿 40　□40　未滿 50　□50 以上 _____公里/時

(3) 您時常紅燈右轉嗎？

□ 無　□ 偶而　□ 普通　□頻繁　□非常頻繁

(4) 您時常兩段式左轉嗎？

□無　□偶而　□普通　□頻繁　□非常頻繁

(5) 您騎車轉彎時經常使用方向燈嗎？

□無　□偶而　□普通　□頻繁　□非常頻繁

24．疲勞度調查：平均騎乘多久會造成您的疲勞，並考慮避免騎車出門

□未滿 10 分　□10　未滿 20 分　□20　未滿 30 分

□30　未滿 40 分　□40　未滿 50 分　□50　未滿 60 分

□60　未滿 75 分　□90 分以上

其中影響原因主要為（單選）：

□注意力不集中　□騎乘姿勢不舒服　□脊椎的退化

□關節機動性衰退　□機車操控性不佳　□其他_____

25.您認為在您在騎乘路途中最為危險路段為（單選）：

□巷道　□大型路段　□十字路口　□停（候）車

□其他_____

是否因高齡退化的因素，考慮以後減少使用機車頻率

□是　□否

26．未來是否考慮使用替代的交通運具取代您現有機車的用途

□ 是（請跳至 1）　　□ 否（請跳至 2）

(1) 若是，以下何種運具可符合您的需求（注意！複選三項）

□計程車/小客車　□公車　□捷運　□腳踏車

□電動代步車　□步行　□其他_____

(2) 若否，以下那些原因為主因（單選，以不考慮經濟因素前提下）？

□其他車輛無法符合機動性需求　□其他車輛的安全性不符合需求

□環保經濟油耗不符合需求　□其他車輛大小不符合需求

□其他車輛無法協助其適應現有交通環境

□身體疾病或退化無法操控其他車輛

□其他 _____

＊＊＊＊　本問卷到此結束，感謝您撥空填寫問卷並細心的回答！　＊＊＊＊＊