National Cheng Kung University

Institute of Telecommunication Management

Master Thesis

A Preference Study of the Middle-aged Adults Using Mobile Payment on Shared Autonomous Vehicles：An Example of LINE Pay

中高齡者採用行動支付共享自駕車之偏好研究

—以 LINE Pay 為例

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July, 2020

doi:10.6844/NCKU202001330

國立成功大學

碩士論文

中高齡者採用行動支付共享自駕車之偏好研究—
以LINE Pay為例

A Preference Study of the Middle-aged Adults Using Mobile Payment on Shared Autonomous Vehicles：An Example of LINE Pay

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中 華 民 國 109 年 7 月 7 日

doi:10.6844/NCKU202001330

Abstract

As the percentage of older people is growing up, we must be proactive to focus on the issues generated by older people. Additionally, Taiwan has reached a developed country level. Due to World War II baby boom happened between 1946 and 1964, which means a dramatic increase in the population aged 65+ will happen after 10 years. However, McKinsey & Company's report shows that multi-passenger robot-taxis could account for 500 billion miles traveled on US roads with the right infrastructure to enable shared mobility about 9 percent of the total by 2030, but they could account for 50 percent of all miles traveled by 2040. Besides, in Taiwan, according to the Act to promote the employment of middle age and senior workers, senior and middle-aged persons used in the Act are defined as the persons at the age of 45 to 65. Thus, the target of subjects in this study starts from 45 years old, and three groups are divided: 45-54, 55-64, and 65+.

Due to Information and Communication Technology rapidly develops, a smartphone is not only can make a phone call and send messages but also browse the Internet and run software programs like a computer. There are lots of applications, such as games, social media, and business-use programs that can run on the smartphone.

Besides, autonomous vehicles have been discussed for many years and they can perceive their surroundings and travel to different locations by themselves through a variety of sensors, such as radar, lidar, GPS, etc. Also, it owns many advantages, including improved fuel efficiency, reduced car crashes, increased safety, and decrease air pollution.

Additionally, according to National Communications Commission (2018) research, there are almost 40% of citizens are using LINE Pay as their main online payment system in 2018, so LINE pay is set as an example of mobile payment. Hence, this study focuses on

doi:10.6844/NCKU202001330

exploring the factors that might attract or stop middle age to use LINE pay for SAV.

As mentioned above, there are four parts in the questionnaire of this study. The questions of latent variables of using LINE pay for SAV are listed in the first part. The choice behavior of whether middle age using LINE pay for SAV is investigated in the second part. The third part inquires about their living habit. Socio-economic status is surveyed in the final part. In summary, the purpose of this research is to enhance middle age adoption of new technologies through policy and strategies design. Thus, this research adopts structural equation modeling (SEM) to explore latent variables in the first step. Based on the result of SEM, hybrid choice models are constructed by adding those latent variables.

Keywords: Middle age, LINE pay, Shared autonomous vehicles, Discrete choice models, Hybrid choice models

doi:10.6844/NCKU202001330

摘要

隨著老年人比例的增長，老年人所產生的議題逐漸深受關注。由於第二次世界大戰的嬰兒潮發生在 1946 年至 1964 年之間，意味著 10 年後 65 歲以上的人口將急劇增加，再加上根據 Mckinsey 的報告(Tyler Duvall, 2019)，預估 2040 年在美國，共享自駕車可占所有旅途的 50%。 此外，勞動部也將中高齡者的年齡範圍定義在 45-65 歲之間。因此本研究的問卷目標年齡為 45 歲以上，本研究將老年人分為 45-54 歲、55-64 歲及 65 歲以上，

而近幾年的資通訊技術的發展極為快速，智慧型手機可以像電腦一樣驅動各式各樣軟體。根據資訊工業策進會（2017）的研究，台灣有 91.5%的老人使用 LINE 是為了跟孩子溝通。再加上，自動駕駛汽車已經被研究多年，它們能夠透過各種傳感器感知周圍環境並自行行駛在道路上，在未來有可能於實際道路運行。

因此，本研究將探討中高齡者對於使用 LINE pay 支付共享自動駕駛汽車費用的偏好及接受度，並尋找哪些因素可能吸引或是影響他們使用這些新科技。 如上所述，本研究問卷分為四個部分，第一部分是根據結構方程模型（SEM）來構建使用 LINE pay 支付共享自動駕駛汽車費用之接受度的問題；第二部分調查個體選擇行為；第三部分為中高齡者的手機及交通運輸的使用習慣；最後則是社會經濟資料的調查。

研究最終目的是希望透過政策和策略增進中高齡對新技術的接受度。因此，本研究首先調查中高齡者的潛在變數，再將潛在變數與方案屬性變數進行綜合評估，此架構被稱為 hybrid choice models。

關鍵字：中高齡者、LINE pay、共享自駕車、離散選擇模型、Hybrid choice models

doi:10.6844/NCKU202001330

誌謝

遙想兩年前剛入學成功大學的時候，還在煩惱著尋找指導教授，如今論文已然進入最後階段，家住高雄的我，在這兩年來，回高雄的次數屈指可數，碩一忙修課、計劃案，碩二忙英文論文撰寫，每天幾乎都是從早 10 待到晚 12，假日也不例外，為的是要讓自己的實力能承擔得起成功大學這個校名，對比今日與昔日的自己，在各層面皆有不同程度上的突破，慶幸自己在這兩年的碩士生涯中，極為深入的探索自己，這趟旅程中的艱辛歷歷在目，走的每一步都在穩固邁向社會的基石。

感謝胡大瀛老師收我當學生，成為少數電管所混雜在交管所的學生，並且在這場試煉中，適時地給予我幫助及方向，讓我能繼續延伸大學所學的運輸專業並結合新的電信領域，產出這篇 123 頁的英文碩士論文，學生著實受益良多，深刻感受扎實的訓練。感謝陳文字老師從論文計畫書到外審給予學生寶貴的審查意見，也謝謝蔡東峻老師及廖彩雲老師於外審時提供的建議，老師們誠心的建議皆為促成此本論文更趨完善的關鍵。

年輕的時候未曾想過未來有一天我會獨立完成論文並通過層層口試關卡，但在這場為期兩年的馬拉松，因為有研究所創造出革命情感的戰友們而美滿，也一一扶持著彼此抵達終點線，謝謝研究室的學長姐們、元亭、冠捷、怡楨、辰陽以及 204 的學長姐，在我撰寫論文的過程中，給我很多不同的建議、照應，我才能順利地通過口試。特別感謝其他研究室的摯友們，沒人叫你看的雅涵、宇婷、俊杰、元亭、柏任及怡棻，還有幫助我甚多的凱峯學長，研究生涯最日常的生活都是跟你們度過，最平凡的最讓人懷念，感謝命運讓我遇見最美好的你們，在我的青春歲月裡，綻放最耀眼的光芒，在學生時期的最後階段建立最真摯的情感。

最後，感謝一直以來默默支持我的家人們，在我無助的時候給我溫暖，也能體諒我的忙碌，有了你們的鼓勵及幫助，才成就了我的碩士學涯，這份成就因為你們而有價值，我將持續努力精進，讓這份價值不斷加值，未來還請繼續多多指教。

陳羿州 謹誌

於國立成功大學 62501 民國 109 年 夏

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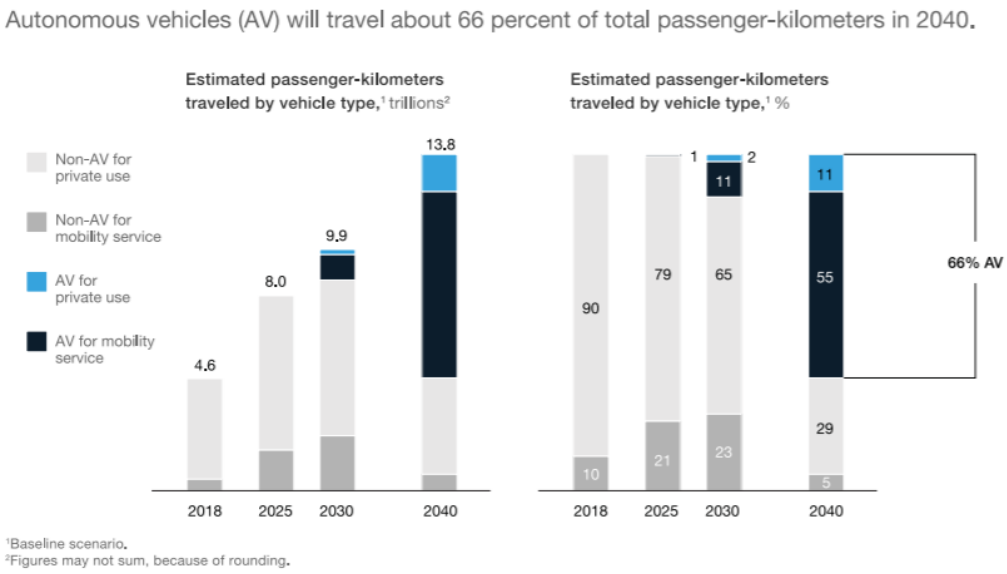
CHAPTER 1 INTRODUCTION

1.1 Research Motivation and Background

With continued decreases in natality and mortality rates, the global population is getting older in the 21st century. In 2017, the global population aged 60+ years has reached 962 million, and there were 382 million older persons in 1980. The number of older people is expected to reach nearly 2.1 billion by 2050 (United Nations, 2017).

In Taiwan, since 2018, the percentage of the elderly aged 65+ has already exceeded 14%, and it represents that Taiwan has entered the phase of an “aged society”, which means there is one senior citizen in every seven people. Thus, the issues generated by older people should be urgently concerned. Due to World War II baby boom happened between 1946 and 1964, which means there will be a dramatic increase in the population aged 65+ after 10 years. Based on the National Development Council’s population estimation system, which predicts the population of the elderly will reach to 5,432 thousand (= 23.1%) in 10 years. However, according to McKinsey & Company’s article：A new look at autonomous-vehicle infrastructure, it shows that multi-passenger robot-taxis could account for 500 billion miles traveled on US roads with the right infrastructure to enable shared mobility-about 9 percent of the total by 2030, but they could account for 50 percent of all miles traveled by 2040. Additionally, based on McKinsey & Company’s analysis and forecast：The future of mobility is at our doorstep, the estimated percentages of passenger-kilometers traveled by AV is only 13% in 2030, but 66% of it in 2040, which presented in Figure 1-1. Thus, the questionnaire’s target of this study will be 45+.

doi:10.6844/NCKU202001330



(Ref：McKinsey Center for Future Mobility, 2019)

Figure 1-1 Passenger-kilometers traveled by AVs in 2040

The AV technology could make carsharing more accessible and affordable. As for conventional carsharing, the walking distance to access shared vehicles is considered to be a key determinant of carsharing usage. Since SAVs will collect their passengers directly at their origin, walking times to access shared vehicles will be reduced to zero. Moreover, AV technology could resolve the relocation issues of one-way carsharing and reduce the costs of providing one-way carsharing services (Firnkorn and Müller, 2015).

As information and communication technology (ICT) developing rapidly, internet and smartphone usage are also increasing dramatically. Smartphones offer many applications, such as watching a video clip on Youtube, playing an online game, shopping, and Voice Over LTE (VoLTE). It is so convenient that feature phones were quickly replaced by smartphones. There are 92.5% of citizens using smartphones as their main cellphone, but people aged 66+ are only 64.4% using smartphones in Taiwan. Moreover, People aged 56-65 owned the highest percentage (52.8%) of considering mobile payment is not important in Taiwan (National Communications Commission, 2018).

doi:10.6844/NCKU202001330

As the middle age getting older, their driving abilities would decline, so there is a thought that AVs' appearance could improve the elderly's mobility. As the issues stated above, a series of empirical trials for the elderly have been conducted, such as the business model, the feasibility, and the acceptance of the elderly in Japan.

Many stakeholders of autonomous vehicles have dedicated to developing AVs technology and implementing lots of AVs trials, including the IT industry, governments, universities, and the automotive industry. There will be a great possibility of AVs' appearance in near future.

Additionally, the related studies about this topic are insufficient in Taiwan. To better understand the middle-aged preferences of new technologies, there are two issues discussed in this study. First, what latent variables will influence middle age using LINE pay for SAV, and second, which types of middle age are more willing to use LINE pay for SAV.

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1.2 Research Objectives

This study explores the factors that might influence the adoption of whether using LINE pay for SAV for middle age in Taiwan and to relate the observable attributes with latent variables and socio-economics variables, finding their correlation. Finally, the results show that different characteristics of middle age have different choices. The main objectives of this study are summarized below:

1. The technology acceptance model (TAM) is applied to explore the middle age latent variables of using LINE pay for SAV.
2. Hybrid choice models are adopted to reveal middle-aged preferences by adding latent variables.
3. Based on the results, it shows the middle-aged choice behavior of using LINE pay for SAV. While the outcomes are revealed, strategies and policy could be design.

1.3 Research Flow Chart

Figure 1-2 presents the research flowchart. Each research procedure is shown below:

1. Research background and motivation

   Describe the significant issues of the elderly around the world. Observe smartphones and autonomous vehicles may bring huge convenience to the elderly in life. Make an inclusive survey and clarify this research's background and motivation, defining the problem to accurately establish a research direction. Confirm whether the objectives are worth to be researched.

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2. Literature review

Categorize papers with different technologies adopted by the middle-aged, analyzing why the paper using the structure as their model, and investigate the current growth trend of the elderly in the world. Moreover, review related papers about preferences and TAM constructs for smartphones or new technologies. As stated above, the literature reviews are including smartphones, the middle age and the elderly, shared autonomous vehicles, stated preference method, the factors affecting technology acceptance, discrete choice models, hybrid choice models, development of technology acceptance model.

3. Research assumption and framework

The suitable methodologies of this study are found out through the literature reviews and the assumptions are inferred, applying in the research.

4. Questionnaire design and revise

The questions of TAM are set in the first part, knowing the participants' mental variables. Shared Autonomous Vehicles (SAVs) are not imported into the real market, so stated preference method and tests are designed to explore middle-aged preferences. The questionnaire of the first version is distributed in Kaohsiung. After that, based on the feedback, the second edition questionnaire is generated.

5. Data collection and analysis

The main target of this survey is Taiwan’s middle age over 45 years old. A sample survey is conducted through a questionnaire adopting convenience sampling. Physical questionnaires are distributed to in front of Chunghwa Telecom and different company’s employees. SurveyCake, a cloud-based survey service platform, is utilized to create this study’s questionnaire. It is distributed to the middle-aged LINE group and Facebook with the lottery.

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6. Model formulation and calibration

Construct discrete choice models by using the collected data, and the parameters are calibrated and analyzed through the PandasBiogeme.

7. Discrete choice models

Estimate the preferences of middle age in different socio-economic status through the results of the PandasBiogeme.

8. Hybrid choice models

Discuss the preferences of middle-aged latent variables by combining latent constructs and individual socioeconomic variables.

9. Conclusions and suggestions

According to the results, this step will deliver conclusions and research gaps in this study. Also, it will give some policy suggestions and strategies to improve middle-aged new technologies acceptance for future research, industries, and authorities.

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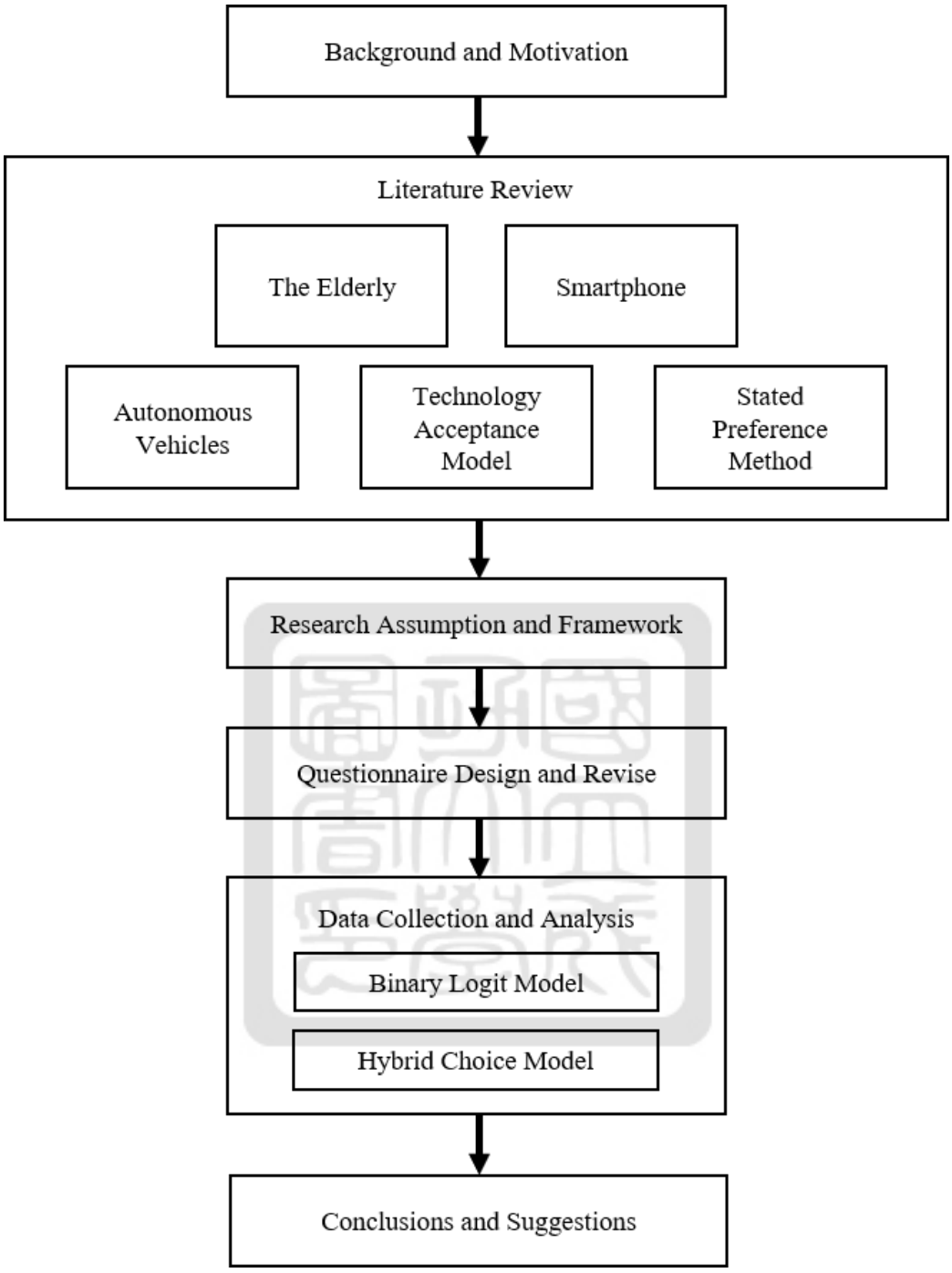

Figure 1-2 Research flow chart

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CHAPTER 2 LITERATURE REVIEW

Issues of the elderly have been discussed for many years. This research discusses the definition of middle age and the elderly and presents situations around the world. In this chapter, related issues, the present situation of the middle age and the elderly adopting new technology, and mobile payment are reviewed.

Each section is summarized as below: Section 2.1 reviews the middle-aged and the elderly definitions, population situation, related research of the elderly using technology. Section 2.2 presents the elderly's smartphone usage and mobile payment used by Taiwan citizens. Section 2.3 describes Autonomous Vehicle features and SAV's related literature. Section 2.4 discusses related factors affecting technology acceptance. Section 2.5 shows the development of the technology acceptance model. Section 2.6 introduces the stated preference (SP) method. Section 2.7 depicts a summary in Chapter 2.

2.1 The Middle Age and the Elderly

To know better the issues of the elderly, this section introduces the definitions, concepts, smartphone usage, and characteristics of the elderly. In the end, the current situation of the elderly in different countries also be discussed.

2.1.1 Definitions of the Middle Age and the Elderly

According to the Oxford English Dictionary middle age is between about 45 and 65: "The period between early adulthood and old age, usually considered as the years from about 45 to 65." The US Census lists the category middle age from 55 to 65. Merriam-Webster is an American company that publishes reference books and is especially known for its dictionaries. It lists middle age from about 45 to 64, while prominent psychologist Erik

doi:10.6844/NCKU202001330

Erikson saw it starting a little earlier and defines middle adulthood as between 55 and 65. The Collins English Dictionary lists it between the ages of about 40 and 60.

In Taiwan, according to the Act to promote the employment of middle age and senior workers, senior and middle-aged persons used in the Act are defined as the persons at the age of 45 to 65.

There are a lot of definitions of the elderly, but most of the research adopted the United Nations' standard. According to the World Health Organization, it was announced that the age definition of the elderly of developing countries is 60+, but in developed countries is set up 65+. If a society's elderly rate over 7%, it is an "aging society." If the percentage surpasses 14%, it is called "aged society". However, if it is over 21%, it is announced to be a "super-aged society."

Based on the Labor Standards Act (Ministry of Labor, 2016), laborers who aged 65+ (elderly) should be forced to retire in Taiwan.

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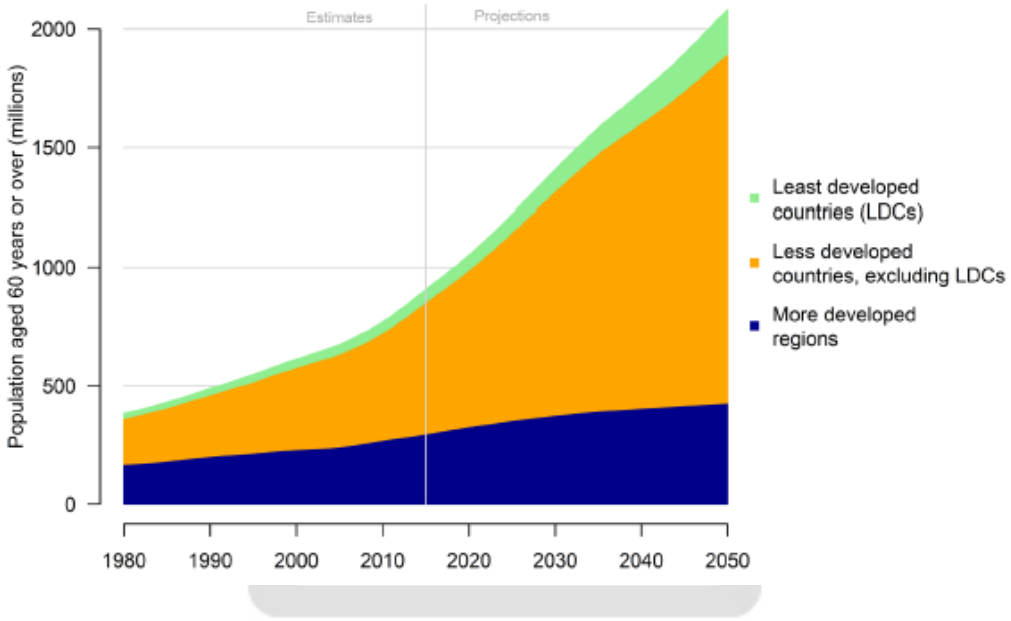
2.1.2 The Elderly Around the World

The developing regions' older population is increasing faster than in the developed areas. The population of global elderly aged 60+ had exceeded 962 million in 2017. It is expected that older adults will reach nearly 2.1 billion. Projections show that 79 percent of the global population aged 60+ will be living in the developing regions (United Nations, 2017).



(Ref: United Nations, 2017)

Figure 2-1 Number of persons aged 60+ by the development group

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In the next decades, the quantity of older adults is expected to increase the fastest in Africa. For Asia, it is expected to grow more than twofold between 2017 to 2050, with the population aged 60+ projected to grow from 549 million to about 1.3 billion (United Nations, 2017).

Table 2-1 Number and distribution of persons aged 60+ by region

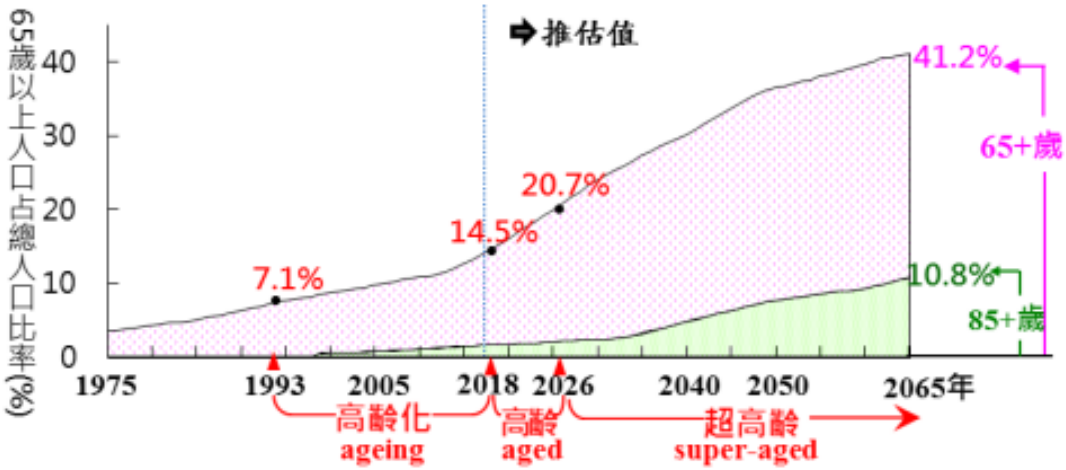
	Number of persons aged 60 years or older in 2017 (millions)	Number of persons aged 60 years or older in 2017 (millions)	Distribution of older persons in 2017 (%)	Distribution of older persons in 2050 (%)
World	962.3	2080.5	100.0	100.0
Africa	68.7	225.8	7.1	10.9
Asia	549.2	1273.2	57.1	61.2
Europe	183.0	247.2	19.0	11.9
Northern America	78.4	122.8	8.1	5.9
Latin America and the Caribbean	76.0	198.2	7.9	9.5
Oceania	6.9	13.3	0.7	0.6

(Ref: United Nations, 2017)

doi:10.6844/NCKU202001330

2.1.3 The Elderly in Taiwan

The elderly group usually be defined as 65+ in Taiwan. As shown in Figure 2-2, the ratio of the elderly exceeded 7% in 1993, becoming an aging society. In March 2018, the ratio already surpassed 14%, officially entering an aged society. Furthermore, it is expected that the ratio will exceed 20% in 2026, turn into a super-aged society.



(Ref: 中華民國國家發展委員會, 2018)

Figure 2-2 Aging time process

Because the World war II baby boom happened from 1946 to 1964, the final generation of the baby boom is aged 55 in 2019, which means a dramatic increase will appear in the population aged 65+ after 10 years. According to the prediction by the National Development Council's population estimation system, the population of the elderly will reach 5,432 thousand in 10 years. However, the purpose of this research is to reveal various characteristics between two middle-aged groups aged under and over 55. Thus, the questionnaire's target of this study will be 45+.

doi:10.6844/NCKU202001330

Table 2-2 Population estimation of the elderly

Estimation Scenario	Item	2018 (y)	2019 (y)	2029 (y)	2030 (y)
High Estimation	Population over 65 (thousand people)	3434	3600	5432	5594
	Ratio of population over 65 (%)	14.56	15.3	22.9	23.6
Medium Estimation	Population over 65 (thousand people)	3434	3600	5432	5594
	Ratio of population over 65 (%)	14.56	15.3	23.1	23.9
Low Estimation	Population over 65 (thousand people)	3434	3600	5432	5594
	Ratio of population over 65 (%)	14.56	15.3	23.3	24.1

*It is estimation value after 2019.

(Ref: 中華民國國家發展委員會, 2018)

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2.1.4 Research of the Elderly Using Advanced Technology

Some scholars have researched about the elderly's new technology acceptance to explore the elderly's acceptance and preferences with various types of new technologies for knowing technologies could significantly benefit the elderly's life.

Given that the elderly are an increasingly large amount of the population and they will benefit from the new technologies. So, issues about aging and information technology are urgent importance (Czaja and Lee, 2009). Plaza et al. (2011) proposed that the elderly are willing to use different kinds of technologies, especially cellphones, which have the essential to enhance the quality of the elderly's life. Smartphones rapidly increasing play a critical role in the home care of older people. Present studies of mobile phone usage among the elderly is including a growing variety of clinical aspect (Joe and Demiris, 2013). Unless technologies meet older people's needs and expectations, they do not adopt and accept technologies (Conci et al., 2009; Venkatesh et al., 2003). Older adults have responded using were mainly at home and related to domestic stuff when they use technology products and services such as Internet and cellphones (Mitzner et al., 2010; Ziefle and Röcker, 2010).

2.2 Smartphones

Smartphone has developed for a few years. Lots of young people adopt new technology easily and fluently. Also, middle age have a high ratio of using a smartphone. However, the group within 56 to 65 owns the highest rate of using an online credit card through a mobile device. This section is giving the present situation of the middle-aged smartphone usage.

2.2.1 Smartphone Usage of Middle Age and the Elderly in Taiwan

The smartphone owned ratio of the household is up to 92.8%. In present, except the

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group aged over 66 is 83.2%, the other groups' smartphone household owning ratio is over 90%. Moreover, the ratio of using LINE at each age group is up to 90%. The survey shows that the highest ratio of social media or instant messaging account still is used by people is LINE. Besides, the age group with the highest rate of 98.4% of using LINE is 56 to 65. (National Communications Commission, 2018)

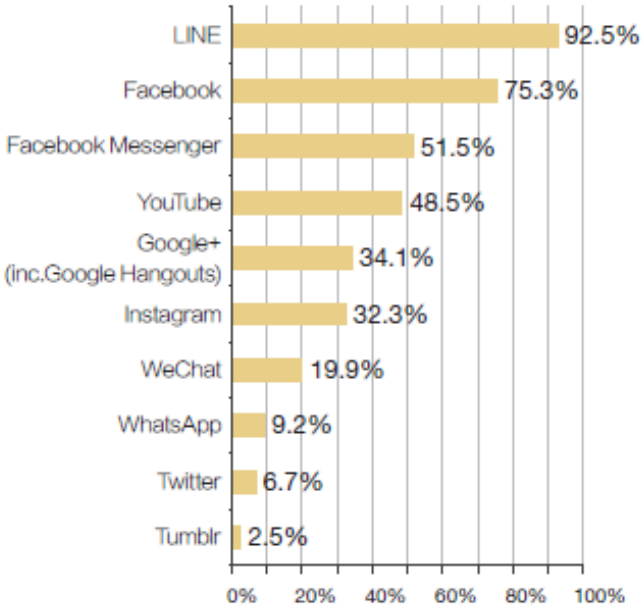

Figure 2-3 Owing to the accounts of social media or instant messaging still be used

(Ref: National Communications Commission, 2018)

The percentage of middle age using mobile payment is relatively lower than younger people. Table 2-3 shows the percentage of each group using mobile payment in Taiwan.

Table 2-3 The percentage of each group using mobile payment in Taiwan

106年（N=1,140）		107年（N=1,069）	
16-24歲	27.2%	16-25歲	22.6%
25-34歲	34.4%	26-35歲	29.9%
35-44歲	20.9%	36-45歲	29.0%
45-54歲	15.4%	46-55歲	11.8%
55歲以上	4.7%	56-65歲	5.7%
-	-	66歲及以上	0.8%

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2.2.2 Comparison of Online Payment Systems

In 2018, there are almost 40% of citizens are using LINE Pay as their main online payment system. However, the group within 56 to 65 owns the highest rate of using an online credit card through a mobile device. There are 42% of people between 56 to 65 are using the mobile payment for buying daily essentials (National Communications Commission, 2018).

Table 2-4 Type of online payment systems used by Taiwan citizens

Rank	2017		2018	
1	Apple Pay	25.9%	LINE Pay	39.6%
2	LINE pay	14.6%	Apple pay	19.4%
3	Credit card online through a mobile device	14.1%	Credit card online through a mobile device	17.5%
4	GOMAJI pay	10.2%	JKOPAY	13.9%
5	EasyCard on smartphone	9.9%	EasyCard on smartphone	7.8%
6	CHT e-wallet	8.9%	O'Pay	7.0%
7	Taiwan mobile e-wallet	8.8%	CHT e-wallet	6.0%
8	P mobile wallet	8.0%	GOMAJI pay	5.3%
9	O'Pay	7.2%	Taiwan mobile e-wallet	5.3%
10	FET Friday wallet	6.3%	FET Friday wallet	4.4%

(Ref: National Communications Commission, 2018)

Online Payment Systems are divided into kinds. One is an induction type, and the other is a code scan type. Table 2-5 shows the advantages and disadvantages of them.

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Table 2-5 Comparison of induction type, code scan type online payment systems

	Induction type	Code scan type
Technique	Near Field Communication (NFC)	Quick Response Codes
The cost of the facility	1. Need inductive machines. 2. Smartphones must own NFC function. 3. Cost Higher.	1. It could be downloaded on the smartphone 2. Complete transaction by Point-of-Sale (POS) machine. 3. Cost lower
Platform	Apple Pay、Samsung Pay、Android Pay	LINE pay、JKOPAY、TaiwanPay
Advantages	Faster transaction	QR codes are more common.
disadvantages	Limited smartphone and transaction machine	1. With the high counterfeit rate 2. Personal information leak easily

In Taiwan, Online payment Systems and electric tickets are usually misunderstood. Especially, people are usually confused with electronic payment and third-party payments. Compared to electronic payments, third-party payments are regulated loose. Third-party payments do not offer functions, such as stored value, transfer. It only plays a role in the capital flow platform. The difference in the electric ticket, electric payment, third-party payments, and mobile payment would be organized in Table 2-6.

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Table 2-6 Comparison of the electric ticket, electric payment, third-party payments, and mobile payment

	Electric ticket	Electric payment	Third-party payment	Mobile payment
Function	Micropayments, pay the processing fees	As same as e-tickets, adding a transfer, stored value functions	Cash flow from buyer to the seller without transfer, stored value functions	Does not exists in Law.
Regulatory Authority	Financial Supervisory Commission	Financial Supervisory Commission	Ministry of Economic Affairs	Financial Supervisory Commission
Regulations and laws	Act Governing Issuance of Electronic Stored Value Cards	The Act Governing Electronic Payment Institutions	Only obey the rules with credit card agency	No exclusive regulations.
Representative	EasyCard, iPass, iCash, HappyCash	LINE Pay, O'Pay, TaiwanPay	JKOPAY, GOMAJI Pay, Pi wallet	Apple Pay, Samsung Pay, Android Pay
Transaction limit	1. A single purchase is up to 1000 dollars. 2. The upper limit of stored value is 10,000 dollars. 3. The upper limit of a day is 30,000 dollars.	1. The upper limit of a month is 30,000 dollars. 2. Flexibility adjusts the transaction limit 100,000 per month. 3. It could not exceed 360,000 per year.	1. Without the function of stored value. 2. The medium of exchange: credit card.	1. Bind a credit card with a smartphone to use.

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2.3 Autonomous Vehicles

The National Highway Traffic Safety Administration (NHTSA, 2015) has indicated that 94 percent of all serious motor vehicle crashes are happened by human error or choices. Autonomous vehicles (AVs) can solve serious crashes from human mistakes. As the trials have been conducted for several years, new business conceptual models, e.g., shared autonomous vehicles (SAVs) appear. Thus, AVs' features and developments would be introduced.

2.3.1 Features of Autonomous Vehicles

The most novel characteristic of AVs is the navigation of the vehicle will be fully automated, so the driver is turn out to be unnecessary. (National Highway Traffic Safety Administration, 2013)

Talebpour and Mahmassani (2016) pointed out Autonomous vehicles differ from connected vehicle systems. They are expected to self-driving through external sensors and huge intelligence.

The society of Automotive Engineers International (SAE International, 2014) defines six different levels of driving automation, from the full manual (Level 0) to full automation (Level 5), i.e. from humans operate the vehicles to full autonomy and drivers can decide whether to involve the system. The detailed taxonomy is shown as below:

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Table 2-7 SAE International's levels of driving automation for on-road vehicles

SAE level	Name	Narrative Definition
The human driver monitors the driving environment		
0	No Automation	the full-time performance by the human driver of all aspects of the dynamic driving task, even when enhanced by warning or intervention systems
1	Driver Assistance	the driving mode-specific execution by a driver assistance system of either steering or acceleration/deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task
2	Partial Automation	the driving mode-specific execution by one or more driver assistance systems of both steering and acceleration/ deceleration using information about the driving environment and with the expectation that the human driver performs all remaining aspects of the dynamic driving task
Automated driving system ("system") monitors the driving environment		
3	Conditional Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task with the expectation that the human driver will respond appropriately to a request to intervene
4	High Automation	the driving mode-specific performance by an automated driving system of all aspects of the dynamic driving task, even if a human driver does not respond appropriately to a request to intervene
5	Full Automation	the full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver

(Ref: SAE International, 2014)

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2.3.2 Shared Autonomous Vehicles

The concept of shared autonomous vehicles combines elements of traditional carsharing and taxi services with AVs (Fagnant and Kockelman, 2015). Car-sharing is thought to be a flexible mobility choice, which can complement public modes, by providing the flexibility of the private car without private car ownership (Shaheen and Cohen, 2013).

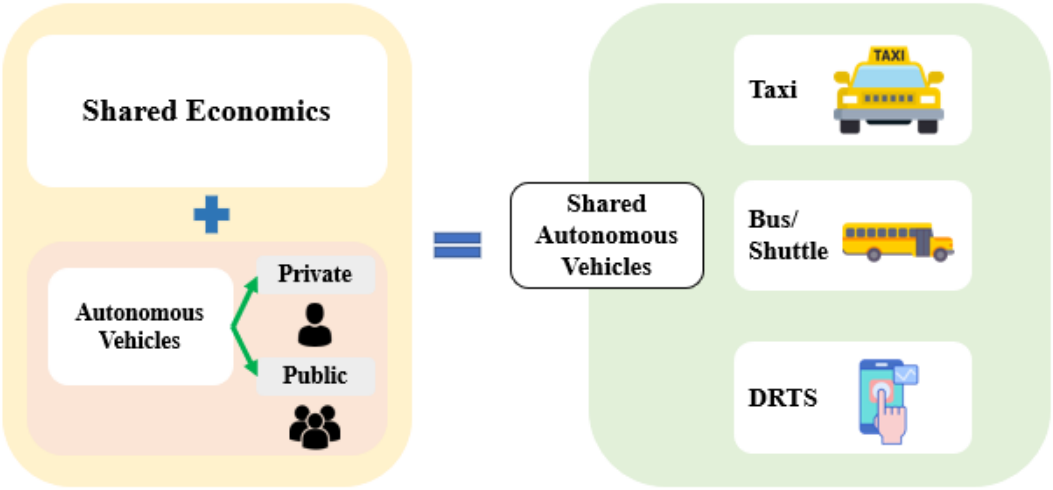

Figure 2-4 The concept of shared autonomous vehicles

The literature indicates that shared autonomous vehicles might be an attractive mobility choice for older travelers (Fagnant and Kockelman, 2015).

Bansal et al. (2016) analyze people's stated frequencies to take SAVs with different pricing scenarios and distinguish the characteristics of potential shared autonomous vehicle adopters.

Furthermore, SAVs could also provide a door to door service, lowering cost, shorter travel time, less waiting time, improving safety, reducing parking cost, and no need to drive (Burns et al., 2013)

2.4 The Factors Affecting Technology Acceptance

There was lots of research investigating human's latent variables towards using new

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technology through the technology acceptance model. Nevertheless, only a few studies were exploring the elderly's latent factors when they faced new technology's manipulation. Thus, this section would introduce the constructs this study will investigate. This research-based on the technology acceptance model as a research structure with external variables: technology anxiety, self-satisfaction, and self-efficacy.

1. Perceived usefulness and perceived ease of use

   The definition of perceived usefulness (PU) is the subjective trust of users that a special system will improve their job performance. Perceived ease of use is described as the level to which individuals trust that using a specific system will be easy (Davis, 1989).

2. Attitude

   According to the theory of reasoned action (Fishbein and Ajzen, 1977), some researchers have announced that one's attitude of using a system would mediate the relationship between perceived usefulness and behavioral intention. The rationale for incorporating attitude is that people generate intentions to engage in behaviors toward they have positive attitudes.

3. Technology anxiety

   Deng et al. (2014) proposed that acceptance of mobile health services by middle and older people, and the consequences showed that attitude, perceived value, technology anxiety positively affected the behavior intention of the elderly.

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4. Self-satisfaction

Self-satisfaction is the satisfaction level deserved from a product/service by users with their achievements (Park et al., 2013).

In China, personal self-esteem effect and self-related life satisfaction effects are stronger in older adults than in young people (Zhang and Leung, 2002).

5. Self-efficacy

Self-efficacy is based on social cognitive theory (Bandura, 1986). It influences what behaviors people choose to perform, the level of effort they are going to use, and the amount of time they are going to conquer obstacles(Bandura, 1982, 1986). Self-efficacy is the conviction a subject maintains as how well a subject can achieve an assignment (Huffman et al., 2013).

2.5 Development of Technology Acceptance Model

The elements affecting technology use have been researched extensively. Some models have been presented to describe technology adoption behavior, such as the Theory of Reasoned Action (TRA) (Fishbein and Ajzen, 1975), the Theory of Planned Behavior (TPB) (Ajzen, 1985), the technology acceptance model (TAM) (Davis, 1986), the technology acceptance model 2 (TAM2) (Venkatesh and Davis, 2000), and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003).

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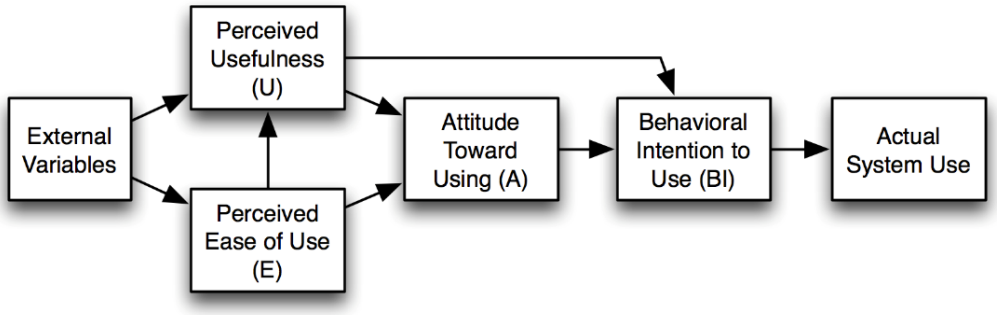

Figure 2-5 Technology acceptance model

(Ref: Davis et al., 1989)

Chen and Chan (2014) have proposed that TAM can be adjusted for use for the elderly and the TAM constructs including PU, PEOU, and AT are important for older adults also for the young.

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2.6 Stated Preference Method

Because shared autonomous vehicles are not yet existing in the real market, the stated preference method is used in this study.

2.6.1 Defining the Stated Preference Method

Stated preference (SP) methods developed in 1970 and it also applied in the marketing field. British scholars firstly applied this method in the transportation field (Kroes and Sheldon, 1988). When discrete choice models are being conducted, reveal preference, and stated preference has been applied, separately.

Revealed preference is based on consequences which are already happened and conduct a questionnaire survey. That is the decider's truly choice behavior. The stated preference method can evaluate the unavailable transport facility or the unconducted transport policy. The experimental design is paired up by observable attributes and level, simulating scenarios, and construct different alternatives based on scenarios.

Moreover, the stated preference method is widely used in travel behavior research to analyze consumers' preference for new products/ services which do not exist for public use (Hensher, 1994).

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Table 2-8 Comparison of Revealed Preference Method and Stated Preference Method

	Revealed Preference Method	Stated Preference Method
Timing	The consequence has happened.	Unavailable or unimplemented case
Advantages	The observed behavior of the subjects is the actual choice behavior.	1. Solving the shortcomings of the Revealed Preference Method. 2. Able to simulate consumers' preference for new attributes/products/services which are not in the real market. 3. Free to design different attributes and levels.
Disadvantages	1. It could not simulate the scenario does not exist or happened. 2. Explanatory variables may exist a high correlation. 3. The degree of variation of Explanatory variables is not enough. Thus, the variable is not significant. 4. Data collection takes more time.	1. The behavior stated by the respondents is not actual behavior. 2. When the combination of scenarios is too complicated, subjects may make incorrect choices.

(Ref: Li,1992；Jeng,1994)

2.6.2 Measurement Scale and Parameter Estimation

Stated preference measurement scale can be separated into three approaches: rank-order, ratings, choice (first preference). According to different preference scales, different

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parameter estimation would be chosen. Table 2-9 shows the features and limitations of the different measurement scales as well as different measurement scale should correspond with its appropriate parameter estimation.

Table 2-9 Measurement Scale and Parameter Estimation of Stated Preference

Measurement Scales	**Rank-order**	**Ratings**	**Choice (first preference)**
Feature	According to preferences of respondents, they are asked to order alternatives.	Respondents are asked to rate the alternatives based on the degree of preference.	Respondents compare a set of alternatives and select the first preference one.
Limit	Unable to show the degree or intensity of preference.	Generally, the score range is between 1-20 points. If the score range is too large, the respondents will not be able to express his/her preferences correctly.	
Parameter Estimation	Non-metric multidimensional scaling	Regression	Discrete choice models
Model Analysis	MONANOVA	Ordinary Least Squares (OLS) Minimizing the Sum of Absolute Error Regression (MSAE)	Probit models Logit models

(Ref: Wu, 2013; Hensher, 1994)

Previous literature indicated that the first preference approach collects data more efficiently and has a complete basic theory; hence it uses the first preference method mostly in transportation research. Also, discrete choice models are widely used because the methodology is solid and easy to understand. This study will use the first preference

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approach as measuring the scale of preference and adopt the discrete choice models to conduct parameter estimation.

2.7 Summary

In recent years, the elderly has rapidly generated and becomes urgent issues in a country, this phenomenon will be more severe next decades. However, according to McKinsey & Company’ s article：A new look at autonomous-vehicle infrastructure, it shows that multi-passenger robot-taxis could account for 500 billion miles traveled on US roads with the right infrastructure to enable shared mobility-about 9 percent of the total by 2030, but they could account for 50 percent of all miles traveled by 2040. Thus, this study aims to predict the middle age preferences and adoption, revealing their latent variables and observable attributes that may influence their decisions. Additionally, technologies are fast developed. Quality of life is also developed more perfectly after the smartphone is born. In the future, autonomous vehicles can become reality to improve road safety, solve road congestion, reduce air pollution, and offer first mile and last-mile services.

In the meantime, shared autonomous vehicles also have been discussed for many facets. Some countries developed AVs’ regulation, legislation, insurance to enhance the AVs’ trials, such as United States, United Kingdom, Singapore, Germany. However, there is not enough research on AVs in Taiwan.

As the literature stated above, this study aims at investigating the middle-aged preference of using LINE pay for SAV in Taiwan. Because the services are not yet available in the real market, the stated preference method is used. Furthermore, it combines latent variables to better pretend consumer’s preference by hybrid choice models.

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CHAPTER 3 RESEARCH METHODOLOGY

As described in Chapter1, the objectives of this study reveal Taiwan's middle age preferences and adoption of using LINE pay for SAV. To achieve goals, discrete choice models, structural equation modeling, and hybrid choice models are applied in this study. This chapter is organized as follows.

The research framework is presented in Section 3.1. Section 3.2 discusses discrete choice models. Section 3.3 describes structural equation modeling. Section 3.4 shows hybrid choice models. Section 3.5 illustrates hybrid choice models design in this study. Section 3.6 summarizes the choice of latent variables. Section 3.7 depicts the observable attributes design of choice models. Finally, in Section 3.8, data analysis is presented.

3.1 Research Framework

The factors and preferences influencing middle age using LINE pay for SAV are explored in this study. Because services of using LINE pay for SAV have not been implemented in the real market, so the stated preference experiment is used to design a survey. Latent variables are described by structural equation modeling (SEM). The technology acceptance model is applied as an SEM model with adding different external latent variables.

Discrete choice models are adopted to establish choice models whether using LINE pay for SAV. The framework of hybrid choice models has been developed to enrich the behavioral realism of discrete choice models by accounting for latent variables such as perceptions and attitudes and employing more flexible error structures. These latent variables are estimated by linear regression analysis between explanatory variables and latent variables. Based on hybrid choice models' results, the utility and percentage of

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whether using LINE pay for SAV can be estimated. Research framework is shown as below：

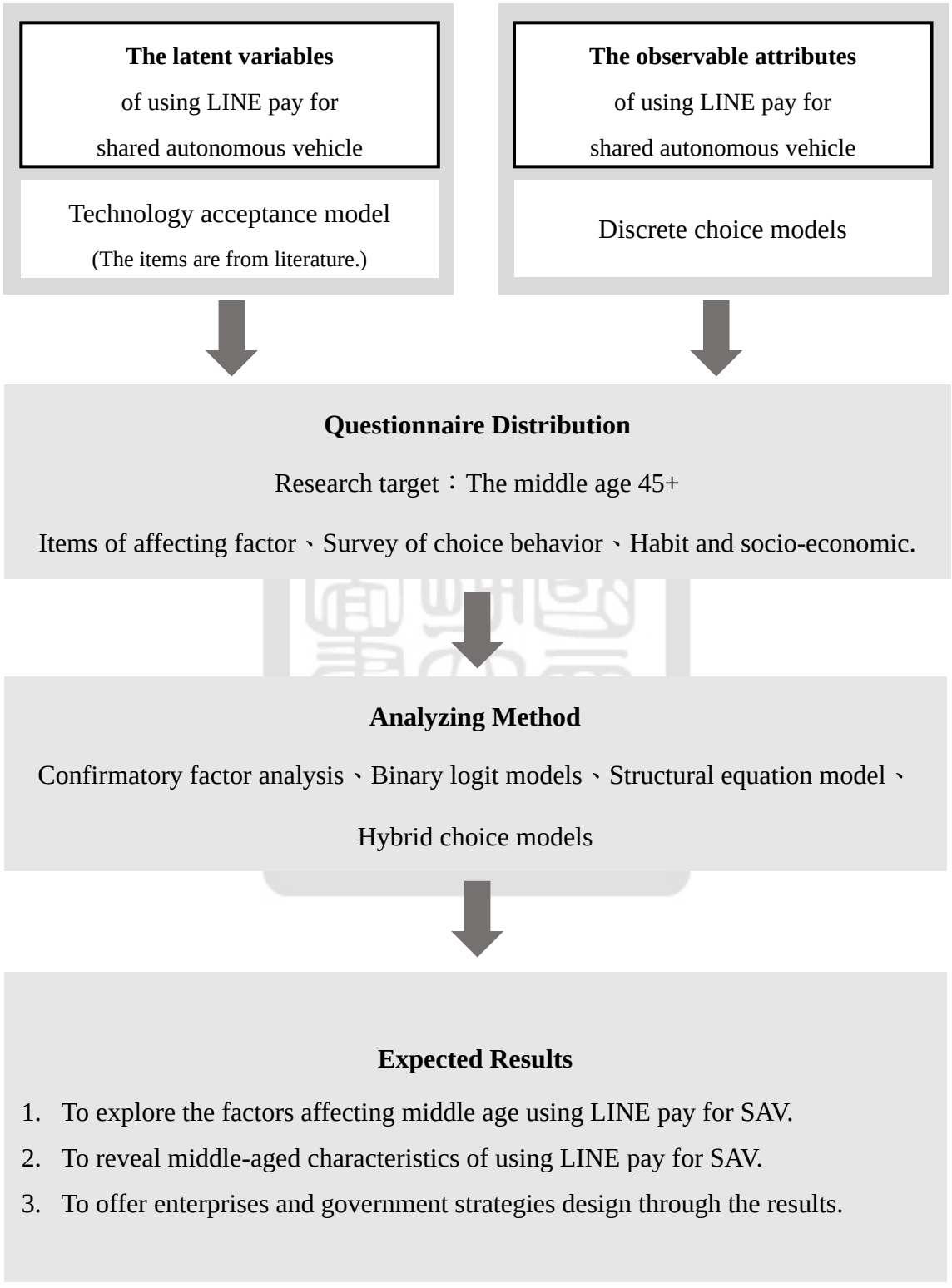

Figure 3-1 Research framework

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3.2 Discrete Choice Models

Discrete choice models have played a crucial role in transportation modeling. Discrete choice models consider the demand to be the result of several decisions made by each individual under consideration, where each decision consists of a choice made among a finite set of alternatives(Ben-Akiva et al., 1985; Labbé et al., 2013). They explain choice behavior simply as a set of preferences ranking all potential outcomes, where the consumer is assumed to choose the most preferred available outcome. Under certain assumptions, consumer preferences can be represented by a utility function such that the choice is the utility-maximizing outcome. These models have traditionally presented an individual's choice process as a ''black box'', in which the inputs are the attributes of available alternatives and the individual's characteristics, and the output is the observed choice(Ben-Akiva, Walker, et al., 2002).

The utility functions U are affected by attributes vector Y of alternatives. They are alternative's observable conditions, such as cost and participants' socioeconomic variables L. Socioeconomic variables are participants' subjective factors, such as age, gender, etc. The utility function is shown below:

$$U = U(Y, L) \tag{1}$$

Assumed that consumers are all rational when they are facing several alternatives, respondents choose the alternative to maximize his/her utility from one of the different alternative designs. For individual p, when the utility of alternative n is bigger than alternative m：

$$U_{np} > U_{mp} \; \forall \, n, m \; \in T_p, n \neq m \tag{2}$$

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U_{np}：Total utility of alternative n brings to individual p.

T_p：Total alternatives faced by individual p.

However, the measurable part (R_{np}) may exist unmeasurable part, which is called measure error (ε_{np}).

$$U_{np} = R_{np} + \varepsilon_{np} \quad (3)$$

R_{np}：The measurable utility of alternative n bring to individual p

ε_{np}：The unmeasurable utility of alternative n bring to individual p

In measurable utility, it could be divided into individual latent factors (Y_{np}) and observable factors (L_{np}) as following：

$$R_{np}(Y_{np}, L_{np})$$

The organized formula above is shown as following：

$$U_{np} = Y'_{np}\alpha_p + \varepsilon_p \quad (4)$$

$$\alpha_p = \alpha + \varepsilon_p \quad (5)$$

$$U_{np} = Y'_{np}\alpha_p + Y'_{np}\gamma_p + \varepsilon_{np} \quad (6)$$

Y_{np}：Explained variance vector in alternative n for individual p (contains Y and L)

α_p： Parameter vector to be estimated

α、γ_p：Average value and deviation of α_p

The logit models are assumed that error terms of the utility functions are independent and identical distributed (IID) with a Gumbel distribution. The most widely used method in

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discrete choice models is multinomial logit models (MNL). An important characteristic of MNL models Independence from Irrelevant Alternatives (IIA).

If alternative n can bring individual p the biggest utility, alternative n will be chosen. The formula is shown as following：

$$P(n|T_P) = Prob(U_{np} > U_{mp}, m \neq n \in T_P) \quad (7)$$

Substitute $U(P_{np}, G_n) = R(P_{np}, G_n) + \varepsilon(P_{np}, G_n)$ into formula (7), simplified as follow：

$R(P_{np}, G_n)$ simplify as R_{np}, $\varepsilon(P_{np}, G_n)$ simplify as ε_{np}, can derive：

$$P_{np} = \text{Prob}(R_{np} + \varepsilon_{np} > R_{mp} + \varepsilon_{mp}, \text{m} \neq \text{n} \in T_p) \quad (8)$$

$$P_{np} = \text{Prob}(R_{np} - R_{mp} + \varepsilon_{np} > \varepsilon_{mp}, \text{m} \neq \text{n} \in T_p) \quad (9)$$

Then differential formula (9)：

$$P(n|T_p) = \frac{e^{R_{np}}}{\sum_{m \in T_p} e^{R_{mp}}} \quad (10)$$

P_{np}：Probability of individual p choosing alternative n

T_p：Total alternatives faced by individual p

If there are only two alternatives, it is called a binary logit model.

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3.3 Structural Equation Modelling

1. Measurement model

The measurement model is to test whether indicators (Items) can fully measure latent variables (Constructs) through confirmatory factor analysis (CFA). The formula is shown as below：

$$S_k = n\left(Y_k, Y_K^* \ ; \beta\right) + w_k \quad (12)$$

S_k：Indicators of a latent variable (Items)

Y_k：Explanatory variables

Y_K^*：Latent variables (constructs)

β：Unknown parameter

w_k：Random error term

2. Structural model

The structural model is used as measuring the causal relationship within latent variables, between explanatory variables and latent variables. Assuming the explanatory variable Y_k is a known condition, the formula is depicted as following：

$$Y_k^* = g(Y_k, \alpha) + v_k \quad (13)$$

Y_k^*：Latent variables (constructs)

Y_k：Explanatory variables

α：Unknown parameter

v_k：Random error term

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3.4 Hybrid Choice Models

Ben-Akiva et al. (1999) added latent variables into discrete choice models and called it hybrid choice models. Hybrid choice models by combining ‘‘hard information’’ (such as socioeconomic characteristics) with ‘‘soft information’’ on population heterogeneity (such as psychological characteristics), explain better decision-makers’ behavior and in doing so a substantial part of the unobserved heterogeneity (Ben-Akiva et al., 2002). The latent factors provided for a richer behavioral representation of the choice process, while the inclusion of taste heterogeneity improved the explanatory power of the model (Ben-Akiva et al., 2002). The framework of the hybrid choice models has been applied in various transportation contexts, such as mode choice (Abou-Zeid et al., 2010; Johansson et al., 2006), vehicle purchase and route choice (Kamargianni and Polydoropoulou, 2013).

The modeling framework is presented in Figure 3-2. The oval sector in the figure represents that latent variable Y* could not be measured directly or be derived by observing. Nevertheless, it can be measured indirectly through observable indicators I. The rectangle sector represent that choice indicators X can be estimated directly. Explanatory variables Y would influence latent variables Y*. Both of explanatory variables and latent variables would affect utility U commonly. There are two parts in the model. One is a choice model and the other is a latent variable model. The latent variable model measures the relationships of explanatory variables Y, latent variables Y*, and observable indicators through measurement model and structure model.

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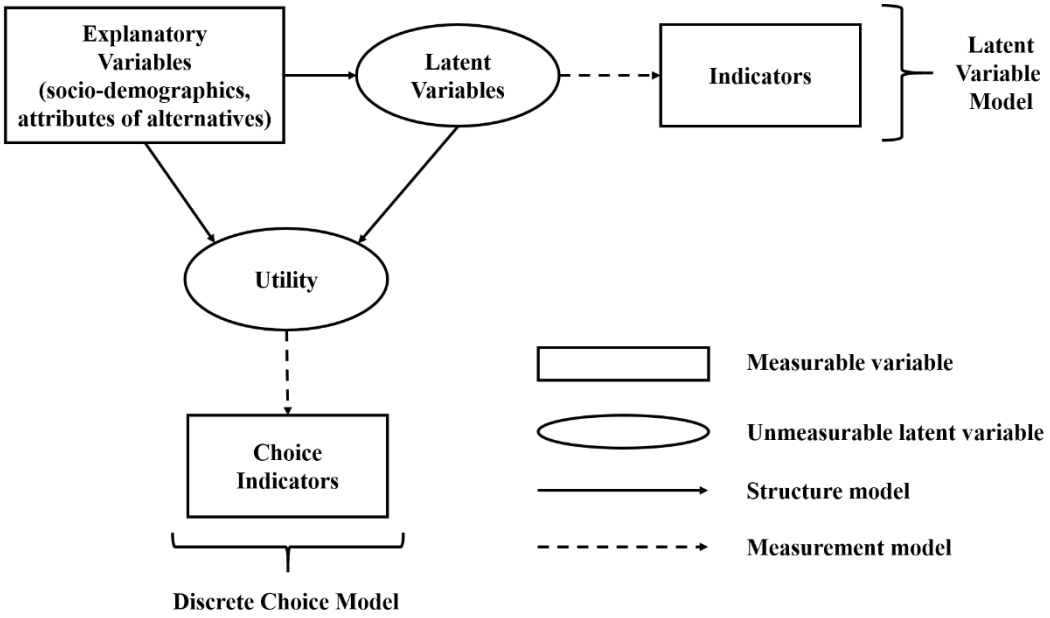

Figure 3-2 Hybrid choice models framework (Ref：Ben-Akiva et al. (1999))

The utility function in choice models is presented down below：

$$U_p = W\left(Y_k, Y_k^* ; \delta\right) + \varepsilon_k \tag{14}$$

Y_k：Explanatory variables

Y_k^*：Latent variables (constructs)

δ：Unknown parameter

ε_k：Random error term

In choice models, the indicators' utility function is presented as Z_q. Assumed that all subjects are rational, they will choose the alternative offering the biggest utility, and the formula is shown as below：

$$Z_q = \begin{cases} 1, if\ U_q = max\{U_q\} \\ 0, otherwise \end{cases} \tag{15}$$

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In summary, hybrid choice models conduct two stages of analysis. First, confirmatory factor analysis is applied to measure if indicators can sufficiently explain the latent variable. Second, linear regression analysis is adopted to understand the correlations between explanatory variables and latent variables, and the measured values are involved in discrete choice models to conduct estimation.

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3.5 Hybrid Choice Models Design

As stated above, it is assumed that all latent variables and their indicators are continuous for simplicity. The model consists of structural and measurement equations. This research investigates the middle-aged preference of whether using LINE pay for SAV. Confirmatory factor analysis, binary logit model, and hybrid choice models are adopted to analyze the characteristics of whether middle age using LINE pay for SAV. Figure 3-3 shows the hybrid choice models structure of this research.

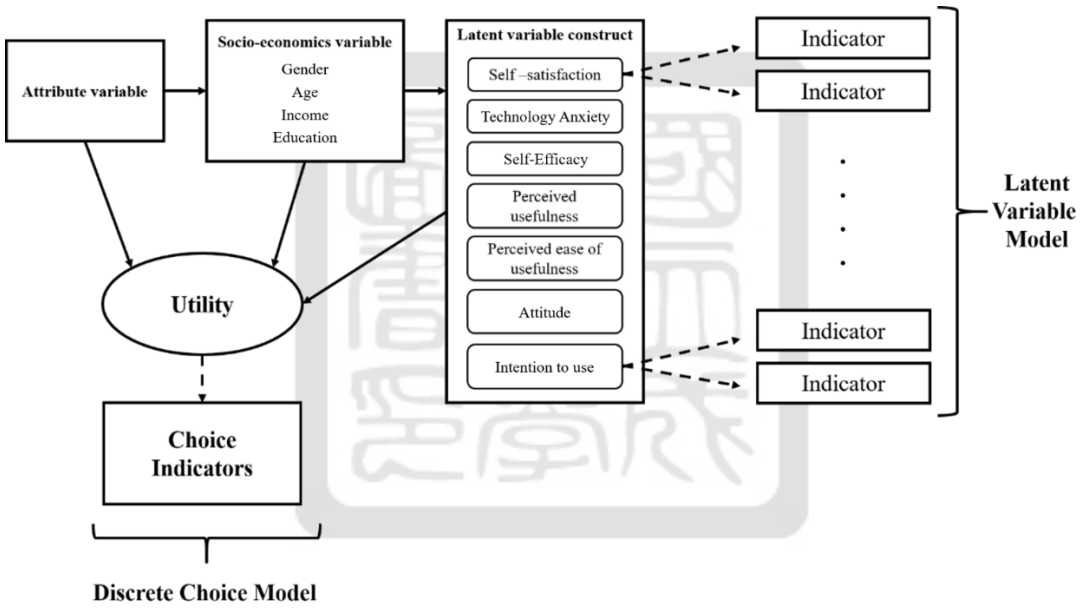

Figure 3-3 Hybrid choice models structure

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3.6 Choice of Latent Variable

This research adopts the technology acceptance model which is proposed by Davis et al. (1989) as structure. Mobile payment can change middle age consuming habits, and it can increase the efficiency of payment, etc. Also, the willingness to use LINE pay for SAV will be influenced by mental, environmental factors for middle age. Thus, this research involves the constructs of self-satisfaction, self-efficacy, and technology anxiety in the model as external variables to explore middle-aged latent factors. The research model is shown below:

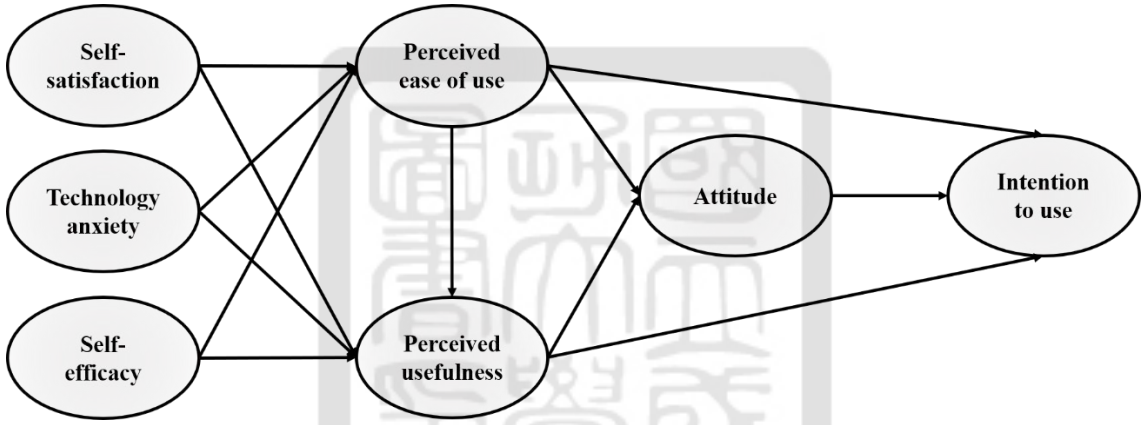

Figure 3-4 Structural equation model

3.6.1 Definitions of Latent Variable

The model of this research is based on the technology acceptance model, adding external variables including self-satisfaction, technology anxiety, and self-efficacy. The definition of each construct is organized as following：

doi:10.6844/NCKU202001330

Table 3-1 Constructs definition of this study

Technology acceptance model		
Constructs	Definition	Ref
Self-satisfaction	The degree to which using LINE pay for SAV gives the user satisfaction with himself or herself or achievements	Park et al. (2013)
Technology anxiety	An individual's apprehension when he or she is faced with the possibility of using LINE pay for SAV.	Venkatesh and Davis (2000) Phang et al. (2006)
Self-efficacy	The judgment of one's knowledge, skill, or ability to use LINE pay for SAV.	Compeau and Higgins (1995)
Perceived ease of use	The degree to which an individual considers that using LINE pay for SAV is easy to use.	Davis et al. (1989)
Perceived usefulness	The degree to which an individual believes that using LINE pay for SAV would enhance his or her performance.	Davis et al. (1989)
Attitude	The strength of one's feelings towards favorableness or unfavorableness towards using LINE pay for SAV.	MacKenzie et al. (1986) Briz-Ponce et al. (2017)
Intention to use	The degree to believe to contain all the motivational factors that induce the actual behaviors that necessarily implies how persistent the effort will be in order to perform a behavior.	Venkatesh and Davis (2000)

doi:10.6844/NCKU202001330

3.6.2 Assumptions of Latent Variable Constructs

The SEM model of this study is based on the technology acceptance model, adding different constructs which are adequate to the middle age accept new technology. The model is assembled by 10 constructs. The assumptions are presented below:

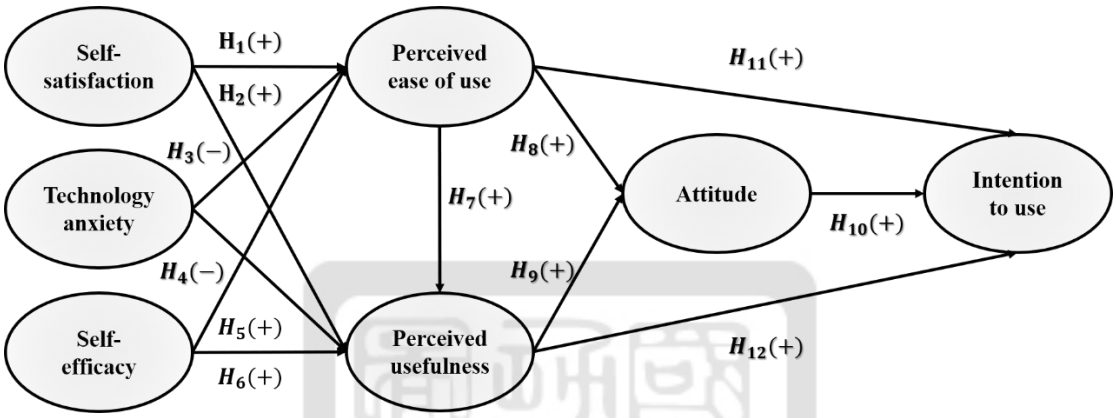

Figure 3-5 Research constructs assumption of this study

Self-satisfaction is the degree in which a product/service gives the user satisfaction with his or her achievements(Park et al., 2013). Self-related positive influence may mediate the effects that physical activity has on life satisfaction (Rejeski and Mihalko, 2001). In China, the effect of individual self-esteem and self-related life domain satisfaction is stronger in the elderly than in the young (Zhang and Leung, 2002).

Self-satisfaction (SS) was considered a positive factor in usage intention and as an intrinsic motivation factor (Ma et al., 2016).

The hypotheses were assumed as follows:

H_1：Self-satisfaction (SS) is positively related to perceived ease of use (PEOU).

H_2：Self-satisfaction (SS) is positively related to perceived usefulness (PU).

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Computer anxiety is defined as individual fear when the subject is faced with the possibility of using computers (Simonson et al., 1987). The foundation of theory could be derived from classic anxiety theory (Phillips et al., 1972). The theory announced that there is a positive effect on effort expectancy by anxiety, which is opposite to perceived ease of use.

From prior research, such as Tsai (2009), Sun et al. (2008), there is a negative relationship between perceived anxiety and perceived usefulness. Hence, the hypotheses are:

H_3: Technology anxiety (TA) is negatively related to perceived ease of use (PEOU).

H_4: Technology anxiety (TA) is negatively related to perceived usefulness (PU).

Self-efficacy affects the user's system anxiety, which finally influences PEOU and perceived usefulness of the system (Igbaria, 1995). Prior research focused on examining the effects of self-efficacy on PEOU, such as Venkatesh and Davis (2000), Venkatesh (2000), Ozturk (2016).

Agarwal et al. (2000) emphasized the strong relationship between perceived ease of use and self-efficacy. This depicts that subjects consider the system easier to use when they believe their efficacy in such a target system. Thus, the related hypotheses are shown as follows:

H_5: Self-efficacy (SE) is positively related to perceived ease of use (PEOU).

H_6: Self-efficacy (SE) is positively related to perceived usefulness (PU).

Two constructs proposed in TAM, TAM2, and STAM have perceived usefulness (PU) and perceived ease of use (PEOU). Perceived usefulness is defined as the individual belief of prospective users that a particular system will improve their job performance (Davis,

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1989). Perceived ease of use is defined as the degree of an individual believes that using a particular system will be from effort (Davis, 1989).

TAM proposed that individuals will form a behavioral intention (BI) concerning which they have a positive attitude (AT), and which they believe will increase their job performance (PU) and reach different helpful rewards without activating the positive attitude. Perceived ease of use is also hypothesized to have a significant influence on attitude which is based on intrinsic motivation whereby the easier a system the greater would be the subject's self-efficacy and perceived control. (Ma et al., 2016).

Perceived usefulness positively influence users' intention to use technology (Kim and Shin, 2015).

Chen and Chan (2014) have announced that TAM can be effectively modified for use for the elderly and that the constructs of TAM, including PU, PEOU, and AT are critical for older adults. The hypotheses related to constructs PU, PEOU, and AT were generated as below:

H_7: Perceived ease of use (PEOU) is positively related to perceived usefulness (PU).

H_8: Perceived ease of use (PEOU) is positively related to attitude (AT).

H_9: Perceived usefulness (PU) is positively related to attitude (AT).

H_{10}: Attitude (AT) is positively related to intention to use (INT).

It is found that the relevant influence between perceived ease of use on the perceived usefulness and also on the intention to use mobile payments (Kim et al., 2010; Li et al., 2014). Leong et al. (2013) mentioned that perceived ease of use is significant influences perceived usefulness and intention to use of NFC-enabled mobile credit cards. However, some of the prior studies proposed that perceived ease of use had no significant influence on intention to

doi:10.6844/NCKU202001330

use of smartphone credit cards, NFC-based mobile payments, and m-commerce (Chong, 2013; Ooi and Tan, 2016; Pham and Ho, 2015; Yadav et al., 2016). Hence, according to the contradictory discussion above, this study is decided to conduct further investigation, so two hypotheses are depicted as following：

H_{11}: Perceived ease of use (PEOU) is positively related to intention to use (INT).

H_{12}: Perceived usefulness (PU) is positively related to intention to use (INT).

3.6.3 Items of Latent Variable Constructs

Seven factors denote the self-satisfaction, technology anxiety, self-efficacy, perceived usefulness, perceived ease of use, attitude, and intention to use corresponds to several items. All items are measured by a 5-point Likert scale. Items and references are shown in Table 3-2.

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Table 3-2 The constructs and items of this research

Constructs	Items	Refs
Self-satisfaction	SS1：Using LINE pay for SAV makes you feel or look younger. SS2：Using LINE pay for SAV increases your sense of achievement. SS3：Using LINE pay for SAV help you to keep pace with the times.	Ma et al. (2016)
Technology anxiety	TA1：Using LINE pay for SAV would make me very nervous. TA2：Using LINE pay for SAV makes me worried. TA3：Using LINE pay for SAV may make me feel uncomfortable. TA4：Using LINE pay for SAV may make me feel uneasy and confused.	Hoque and Sorwar (2017)
Self-efficacy	SE1：I can use LINE pay for SAV if there is a manual for it. SE2：I can use LINE pay for SAV if someone shows me how to do it first. SE3：I think I can use LINE pay for SAV without help. SE4：I can use LINE pay for SAV although I had not used it before. SE5：I would not spend much time to learn how to use LINE pay for SAV.	Lee et al. (2019)

doi:10.6844/NCKU202001330

Table 3-2 The constructs and items of this research (Cont.)

Constructs	Items	Refs
Perceived usefulness	PU1：Using LINE pay for SAV improves the course of my daily life. PU2：Using LINE pay for SAV in my daily life increases my productivity. PU3：Using LINE pay for SAV enhances the effectiveness of my daily life. PU4：I find LINE pay for SAV to be useful in my daily life.	Schmidthuber et al. (2018)
Perceived ease of use	PEOU1：I think use LINE pay for SAV is easy to use. PEOU2：My interaction with using LINE pay for SAV is clear. PEOU3：I can easily learn how to operate such system.	Li et al. (2019)
Attitude	AT1：It is a good idea to use LINE pay for SAV. AT2：I think using LINE pay for SAV meets most people’s demands. AT3：In general, I have a positive attitude about using LINE pay for SAV.	Tsai et al. (2019)
Intention to use	INT1：I intend to use LINE pay for SAV in the future. INT2：I will always try to use LINE pay for SAV in my daily life. INT3：I plan to use LINE pay for SAV frequently.	Schmidthuber et al. (2018)

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3.7 Observable Attributes Design

1. Transfer discount

Because SAVs mainly serve the specific district which like existed shuttle bus, it will combine other modal to transfer, corresponding middle-aged demand. The government offers different transfer discounts to attract people to take public transportation system. Thus, we choose the transfer discount as one of the observable attributes, exploring their preference. The discount references for transportation are from the electric tickets company, such as EasyCard, iPASS, and LINE pay, etc.

In present, using iPASS to pay for the metro fee deserves a 15% ticket discount in Kaohsiung, deserving a 30% ticket discount in Taipei. For paying railway fees by EasyCard or iPASS derive a 1% ticket discount with the unreserved seat.

- Using LINE pay: Derive the discount of 15%, 20%, 30%.
- Without using LINE pay: No transfer discount.

2. LINE points feedback

Using Taiwan LINE pay for paying Kaohsiung Rapid Transit's fee can derive 30% discount feedback. However, paying Kaohsiung metro's fee through traffic QR code operated by LINE can derive 20% LINE points feedback. (one of the LINE points equals to NTD 1.) Thus, as stated above, this study considers them as LINE point feedback's baseline.

- Using LINE pay: Derive the LINE points of 10%, 20%, 30%.
- Without using LINE pay: No transfer discount.

3. Smartphone malfunction percentage

Using LINE pay, the middle age must install the application on the smartphone. However, to offer better service, an APP update is a routine. When APP continually updates, it usually causes the older smartphone incompatible with the APP. Blancco technology

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company which is British information security assessed the efficacy of the Android and iOS system in 2017 Q3. The result is shown that the Android system's failure rate up to 34%. However, the iOS system's failure rate is 16%. IOS system is more stable than Android. This study set Android and iOS as a research target, referring to the highest failure rate iPhone type as an assumption basis.

- Using LINE pay: The APP failure rate is 15%, 25%, 35%.
- Without using LINE pay: No failure rate.

Blancco Technology Group analyzed the failure rate of the iPhone. Each iPhone's failure rate is shown as follows:

Table 3-3 The failure rate of each iPhone type

iPhone Type	Failure Rate (%)
iPhone 6	22%
iPhone 6s	16%
iPhone 6s plus	9%
iPhone 6 plus	8%
iPhone 7	8%
iPhone 7 plus	7%
iPhone 5s	5%
iPhone X	3%
iPhone 8 plus	3%

4. Queueing time of pre-paid

Martín-Cejas (2006) analyzed the reasonable waiting time in front of the front desk should be smaller or equals to 7.5 mins, and the average time at the front desk is 1.5 mins. However, the median between 7.5 mins and 1.5 mins is 4.5 mins. Thus, the attribute levels of queueing time are 7.5 mins, 4.5 mins, 1.5 mins.

doi:10.6844/NCKU202001330

- Using LINE pay: No queueing time.
- Without using LINE pay: The levels of queueing time are 7.5 mins, 4.5 mins, 1.5 mins.

Finally, this study organized four observable attributes as shown in Table 3-4

Table 3-4 Observable attribute level of this research

	Use LINE pay	Without using LINE pay
Transfer discount	15%, 20%, 30% discount of shared autonomous vehicles fee.	No discount.
LINE points feedback	10%, 20%, 30% LINE points feedback of shared autonomous vehicles fee.	No LINE points.
Smartphone malfunction	15%, 25%, 35% percentage of smart phone malfunction.	No incompatibility percentage.
Queueing time of pre-paid	No need to store value.	1.5, 4.5, 7.5 mins waiting time to store value.

The observable attributes combination of the questionnaire is conducted orthogonal experimental design, so scenarios are generated. There are 9 scenarios generated. Three scenarios are selected to conduct convenience sampling, exploring middle-aged choice behavior.

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Table 3-5 Orthogonal design of using LINE pay for SAV

Using LINE pay for SAV									
Scenario	1	2	3	4	5	6	7	8	9
Transfer discount	30%	30%	20%	20%	20%	15%	15%	30%	15%
LINE points feedback	20%	30%	10%	30%	20%	30%	10%	10%	20%
Smartphone malfunction	35%	15%	35%	25%	15%	35%	15%	25%	25%
Queueing time of pre-paid	1.5	4.5	4.5	1.5	7.5	7.5	1.5	7.5	4.5

3.8 Data Analysis

Discrete choice models are estimated by Biogeme. SPSS and AMOS are applied to analyze structural equation modeling.

Biogeme (Bierlaire's Optimization package for GEV Models Estimation) is a free and open-source package that is designed for the estimation of discrete choice models. PandasBiogeme is a completely new version of the software. It was not a standalone executable anymore, but a python package.

doi:10.6844/NCKU202001330

CHAPTER 4 EMPIRICAL ANALYSIS

According to the research methodology mentioned in Chapter 3, hybrid choice models are adopted to reveal middle-aged characteristics of whether using LINE pay for SAV. This chapter further discusses the empirical analysis. Section 4.1 presents the questionnaire design. Section 4.2 shows descriptive statistics analysis. Binary logit analysis is presented in Section 4.3. Section 4.4 depicts structural equation modeling. Section 4.5 describes hybrid choice models. In Sections 4.6 and 4.7 reveal elastic analysis and sensitivity analysis, respectively.

4.1 Survey Design

The survey of this study is divided into four parts. The first part is used to describe middle-aged psychology about using LINE pay for SAV through structural equation modeling (SEM). The technology acceptance model (TAM) is adopted to be the model of SEM. There are also three external variables in the model, including self-satisfaction, technology anxiety, and self-efficacy. (measured on a 5-point Likert scale, where 1 strongly disagrees, 2 disagrees, 3 is neutral, 4 is agreed, 5 strongly agrees) The second part is to investigate the choice behavior of whether using LINE pay for SAV. Trip characteristics and habits of using a smartphone are surveyed in the third part. Socio-economic status is inquired in the fourth part. Finally, a survey of the first version is generated.

However, a survey of the first version is used to pretest. Furthermore, according to middle-aged opinions, descriptions, and questions in the survey which are difficult to understand and unnecessary are deleted. Hence, the modified survey is applied to be a formal questionnaire.

The subjects of this survey are required Taiwan’s middle age over 45 years old.

doi:10.6844/NCKU202001330

Additionally, the method of sampling is convenience sampling. Physical questionnaires are distributed in front of the Chunghwa Telecom store and to different company's employees.

SurveyCake, a cloud-based survey service platform, is utilized to create our online questionnaire. It is distributed to the middle-aged LINE group and Facebook with the lottery. All middle age is all requested to complete all questions before they leave the survey webpage. The valid quantities of physical questionnaires and on-line questionnaires are respectively 137 and 300. Therefore, the valid questionnaire of the total amount is 437.

For the discrete choice model, each questionnaire has three scenarios and each of them is considered as one observation. Abdel-Aty et al. (1997) mentioned that in contrast to the revealed preference approach, repeated hypothetical choice sets are often presented to the respondents in the stated preference approach. In the first preference, the data relate directly to discrete choice responses, and estimation takes place using the repeated observations on each individual (Hensher, 1994). The MNL model has been used in the majority of the stated choice applications (e.g. Louviere and Woodworth (1983)；(Wardman, 1988)).

The major reasons for introducing repeated games for each stated preference design are to avoid too few observations for the stated choice modeling and to capture respondents' preferences over a wider range of options. To increase the quantity of stated preference data, a research team faces many options, which include increasing the number of respondents and increasing the number of observations per respondent. Statistically, the former is superior because the latter is associated with the repeated measurement problem, whereby the error terms of a respondent are intrinsically auto-correlated (Loo et al., 2006). To estimate (and correct) the repeated measurement problem, Ouwersloot and Rietveld (1996) carefully examined the magnitude of the problem with the survey results of 149 respondents facing 4 repeated stated preference games. The outcomes of their Chamberlain-Hsiao and pooled estimations show that ‘‘in general, however, this (repeated observations) effect is modest: no

doi:10.6844/NCKU202001330

parameters change signs or change from being insignificant to significant or vice versa.

Furthermore, Bunch et al. (1993) ignored the effect of heterogeneity by indicating that in small numbers of repeated observations from each individual the properties of parameter estimates themselves do not rely on the strict independence assumption, and the benefits of using a much larger pooled data set more than outweigh this concern.

Consequently, the number of repeated stated preference games is small in a survey of this research (only 3) and similar to the findings of Ouwersloot and Rietveld (1996), the individual and pooled estimations show that the effect of the repeated measurement is modest. Thus, the overall observations were used to estimate the models, which gives a total of 1311 observations (i.e. 437 respondents each making three games).

doi:10.6844/NCKU202001330

4.2 Descriptive Statistics Analysis

1. Socio-economic characteristics

The descriptive statistics for socio-economic variables are depicted in Table 4-1. The percentage of males and females is 43.9% and 56.1%. In the age's sample size, the group of 45-54 is the highest, 51%, and group 55-64, 44.4%, is higher than group over 65, 4.6%. The highest sample size of education is a bachelor's degree, 57.7%, and a master or doctoral degree is as same as high school graduates in the amount of 20.1%. The residence percentage of Kaohsiung, Taipei, and Taichung were respectively 48.7, 13.5, and 10.5. Group of 50,001-100,000 has the highest percentage of 30.7% in income. Group of 40,001-50,000 occupied 22.7% in income. People who earned 30,001-40,000, Greater than 100,001, and 20,001-30,000 were respectively 13.3%, 11.9%, and 11%.

doi:10.6844/NCKU202001330

Table 4-1 Descriptive statistics for socioeconomic variables

Variables	Classification	Samples (N)	Percentage
Gender	Male	192	43.9%
	Female	245	56.1%
Age	45-54	223	51%
	55-64	194	44.4%
	Over 65	20	4.6%
Education	Junior high school or below	9	2.1%
	Senior high school	88	20.1%
	Bachelor	252	57.7%
	Master or doctoral	88	20.1%
Residence	Keelung	1	0.2%
	Taipei	59	13.5%
	Taoyuan	31	7.1%
	Hsinchu	7	1.6%
	Miaoli	1	0.2%
	Taichung	46	10.5%
	Changhua	27	6.2%
	Nantou	2	0.5%
	Yunlin	2	0.5%
	Chiayi	5	1.1%
	Tainan	24	5.5%
	Kaohsiung	213	48.7%

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	Pingtung	14	3.2%
	Hualien	3	0.7%
	Other	2	0.5%
Income	Less than 10,000	22	5%
	10,001-20,000	24	5.5%
	20,001-30,000	48	11%
	30,001-40,000	58	13.3%
	40,001-50,000	99	22.7%
	50,001-100,000	134	30.7%
	Greater than 100,001	52	11.9%
Notes	N = 437		

2. Habit-related characteristics

51.3 % of middle-aged has used mobile payment, but only 25.2% of them have used LINE pay. Also, nearly half of middle age use car. It seems that private modes are commonly used over 50%, so the frequency of transportation in group 1 to 2 times in half-year owned 37.3% the highest percentage. There are 59.2% middle age use smartphones over 3 hours per day, but only 38.9 % middle age use LINE over 3 hours per day. Table 4-2 shows the descriptive statistics for habit-related variables.

doi:10.6844/NCKU202001330

Table 4-2 Descriptive statistics for habit-related variables

Variables	Classification	Samples (N)	Percentage
Have you used a mobile payment?	Yes	224	51.3%
	No	213	48.7%
Have you used LINE pay?	Yes	110	25.2%
	No	327	74.8%
The most commonly used means of transportation	Motor	148	33.9%
	Car	213	48.7%
	Public Transportation	71	16.2%
	Taxi	2	0.5%
	Other	3	0.7%
Frequency of public transportation	Less than once a year	67	15.3%
	1 to 2 times in half-year	163	37.3%
	1 to 2 times per month	102	23.3%
	3 to 4 times per month	39	8.9%
	More than 4 times per month	66	15.1%
Hours of using smartphone per day	Within 1 hour	36	8.2%
	1 to 3 hours	142	32.5%
	3 to 5 hours	133	30.4%
	More than 5 hours	126	28.8%
Hours of using LINE per day	Within 1 hour	104	23.8%
	1 to 3 hours	163	37.3%
	3 to 5 hours	93	21.3%
	More than 5 hours	77	17.6%
Notes	N = 437		

doi:10.6844/NCKU202001330

4.3 Binary Logit Analysis

4.3.1 Variable Settings

1. Alternative specific constant

The hypothetical scenarios of this research have two alternatives using LINE pay for SAV and without using LINE pay. The base of the estimation process is without using LINE pay.

2. Generic variable

The generic variable is assumed variable has the same marginal utility to different alternatives. In this research, the generic variables are transfer discount, LINE points feedback, smartphone malfunction percentage, and queueing time of pre-paid. The value is set by scenarios this research offer.

3. Alternative specific variable

The alternative specific variables are socio-economic variables, the habit of taking public transportation and using a smartphone. The alternative specific variable is including income per month, hours of using smartphones per day, hours of using LINE per day, etc. The detailed information is described as following：

- Aged over 55：Set with dummy variable；Aged over 55 set as 1, otherwise setting as 0.
- Monthly income from 40,001 to 100,000：Set with dummy variable；Middle age whose monthly income are from 40,001 to 100,000 is set as 1, otherwise setting as 0.
- Education level at bachelor’s degree：Set with dummy variable；Middle age whose education level at bachelor’s degree is set as 1, otherwise setting as 0.

doi:10.6844/NCKU202001330

- The main vehicle used in life is motor：Set with dummy variable；Middle age whose main vehicle used in daily life is motor is set as 1, otherwise setting as 0.
- Using LINE over 5 hours per day：Set with dummy variable；Middle age who using LINE over 5 hours per day is set as 1, otherwise setting as 0.

4.3.2 Results of Binary Logit Analysis

The results of the binary logit model are shown in Table 4-3. In the binary logit model, BL1 and BL2 are generated. Mode BL1 is estimated by observable attributes, and BL2 is evaluated by observable attributes and socio-economic variables. As the result, if the parameter is bigger than 0 and significant, which means it positively influences middle age. Additionally, the value's magnitude represents the power of utility. In mode BL1, the significant observable attributes are transfer discount, LINE points feedback, and smartphone malfunction percentage. The detailed description is depicted down below：

- The coefficient of transfer discount is positive and significant. It represents that when transfer discount gets higher, the middle-aged aspiration of using LINE pay for SAV also gets higher.
- The coefficient of LINE points feedback is positive and significant. It shows that if LINE could feedback more LINE points, middle age would more prefer using LINE pay for SAV.
- The coefficient of smartphone malfunction percentage is negative and significant. It means that when APP updates, the percentage of appearing malfunction or incompatible smartphone operating system getting higher, and middle age would have less aspiration to use LINE pay for SAV.

In mode BL2, the significant observable attributes are the same as BL1, so this part focuses on the detailed description of socio-economic variables.

doi:10.6844/NCKU202001330

- The coefficient of aged over 55 is negative correlation and significant, which means middle age who aged over 55 is not prefer using LINE pay for SAV. It could be speculated that this group is older than other groups, and their concept of new technologies acceptance might be anxiety. Results of the prior study show that mature over 55 years old are less likely to adopt mobile banking, and they report a lower level of intent to use Internet banking than the youngest age segment (Laukkanen, 2016).
- The coefficient of income from NTD$40,001 to NTD$100,000 is a positive correlation and significant, which means middle age who got monthly income from 40,001 to 100,000 are preferring to use LINE pay for SAV. It could be inferred mobile payment is the combination of credit cards and smartphones. Middle age who got higher income means their economy is more stable, so the percentage they using LINE pay for SAV is higher.
- The coefficient of bachelor's degree is a positive correlation and significant, which means middle age who have a bachelor's degree are preferring to use LINE pay for SAV than other groups of education level. This result could be implied that people who have high education would accept more information and knowledge, so they might try new things easily.
- The coefficient of motor usually used by middle age in daily life is negative correlation and significant. The reason may be that middle age does not need this service, a cause shared autonomous vehicle belonging to public transportation. With the condition, they already owned private mode, so there is no strong reason for middle age to apply this service.

doi:10.6844/NCKU202001330

- The coefficient of using LINE over 5 hours per day is a positive correlation and significant. That could be assumed that the middle age is more familiar with the service, process, and interface offered by LINE.

doi:10.6844/NCKU202001330

Table 4-3 Result of binary logit models

Explanatory variables	BL1		BL2	
Parameters	Coeff.	t-value	Coeff.	t-value
Alternative Specific Constants (ASC)				
Constant_Use	0.62	5.04***	0.55	3.33***
Generic Variable (GV)				
Transfer discount	1.30	7.15***	1.32	6.98***
LINE points feedback	2.32	6.57***	2.39	6.61***
Smartphone malfunction Percentage	-1.96	-5.53***	-2.06	-5.68***
Queueing time of Pre-paid	-0.02	-0.46	-0.02	-0.41
Alternative Specific Variables (ASV)				
Aged over 55			-0.32	-2.46**
INC_NTD$40,001 to NTD$100,000			0.30	2.24**
Bachelor's degree			0.36	2.80***
Main vehicle_ Motor			-0.41	-3.11***
LINE use_ over 5 hours			0.32	1.82*
LL(0)	-908.72		-908.72	
LL(β)	-766.54		-744.41	
ρ^2	0.16		0.18	
Adjusted ρ^2	0.15		0.17	
Number of observations	1311		1311	
Notes	***：At an 1% significance level (t>2.58) **：At an 5% significance level (t>1.96) *：At a 10% significance level (t>1.64) LL(0)：Null log-likelihood LL(β)：Final log-likelihood INC：Monthly income The main vehicle：Vehicle be used in daily life LINE use：Hours of LINE be used			

doi:10.6844/NCKU202001330

4.4 Structural Equation Modelling

The conceptual model of this study includes several relationships among multiple independent variables and dependent variables. To measure these causal relationships simultaneously, structural equation modeling (SEM), which is deemed to be a method for testing the relationships among constructs, is applied. The fitness indicators and criteria assessed for the structural model are the same as the measurement model.

4.4.1 Measurement Model Analysis

SPSS and Amos Graphics are adopted to analyze structural equation modeling, testing its goodness-of-fit in this research. Additionally, the constructs of this study are based on the technology acceptance model, including “self-satisfaction”, “self-efficacy”, “technology anxiety”, “perceived ease of use”, “perceived usefulness”, “attitude”, and “intention to use”.

According to the results of reliability and confirmatory factor analysis. The total amount of items is 25. Because the standardized factor loading of self-efficacy1, self-efficacy2, and self-efficacy3 are lowering than 0.5, they are deleted. Those 22 items are analyzed shown as following：

doi:10.6844/NCKU202001330

Table 4-4 Results of reliability analysis and confirmatory factor analysis

Constructs	Standardized Factor Loading	Cronbach's α	CR	AVE
Self-satisfaction (SS)		0.86	0.87	0.68
SS1	0.87			
SS2	0.83			
SS3	0.79			
Technology anxiety (TA)		0.92	0.93	0.76
TA1	0.82			
TA2	0.86			
TA3	0.91			
TA4	0.88			
Self-efficacy (SE)		0.89	0.90	0.80
SE3	0.92			
SE4	0.87			
Perceived usefulness (PU)		0.90	0.90	0.70
PU1	0.76			
PU2	0.87			
PU3	0.91			
PU4	0.79			

doi:10.6844/NCKU202001330

Constructs	Standardized Factor Loading	Cronbach's α	CR	AVE
Perceived ease of use (PEOU)		0.89	0.90	0.74
PEOU1	0.88			
PEOU2	0.79			
PEOU3	0.91			
Attitude (ATT)		0.91	0.91	0.77
ATT1	0.88			
ATT2	0.87			
ATT3	0.88			
Intention to use (INT)		0.94	0.94	0.83
INT1	0.93			
INT2	0.92			
INT3	0.90			

doi:10.6844/NCKU202001330

The goodness-of-fit indices of confirmatory factor analysis are presented in Table 4-5. Each indicator value of the measurement model is corresponding to the requested criteria.

Table 4-5 Goodness-of-fit indices of the measurement model

Indicators	Criteria	Measurement model
Chi-Square/df	<3 is good	2.60
RMSEA	≦0.08 is good	0.06
GFI	GFI ≧0.9 means satisfactory fit 0.8< GFI<0.9 means acceptable fit	0.91
AGFI	AGFI≧0.9 means satisfactory fit 0.8< AGFI<0.9 means acceptable fit	0.88
NFI	NFI≧0.9 means satisfactory fit 0.8< NFI<0.9 means acceptable fit	0.94
CFI	CFI≧0.9 means satisfactory fit 0.8< CFI<0.9 means acceptable fit	0.96
PNFI	0-1 bigger is better	0.77
PGFI	0-1 bigger is better	0.67
RMR	<0.1	0.03

doi:10.6844/NCKU202001330

Moreover, this study applies discriminant validity to confirm whether the square root of AVE for each construct is larger than its correlation with other constructs. As shown in Table 4-6, it shows that there is the discriminant validity in this study, and the constructs are distinct from each other.

Table 4-6 Results of discriminant validity

	Mean	SD	**SS**	**TA**	**SE**	**PU**	**PEOU**	**ATT**	**INT**
SS	3.43	0.80	**0.83**						
TA	2.67	0.86	-0.12	**0.87**					
SE	3.22	0.98	0.17	-0.34	**0.89**				
PU	3.59	0.73	0.52	-0.24	0.39	**0.83**			
PEOU	3.56	0.73	0.36	-0.38	0.63	0.68	**0.86**		
ATT	3.84	0.75	0.40	-0.18	0.33	0.69	0.58	**0.88**	
INT	3.64	0.81	0.47	-0.27	0.45	0.74	0.63	0.75	**0.91**

doi:10.6844/NCKU202001330

4.4.2 Structural Equation Modelling Analysis

The research hypotheses of this study are examined by Amos Graphics, knowing the relationships between each construct. Each indicator of the measurement model is corresponding to the requested criteria.

Table 4-7 Goodness-of-fit indices of the structural model

Indicators	Criteria	Structural model
Chi-Square/df	<3 is good	2.64
RMSEA	≦0.08 is good	0.06
GFI	GFI ≧0.9 means satisfactory fit 0.8< GFI<0.9 means acceptable fit	0.90
AGFI	AGFI≧0.9 means satisfactory fit 0.8< AGFI<0.9 means acceptable fit	0.87
NFI	NFI≧0.9 means satisfactory fit 0.8< NFI<0.9 means acceptable fit	0.94
CFI	CFI≧0.9 means satisfactory fit 0.8< CFI<0.9 means acceptable fit	0.96
PNFI	0-1 bigger is better	0.79
PGFI	0-1 bigger is better	0.69
RMR	<0.1	0.03

doi:10.6844/NCKU202001330

Figure 4-1 shows the structural model with standardized path estimates and t-value in parentheses. Most of the hypotheses in the model are supported, except technology anxiety to perceived usefulness. The results of hypotheses testing for the structural model are organized in Table 4-8.

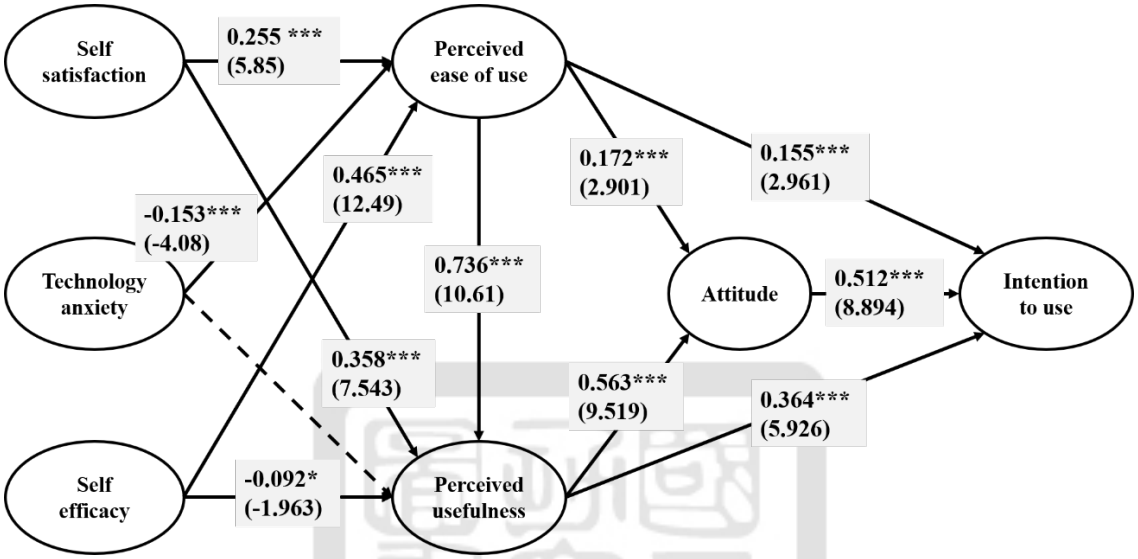

Figure 4-1 Results of structural model

doi:10.6844/NCKU202001330

Table 4-8 Results of hypotheses testing for the structural model

Hypotheses	Estimate	T-value	Testing results
H_1：Self-satisfaction → Perceived ease of use	0.26	5.85	Support
H_2：Self-satisfaction → Perceived usefulness	0.36	7.54	Support
H_3：Technology anxiety → Perceived ease of use	-0.15	-4.08	Support
H_4：Technology anxiety → Perceived usefulness	0.04	0.96	Not support
H_5：Self-efficacy → Perceived ease of use	0.47	12.49	Support
H_6：Self-efficacy → Perceived usefulness	-0.09	-1.96	Support
H_7：Perceived ease of use → Perceived usefulness	0.74	10.61	Support
H_8：Perceived ease of use → Attitude	0.17	2.90	Support
H_9：Perceived usefulness → Attitude	0.56	9.52	Support
H_{10}：Attitude → Intention to use	0.51	8.89	Support
H_{11}：Perceived ease of use → Intention to use	0.16	2.96	Support
H_{12}：Perceived usefulness → Intention to use	0.36	5.93	Support

H_1：Self-satisfaction (SS) is positively related to perceived ease of use (PEOU).

The relationships between “self-satisfaction” and “perceived ease of use” are the same as the expected assumption. It is a significant and positive correlation. It means that self-satisfaction would influence perceived ease of use. Additionally, if they could

doi:10.6844/NCKU202001330

derive self-satisfaction by using LINE pay for SAV, they would perceive the service is easy to use.

H_2：Self-satisfaction (SS) is positively related to perceived usefulness (PU).

The relationships between “self-satisfaction” and “perceived usefulness” are the same as an expected assumption. It is a significant and positive correlation. It could be described that when using LINE pay for SAV could build their self-satisfaction, they would perceive this service’s usefulness.

H_3: Technology anxiety (TA) is negatively related to perceived ease of use (PEOU).

The relationships between “technology anxiety” and “perceived ease of use” are the same as the expected assumption. It is a significant and negative correlation. If they have technology anxiety before using LINE pay for SAV, they will not perceive the service ease of use.

H_4: Technology anxiety (TA) is insignificant to perceived usefulness (PU).

The path from “technology anxiety” to “perceived ease of use” is not significant. It could be speculated that technology anxiety would not affect their feeling of perceiving the service’s usefulness. According to Mohamed and Karim (2012) result, there is no significant relationship between computer application anxiety and perceived usefulness. Baki et al. (2018) proposed that research reviewed within the scope of this study found out that the relationship between computer anxiety and perceived ease of use has been tested and accepted more frequently than the one between computer anxiety and perceived usefulness.

H_5: Self-efficacy (SE) is positively related to perceived ease of use (PEOU).

doi:10.6844/NCKU202001330

The relationships between “self-efficacy” and “perceived ease of use” are the same as the expected assumption. It is significant and positively related to perceived ease of use. It could be assumed that they owned self-efficacy before using LINE pay for SAV, they would perceive its ease of use.

H_6: Self-efficacy (SE) is negatively related to perceived usefulness (PU).

The relationships between “self-efficacy” and “perceived usefulness” are rejecting the expected assumption. It is significant and negatively related to perceived ease of use. It seems that using LINE pay for SAV is not perceived usefulness by middle age regardless of whether they have self-efficacy. This result is consistent with the previous study conducted by Al-Haderi (2013). Other similar results are generated by studies (Chau, 2001; Klopping and McKinney Jr, 2006) which are exhibiting the insignificant effect of computer self-efficacy on beliefs. Consistent with the results provided in Hasan (2007), the effect of system self-efficacy on perceived usefulness was negative. One possible explanation is that people exhibiting high system self-efficacy beliefs may be able to identify the limitations of mobile payments that may not be immediately obvious to those exhibiting low efficacy beliefs (Chau, 2001).

H_7: Perceived ease of use (PEOU) is positively related to perceived usefulness (PU).

The relationships between “perceived ease of use” and “perceived usefulness” are the same as the expected assumption. It is significant and positively related to perceived ease of use. It means that if middle age perceived using LINE pay for SAV ease of use, they would perceive its usefulness.

H_8: Perceived ease of use (PEOU) is positively related to attitude (AT).

doi:10.6844/NCKU202001330

The relationships between “perceived ease of use” and “attitude” are the same as the expected assumption. It is significant and positively related to perceived ease of use. If middle-age perceived using LINE pay SAV, they would have a positive attitude about it.

H_9: Perceived usefulness (PU) is positively related to attitude (AT).

The relationships between “perceived usefulness” and “attitude” are the same as an expected assumption. It is significant and positively related to perceived ease of use. Similarly, if middle age has positive usefulness about using LINE pay for SAV, they will have a positive attitude to use the service.

H_{10}: Attitude (AT) is positively related to intention to use (INT).

The relationships between “attitude” and “intention to use” are the same as an expected assumption. It is significant and positively related to perceived ease of use. The middle age has a positive attitude to use this service, and they will own the intention to use it.

H_{11}: Perceived ease of use (PEOU) is positively related to intention to use (INT).

The relationships between “perceived ease of use” and “intention to use” are the same as an expected assumption. It is significant and positively related to perceived ease of use. The reason may be that once middle-age perceived ease of the service’s use, they would have the intention to use it.

doi:10.6844/NCKU202001330

H_{12}: Perceived usefulness (PU) is positively related to intention to use (INT).

The relationships between “perceived usefulness” and “intention to use” are the same as expected assumptions. It is significant and positively related to perceived ease of use. It represents the positive use of using LINE pay for SAV middle age perceived, then they would have the intention to use the service.

doi:10.6844/NCKU202001330

4.5 Hybrid Choice Models

This study analyzes the choice behavior of whether middle age using LINE pay for SAV through hybrid choice models. There are three phases in the analyzing process. First, to analyze the correlations between items and constructs by confirmatory factor analysis to confirm whether the construct could be measure by items. Second, to inspect the relationship between constructs by structural equation model (SEM). Third, to know the correlations between constructs and socio-economic variables by conducting regression analysis. Finally, hybrid choice models would be used for analyzing their choice behavior by involving latent variables.

Furthermore, this study also divides the sample into two groups. Subsection 4.5.3 reveals the hybrid choice models results whose age is under 55. Subsection 4.5.4 presents the hybrid choice models results whose age is 55 and above.

doi:10.6844/NCKU202001330

4.5.1 Regression Analysis

The linear regression analysis of this research is conducted by SPSS, knowing the correlations between latent variables and socio-economic characteristics. However, 7 latent variables are including self-satisfaction, technology anxiety, self-efficacy, perceived usefulness, perceived ease of use, attitude, and intention to use. The explanatory variable is a socio-economic variable. The coefficients between construct and socio-economic variables are incorporated with each middle age socioeconomic status. Parameters of every individual are derived from the estimation.

doi:10.6844/NCKU202001330

Table 4-9 Result of regression analysis

Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Self-satisfaction	Constant	2.194	.000***	3.398	.003***	.045	.032
	Experience of using LINE pay	.175	.046**				
	Using the motor as the main mode	1.026	.004***				
	Using the car as the main mode	1.064	.003***				
	Using public transportation as the main mode	1.092	.003***				
	Aged 55-64 years old	.152	.046**				
	Educated at college	.131	.087*				

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Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Technology anxiety	Constant	2.872	.000***	13.837	.000***	.138	.128
	Experience of using mobile payment	-.332	.000***				
	Experience of using LINE pay	-.244	.016**				
	Educated at junior high (or under it)	.682	.013**				
	Educated at senior high	.286	.004***				
	Income over 100,001	-.340	.005***				
Self-efficacy	Constant	3.403	.000***	11.003	.000***	.171	.155
	Experience of using mobile payment	.124	.030**				
	Experience of using LINE pay	.242	.000***				
	Frequency less than one time per year of taking public transportation	-.163	.026**				
	Using LINE for 3-5 hours	.105	.094*				
	Using LINE over 5 hours	.178	.010**				
	Woman	-.110	.031**				

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	Aged 55-64 years old	-.169	.001***				
	Educated at junior high (or under it)	-.451	.014**				
Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Perceived usefulness	Constant	3.323	.000***	14.454	.000***	.191	.178
	Experience of using LINE pay	.397	.000***				
	Using taxi as main mode	-1.450	.002***				
	Frequency 1-2 times per month of taking public transportation	.266	.001***				
	Frequency 3-4 times per month of taking public transportation	.451	.000***				
	Using LINE over 5 hours	.254	.003***				
	Income under 10,000	.291	.048**				
	Income 40,001-50.000	-.201	.009***				

doi:10.6844/NCKU202001330

Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Perceived ease of use	Constant	3.354	.000***	13.224	.000***	.237	.219
	Experience of using LINE pay	.402	.000***				
	Using taxi as main mode	-1.503	.001***				
	Frequency 1-2 times per month of taking public transportation	.199	.009***				
	Frequency 3-4 times per month of taking public transportation	.394	.000***				
	Using LINE for 3-5hours	.144	.070*				
	Using LINE over 5 hours	.297	.001***				
	Educated at junior high (or under it)	-.496	.026**				
	Educated at senior high	-.292	.000***				
	Income under 10,000	-.393	.008***				
	Income 40,001-50.000	.156	.039**				

doi:10.6844/NCKU202001330

Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Attitude	Constant	3.655	.000***	9.545	.000***	.167	.150
	Experience of using LINE pay	.266	.001***				
	Frequency 1-2 times per month of taking public transportation	.181	.026**				
	Frequency 3-4 times per month of taking public transportation	.381	.001***				
	Over 5 hours of using the smartphone	-.276	.005***				
	Using LINE for 3-5hours	.234	.007***				
	Using LINE over 5 hours	.641	.000***				
	Woman	-.123	.070*				
	Income under 10,000	-.280	.068*				
	Income 40,001-50.000	.181	.025**				

doi:10.6844/NCKU202001330

Construct	Socio-economic variable	Coeff.	Significance	F	Significance	R^2	$\bar{R}^2$
Intention to use	Constant	3.349	.000***	11.772	.000***	.199	.182
	Experience of using mobile payment	.221	.006***				
	Experience of using LINE pay	.291	.002***				
	Frequency 1-2 times per month of taking public transportation	.189	.026**				
	Frequency 3-4 times per month of taking public transportation	.343	.006***				
	Over 5 hours of using the smartphone	-.249	.015**				
	Using LINE for 3-5hours	.198	.033**				
	Using LINE over 5 hours	.625	.000***				
	Income under 10,000	-.360	.026**				
	Income 20,001-30.000	-.313	.006***				

*p<0.1，**p<0.05，***p<0.

doi:10.6844/NCKU202001330

4.5.2 Results of Hybrid Choice Models

The relationships between socio-economic characteristics and latent variables are found through linear regression analysis presented above. Hence, every middle age has its parameter of latent variables. In hybrid choice models, individual choice behaviors of observable attributes and latent variables are explored. The estimation is set without using LINE pay for SAV as the base. The results of the analysis are depicted in Table 4-10.

In mode HL1, the observable attributes of transfer discount, LINE points feedback, and smartphone malfunction percentage are significant. The results of the analysis are described as following：

- The coefficient of transfer discount is a significant and positive correlation. It represents that if transfer discount is offered higher, middle age would more prefer using LINE pay for SAV.
- The coefficient of LINE points feedback is a significant and positive correlation. When the service could offer more LINE points to those using it, middle age would more prefer using it.
- The coefficient of smartphone malfunction percentage is a significant and negative correlation. It means that the percentage higher, the lower preference of using LINE pay for SAV.
- The coefficient of queueing time of Pre-paid is not significant. It might be assumed that convenience stores are very intensive in Taiwan. Even if middle age without using LINE pay for SAV, passengers must buy a ticket or pre-pay to Easycard or iPASS, the queueing time of pre-paid might be acceptable.

doi:10.6844/NCKU202001330

In mode HL2, latent variables are involved in the estimation. The results are explained down below：

- The coefficient of perceived ease of use is a significant and positive correlation. They consider that if using LINE pay for SAV is easy to use, owning a clear purpose, and learning it easily, then they would more prefer using LINE pay for SAV. The reason might be if the service is easy, they could learn it fast.
- The coefficient of self-satisfaction is a significant and negative correlation. If the service could make them younger, more sense of achievement, and more keeping pace with time, they would not prefer using LINE pay for SAV. Gagliardi (1995) found that adopters with lower (more realistic) expectations tended to adopt the innovation more easily. High expectations often resulted in the rejection of technology after a trial period.

doi:10.6844/NCKU202001330

Table 4-10 Result of hybrid choice models (Whole samples)

Explanatory variables	HL1		HL2	
Parameters	Coeff.	t-value	Coeff.	t-value
Alternative Specific Constants (ASC)				
Constant_Use	0.62	5.04***	1.46	3.39***
Generic Variable (GV)				
Transfer discount	1.30	7.15***	1.60	6.92***
LINE points feedback	2.32	6.57***	2.54	6.89***
Smartphone malfunction Percentage	-1.96	-5.53***	-1.67	-4.31***
Queueing time of Pre-paid	-0.02	-0.46	-0.03	-0.81
Alternative Specific Variables (ASV)				
Perceived ease of use			0.93	4.58***
Self-satisfaction			-1.03	-2.30**
LL(0)	-908.72		-908.72	
LL(β)	-766.54		-755.62	
ρ^2	0.16		0.17	
Adjusted ρ^2	0.15		0.16	
Number of observations	1311		1311	
Notes	***：At an 1% significance level (t>2.58) **：At a 5% significance level (t>1.96) *：At a 10% significance level (t>1.64) LL(0)：Null log likelihood LL(β)：Final log-likelihood			

doi:10.6844/NCKU202001330

4.5.3 Results of Hybrid Choice Models－Aged Under 55

There is no difference in generic variables between the two groups, so only alternative specific variables of the two groups will be discussed separately. First, the results of the group under 55 years old are introduced as following：

- The coefficient of self-satisfaction is a significant and negative correlation. This result is the same as Table 4-10, but it is especially influencing the group under 55 years old.
- The coefficient of intention to use is a significant and positive correlation. It means that if their intention to use LINE pay for SAV is higher, then they will more prefer using it.

doi:10.6844/NCKU202001330

Table 4-11 Result of hybrid choice models (Aged under 55)

Explanatory variables / Parameters	HL1 Coeff.	HL1 t-value	HL2 Coeff.	HL2 t-value
Alternative Specific Constants (ASC)				
Constant_Use	0.68	3.83***	1.15	1.66*
Generic Variable (GV)				
Transfer discount	1.56	5.59***	1.75	4.84***
LINE points feedback	2.81	5.16***	2.99	5.22***
Smartphone malfunction Percentage	-2.41	-4.40***	-2.30	-3.77***
Queueing time of Pre-paid	-0.06	-1.02	-0.07	-1.13
Alternative Specific Variables (ASV)				
Self-satisfaction			-1.26	-2.49**
Intention to use			1.17	4.24***
LL(0)	-463.72		-463.72	
LL(β)	-359.71		-350.20	
ρ^2	0.22		0.25	
Adjusted ρ^2	0.21		0.23	
Number of observations	669		669	
Notes	***：At an 1% significance level (t>2.58) **：At a 5% significance level (t>1.96) *：At a 10% significance level (t>1.64) LL(0)：Null log likelihood LL(β)：Final log likelihood PT：Public transportation			

doi:10.6844/NCKU202001330

4.5.4 Results of Hybrid Choice Models－Aged 55 and above

The estimation results of the group aged 55 and above are summarized in Table 4-12. The adjusted rho-square of the group of aged 55 and above is lower than the group of aged under 55. The adjusted rho-square is 0.097 and 0.23, respectively. However, the lower adjusted rho-squared shows that this research does not precisely capture this group's characteristics or this middle-aged group is the heterogeneity, so it is not easy to catch their features. $\boldsymbol{\rho^2}$ is a measure of the predictive ability of the model, in that better models will tend to have higher predicted probabilities of the chosen alternatives, which means greater information explained, or lower entropy or uncertainty (Mokhtarian, 2016).

- The coefficient of attitude is a significant and negative correlation. It shows that a group of 55 and above got a more positive attitude about using LINE pay for SAV, they would not prefer using it. It could be speculated that even if they have a positive attitude to use the services, their individual socioeconomic and demographic characteristics might influence their decision.
- The coefficient of self-efficacy is a significant and negative correlation. It means that if they have higher self-efficacy, they will not prefer using LINE pay for SAV.
- The coefficient of perceived ease of use is a significant and positive correlation. It represents that this group of people perceived higher ease of using LINE pay for SAV, then they will more prefer using it.
- The coefficient of self-satisfaction is a significant and positive correlation. It means that if these services can bring self-satisfaction to middle age over 55, they will prefer using LINE pay for SAV.

doi:10.6844/NCKU202001330

Table 4-12 Result of hybrid choice models (Aged 55 and above)

Explanatory variables	**HL1**		**HL2**	
Parameters	Coeff.	t-value	Coeff.	t-value
Alternative Specific Constants (ASC)				
Constant_Use	0.55	3.23***	0.46	2.15**
Generic Variable (GV)				
Transfer discount	1.12	4.56***	1.11	4.42***
LINE points feedback	1.99	4.20***	2.01	4.19***
Smartphone malfunction Percentage	-1.66	-3.51***	-1.74	-3.61***
Queueing time of Pre-paid	0.02	0.28	0.02	0.32
Alternative Specific Variables (ASV)				
Attitude			-1.67	-2.81***
Self-efficacy			-1.67	-2.32**
Perceived ease of use			1.75	3.19***
Self-satisfaction			1.37	2.08**
LL(0)	-445		-445	
LL(β)	-399.81		-392.77	
ρ^2	0.10		0.12	
Adjusted ρ^2	0.09		0.10	
Number of observations	642		642	
Notes	***：At an 1% significance level (t>2.58) **：At a 5% significance level (t>1.96) *：At a 10% significance level (t>1.64) LL(0)：Null log likelihood LL(β)：Final log-likelihood			

doi:10.6844/NCKU202001330

4.6 Elastic Analysis

Based on the result of hybrid choice models as stated above, the utility value and choice percentage for each middle age of using and not using LINE pay for SAV can be calculated. The average percentage of using the services is 40.81%, and for not using the service is 59.19%. The results are shown as following：

Table 4-13 The choice percentage of whether using the services

	Average Percentage (%)
Use	40.81%
Not use	59.19%

There are four observable attributes, including transfer discount, LINE points feedback, smartphone malfunction percentage, and queueing time of prepaid in this research. To explore if the observable attributes' variation were increasing 1%, how many percentages will middle age choose to use LINE pay for SAV. The elastic analysis is applied, and the result is depicted in Table 4-14.

Table 4-14 Elastic analysis of observable attributes

	Transfer discount	**LINE points feedback**	**Smartphone malfunction percentage**	**Queueing time of pre-paid**
Percent of using	0.108	0.135	-0.105	-0.03
Percent of no using	-0.108	-0.135	0.105	0.03

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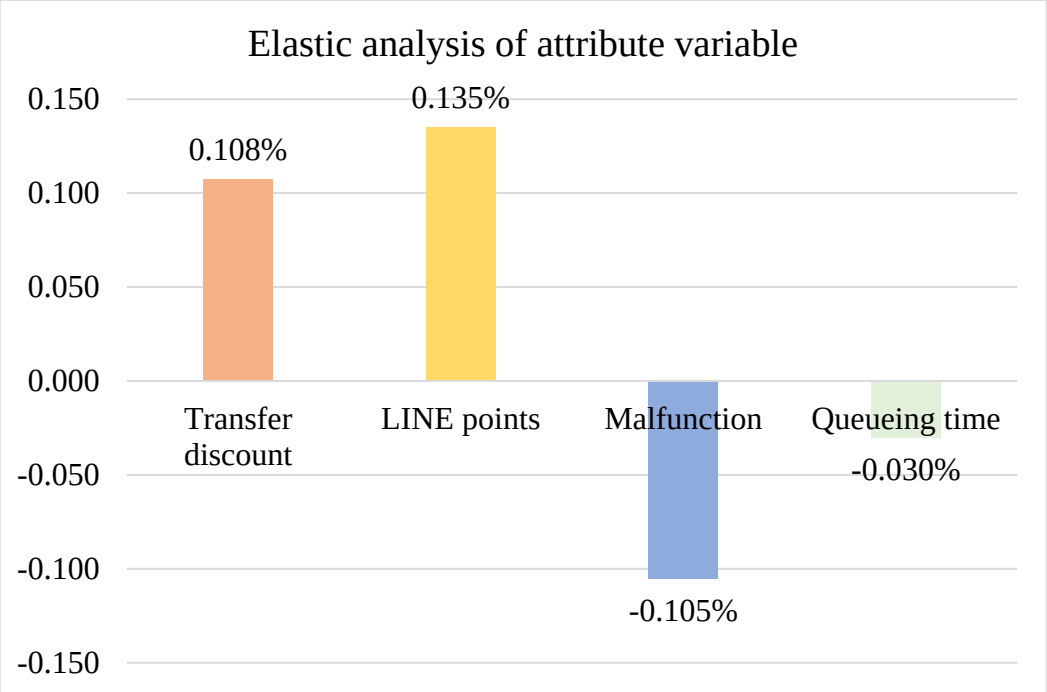

Figure 4-2 Elastic analysis of observable attributes

4.7 Sensitivity Analysis

This section is aimed to know the variation of choice percentage when middle age facing different observable attributes under increasing/decreasing 10%, 20%, and 30%.

doi:10.6844/NCKU202001330

- Sensitivity analysis of transfer discount

Table 4-15 Sensitivity analysis of transfer discount

	Adjusted proportion	Using LINE pay	Variation proportion
Transfer discount	-30%	37.6%	-3.18%
	-20%	38.68%	-2.13%
	-10%	39.74%	-1.07%
	Base	40.81%	0
	10%	41.89%	1.08%
	20%	42.98%	2.17%
	30%	44.07%	3.26%

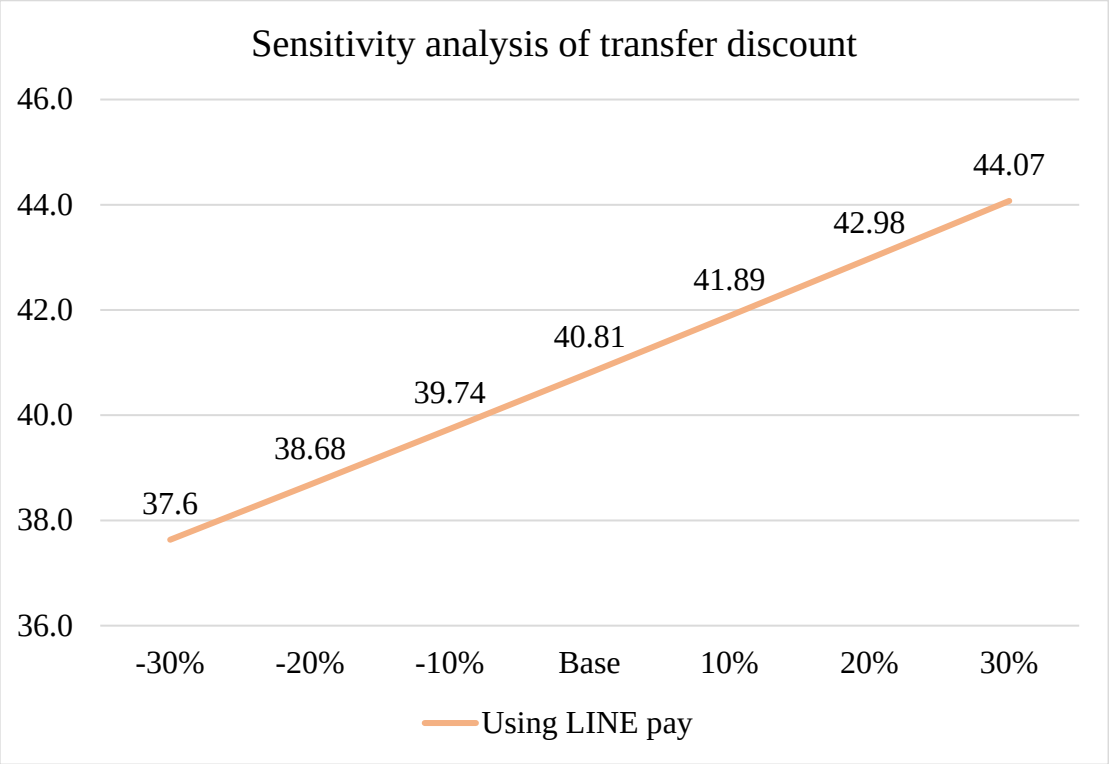

Figure 4-3 Sensitivity analysis of transfer discount

doi:10.6844/NCKU202001330

- Sensitivity analysis of LINE points feedback

Table 4-16 Sensitivity of LINE points feedback

	Adjusted proportion	Using LINE pay	Variable proportion
LINE points feedback	-30%	36.87%	-3.93%
	-20%	38.16%	-2.65%
	-10%	39.47%	-1.34%
	Base	40.81%	0
	10%	42.17%	1.36%
	20%	43.55%	2.75%
	30%	44.96%	4.15%

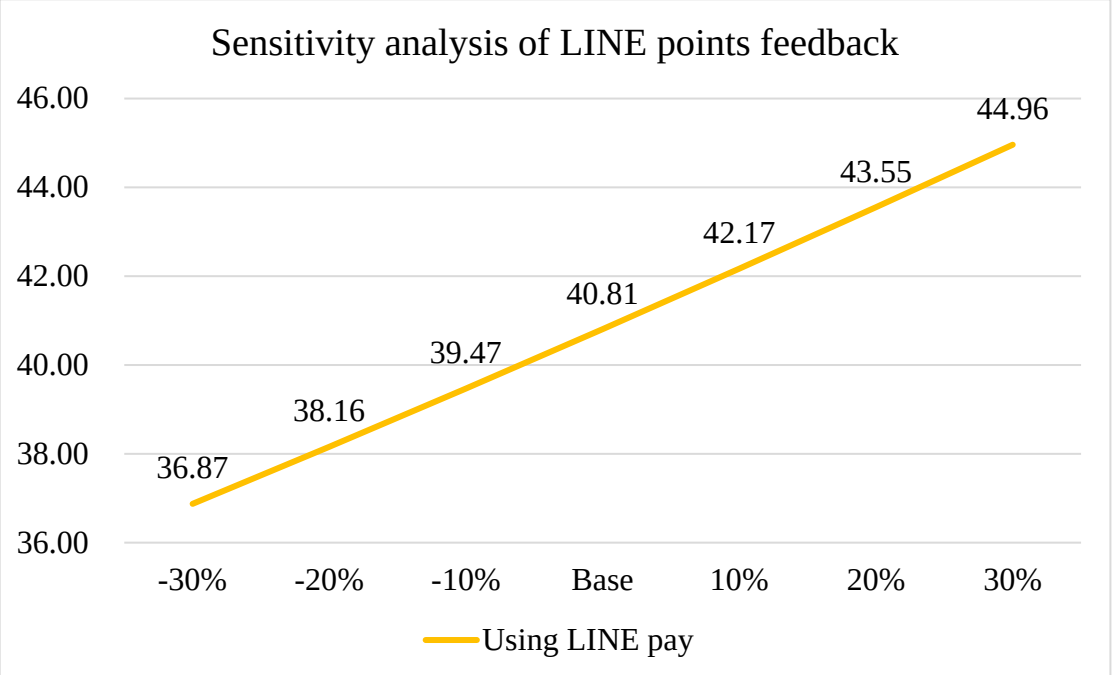

Figure 4-4 Sensitivity analysis of LINE points feedback

doi:10.6844/NCKU202001330

- Sensitivity analysis of smartphone malfunction percentage

Table 4-17 Sensitivity of smartphone malfunction percentage

	Adjusted proportion	Using LINE pay	Variable proportion
Smartphone malfunction percentage	-30%	44.03%	3.22
	-20%	42.94%	2.14
	-10%	41.87%	1
	Base	40.81%	0
	10%	39.76%	-1.05
	20%	38.73%	-2.08
	30%	37.72%	-3.09

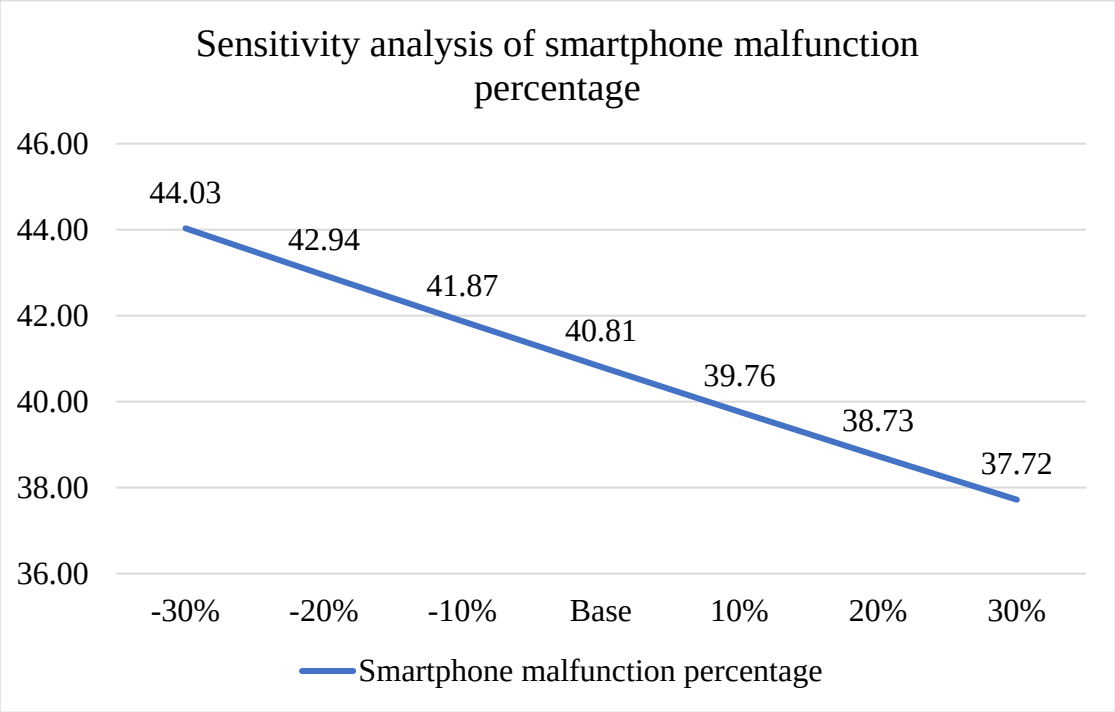

Figure 4-5 Sensitivity analysis of smartphone malfunction percentage

doi:10.6844/NCKU202001330

- Sensitivity analysis of queueing time of prepaid

Table 4-18 Sensitivity of queueing time of prepaid

	Adjusted proportion	Using LINE pay	Variable proportion
Queueing time of prepaid	-30%	41.71%	0.91%
	-20%	41.41%	0.6%
	-10%	41.11%	0.3%
	Base	40.81%	0
	10%	40.51%	-0.3%
	20%	40.21%	-0.6%
	30%	39.9%	-0.9%

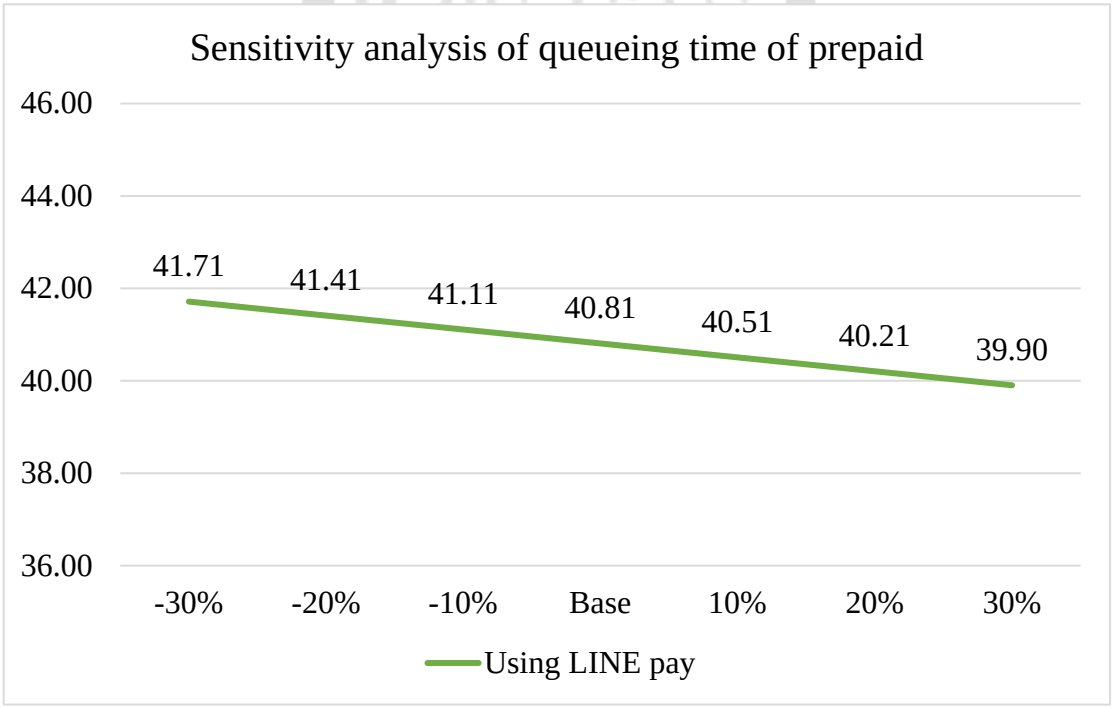

Figure 4-6 Sensitivity analysis of queueing time of prepaid

doi:10.6844/NCKU202001330

- Sensitivity analysis of observable attributes

The sensitivity analysis of the four observable attributes of this research is presented in Table 4-8. The important result is that LINE points feedback is the biggest positive factor of whether middle age using LINE pay for SAV in four observable attributes. Also, it could be found that smartphone malfunction is the most influential negative factor. Hence, when the application of mobile payment is being updated, the operation firm must guarantee its stability.

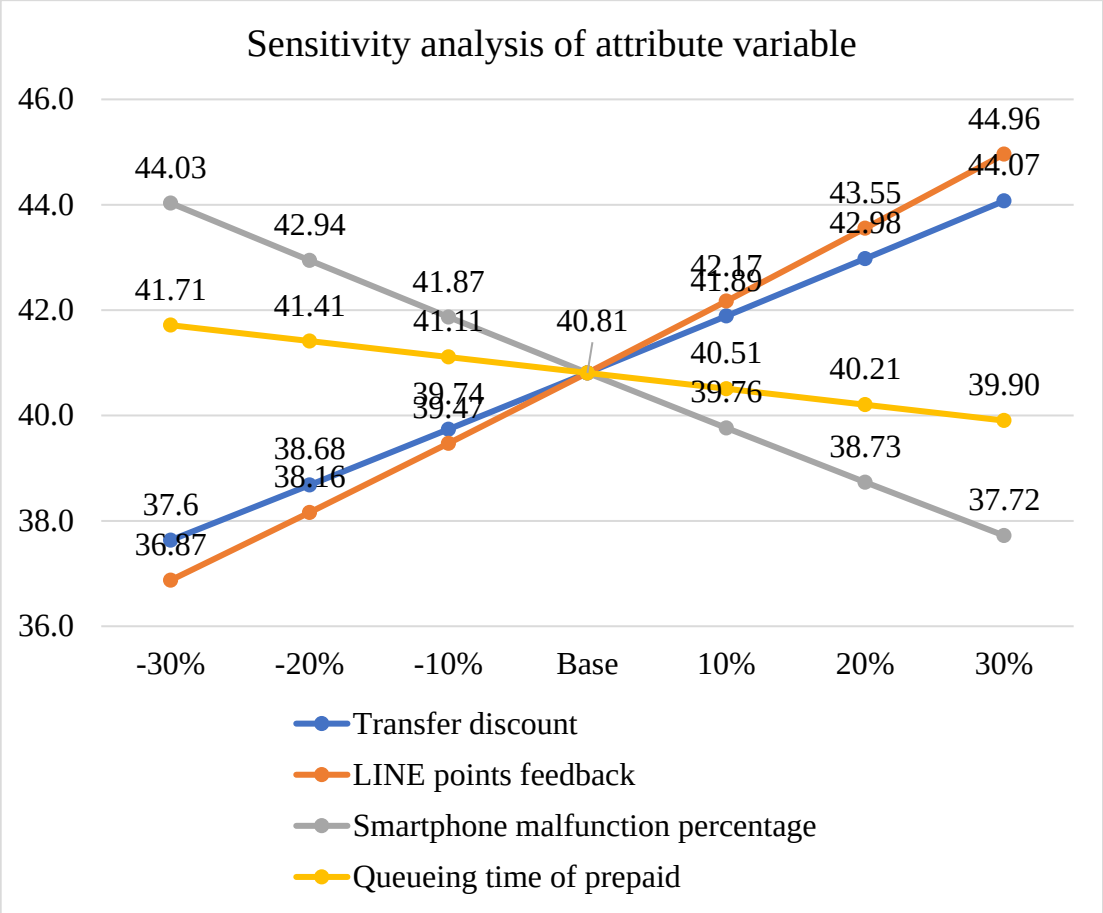

Figure 4-7 Sensitivity of observable attributes

doi:10.6844/NCKU202001330

CHAPTER 5 CONCLUSIONS AND SUGGESTIONS

This research is mainly exploring middle age choice behavior of using LINE pay for SAV. The observable attributes of intention to use LINE pay for SAV are known by logit regression. Finally, latent variables are measured by hybrid choice models. This chapter is divided into three sections. Section 5.1 shows conclusions including responses of research purposes and explanations of estimation results. Section 5.2 presents suggestions, such as academic and practical contribution. Finally, the limitations and future research are given in Section 5.3.

5.1 Conclusions

This study is mainly discussing middle age preferences and choice behavior of using LINE pay for SAV, revealing the factors of influencing their choice. However, those factors could be divided into observable attributes and latent variables. All of them could be summarized as following：

1. **The influential power of LINE points feedback is bigger than the transfer discount for middle age using LINE pay for SAV.**

Based on the result of sensitivity analysis, with LINE points feedback's amplitude of variation adjusted from 10% to 30%, the percentage of middle-age choose to use LINE pay for SAV increases from 1.36% to 4.15%. Compared to the transfer discount, the change in proportion increasing from 1.08 to 3.26% is lower than LINE points feedback. It shows that LINE points feedback is a crucial impact factor when promotes using LINE pay for SAV.

doi:10.6844/NCKU202001330

2. **Middle age who familiar with the LINE system helps to increase their preference of using LINE pay for SAV.**

Through the results of binary logit models, we could find that using LINE over 5 hours per day will prefer using LINE pay for SAV. Additionally, according to the results of hybrid choice models, perceived ease of using LINE pay for SAV is positive affect middle age. It is reasonable if increases their feeling of easy to use, they will prefer using LINE pay for SAV.

3. **Self-satisfaction brings different effects between the two groups.**

Based on the results of hybrid choice models－aged under 55, middle-age who get more self-satisfaction from the services will not prefer using LINE pay for SAV. However, the group aged over 55 and above perform the opposite outcome. If the services bring the group aged over 55 and above more satisfaction, they will prefer using the services. As the result, 55 may be a dividing line of self-satisfaction. Middle age over 55 care more about the feelings of younger, keeping pace with time, and increasing their achievements while they are using LINE pay for SAV.

4. **Middle age who highly depends on LINE is the target of loyal customers.**

We found that users using LINE with high hours per day would prefer using LINE pay for SAV. Additionally, the smartphone malfunction is the main negative factor to influence middle-aged choice based on the result of sensitivity analysis. When the APP's malfunction percentage decreases between 10% to 30%, the probability of middle age choosing to use the service will increases from 1% to 3.22%. In conclusion, if the stability of the APP increases, it will attract more middle age to use it. Middle age who are highly addicted to LINE should be the firm's target.

doi:10.6844/NCKU202001330

5. The key factors are not to be found aged 55 and above.

According to Mokhtarian (2016), $\boldsymbol{\rho^2}$ is a measure of the predictive ability of the model, in that better models will tend to have higher predicted probabilities of the chosen alternatives, which means greater information explained, or lower entropy or uncertainty (Mokhtarian, 2016). In this study, the adjusted ρ2 in aged 55 and above is lower than under 55. The reason might be that this study does not find the key factors influencing aged over 55 to use LINE pay for SAV.

5.2 Suggestions

Based on estimation results and conclusions, this study could summarize them, giving strategies and policy design. Here we can separate different stakeholders, such as a corporation (i.e. LINE, SAVs firm), middle age, and government.

1. LINE corporation

Based on the results of the sensitivity analysis, we can suggest that LINE could cooperate with SAVs firm, and offer suitable LINE points feedback percentage, creating attraction of the services. Additionally, smartphone malfunction percentage must be low to avoid middle-age abandoning this service. The interface should be clear and simple, making the middle age could learn it fast.

For marketing, they could use their advantages of LINE users' data, focusing on middle age who using LINE over 5 hours per day to precise marketing in its initial promotion phase.

2. Shared autonomous vehicles firm

The suggestions are familiar with mentioned above. The firm could offer a transfer discount when middle age takes different public transportation. Also, the process of using LINE pay for SAV must be easy to operate for them or they could arrange staff to show them how to use it.

doi:10.6844/NCKU202001330

3. Middle age

In 2018, there are almost 40% of citizens are using LINE Pay as their main online payment system. However, in this study, there are 51.3% have been used mobile payment, but only 25.2% middle age have been used LINE pay. This research suggests that not only LINE corporation could promote the service by precision marketing, but also middle age should pay attention to preferential information.

4. Government

In the policy aspect, the Ministry of Transportation and Communications (MOTC) could collaborate with SAVs firm to offer different discount alternatives. Moreover, it could open teaching courses about operating smartphones to reduce their anxiety. Additionally, based on the result whose main mode in daily life is motor is not preferring using the services, and the reason might be that motorcycle has high flexibility. After the issue is solved, this service would have a chance to be more adopted.

doi:10.6844/NCKU202001330

5.3 Limitations and Future Research

The topic of this study may be uneasy for middle age to answer. It is combining two issues, such as mobile payment and shared autonomous vehicles. Middle age might be confused when answering the questionnaire. The results of the queueing time of prepaid in this research are not corresponding to our expected result. The reason might be the density of convenience stores in Taiwan are high, so it has no obvious difference to the alternative. Moreover, the sample of this study is centralized in the south of Taiwan, so it could be suggested that the distribution area of the sample should be average. Moreover, if the objective LINE pay is replaced by another mobile payment, the results possibly differ from this research.

For future research, it could be suggested that observable attribute should refer to other variables which can significantly affect their choice. Additionally, there are different latent variables or socio-economic and habit variables that can be investigated, so through literature review, other variables can be tried to explore the middle-aged psychological status towards new technology. Furthermore, SAVs could bring lots of benefits to the countryside, so the investigation could start from the countryside where might be the first demonstration site.

doi:10.6844/NCKU202001330

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APPENDIX A

消費者對於行動支付偏好之選擇行為問卷

親愛的受訪者:

您好，這份問卷目的為瞭解消費者「**使用 LINE PAY 支付共享自動駕駛車的費用**」之接受度及偏好。請依照您的實際感受填答。本問卷僅供學術研究之使用，絕不對外公開資料，並採不記名方式進行，敬請安心作答，誠摯的感謝您的協助!

填答完整且為有效樣本者，我們將提供 30 張 7-11 一百元禮券進行抽獎。

國立成功大學 交通管理科學系暨電信管理所
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背景說明

- **共享自動駕駛車**

指不須人為操作而能自行上路的汽車，一台車約可搭載 4-6 人，固定的站點、路線和班次，但是因為不需要司機成本，所以可以設置更多的站點、路線和班次，性質接近計程車，但是價格比計程車低許多。

- **LINE pay**

為內建於 LINE 的行動支付服務功能，在 LINE pay 上綁定信用卡或銀行帳戶，可提供儲值、轉帳、付款、繳費，如:可以用 LINE pay 乘車碼搭乘高雄捷運。

＊註 1：可以依照綁定不同的銀行帳戶，享有不同的 LINE points 回饋。

＊註 2：LINE points 1 點＝新台幣 1 元，可用於日常消費。

doi:10.6844/NCKU202001330

第一部分

問卷題目	極不同意	不同意	普通	同意	非常同意
1. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我看起來**較年輕**。	□1	□2	□3	□4	□5
2. 我覺得使用 LINE pay 支付共享自駕車的費用，會增加我的**成就感**。	□1	□2	□3	□4	□5
3. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我**跟上時代腳步**。	□1	□2	□3	□4	□5
4. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我**很緊張**。	□1	□2	□3	□4	□5
5. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我**擔心**。	□1	□2	□3	□4	□5
6. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我**不自在**。	□1	□2	□3	□4	□5
7. 我覺得使用 LINE pay 支付共享自駕車的費用，會讓我**感覺困惑、不輕鬆**。	□1	□2	□3	□4	□5
8. 如果 **LINE pay 有教學操作方式**，我能夠根據教學步驟自己使用 LINE pay 支付共享自駕車的費用。	□1	□2	□3	□4	□5
9. 如果**有人先教我如何操作**，我能夠自己使用 LINE pay 支付共享自駕車的費用。	□1	□2	□3	□4	□5
10. 我能夠自行使用 LINE pay 支付共享自駕車的費用，**不需要其他協助**。	□1	□2	□3	□4	□5
11. 我能夠自己使用 LINE pay 支付共享自駕車的費用，**即使之前沒使用過**。	□1	□2	□3	□4	□5
12. 我**不願意花太多時間**學習如何使用 LINE pay 支付共享自駕車的費用。	□1	□2	□3	□4	□5
13. 我覺得使用 LINE pay 支付共享自駕車的費用可以**改善日常生活**。	□1	□2	□3	□4	□5
14. 我覺得使用 LINE pay 支付共享自駕車的費用可以**增加我的行動效率**。	□1	□2	□3	□4	□5
15. 我覺得使用 LINE pay 支付共享自駕車的費用可以**增進我的生活效率**。	□1	□2	□3	□4	□5
16. 我覺得使用 LINE pay 支付共享自駕車的費用在生活上是**有用的**。	□1	□2	□3	□4	□5

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17.我覺得使用 LINE pay 支付共享自駕車的服務是**簡單容易的**。	□1	□2	□3	□4	□5
18.我覺得使用 LINE pay 支付共享自駕車的目的是**清楚明確的**。	□1	□2	□3	□4	□5
19.我覺得學習使用 LINE pay 支付共享自駕車的服務是**輕鬆的**。	□1	□2	□3	□4	□5
20.我覺得使用 LINE pay 支付共享自駕車費用是**好的構想**。	□1	□2	□3	□4	□5
21.我覺得使用 LINE pay 支付共享自駕車費用**符合大眾的需求**。	□1	□2	□3	□4	□5
22.整體來說，我對使用 LINE pay 支付共享自駕車的費用**持正向態度**。	□1	□2	□3	□4	□5
23.未來我**有意願使用** LINE pay 支付共享自駕車費用。	□1	□2	□3	□4	□5
24.我將會在生活上**試著使用** LINE pay 支付共享自駕車費用。	□1	□2	□3	□4	□5
25.未來我會**盡可能地使用** LINE pay 支付共享自駕車費用。	□1	□2	□3	□4	□5

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第二部分 情境單選題

此部分為情境問卷，共有三個假設情境，每個情境中有二個選擇方案。請根據您目前搭乘大眾運輸的狀況及參考以下資訊，**於 3 個情境中，各別勾選一個最吸引您的方案**。

方案舉例如下：

假設旅行距離為 10 公里，票價為 60 元，大約為左營高鐵到夢時代；安平古堡到奇美博物館的距離。

- 使用 LINE pay 之**轉乘折扣**：票價 60 元 * **30%** = 折扣 18 元 。
- 使用 LINE pay 之 LINE points **點數回饋**：票價 60 元 * **20%** = 回饋 12 元。
- 使用 LINE pay，可能會有軟體與手機不相容之 APP **故障機率**。
- **不**使用 LINE pay，使用一卡通或悠遊卡支付，有不同的儲值**排隊時間**。

情境 1	方案	
	使用 LINE pay	**不使用 LINE pay**
轉乘折扣	車票票價 30%	無轉乘折扣
LINE points 點數回饋率	車票票價 20%	無 LINE points
APP 故障率	35%	無故障機率
儲值排隊時間	0 分鐘	1.5 分鐘
請勾選一個	□	□

情境 2	方案	
	使用 LINE pay	**不使用 LINE pay**
轉乘折扣	車票票價 30%	無轉乘折扣
LINE points 點數回饋率	車票票價 30%	無 LINE points
APP 故障率	15%	無故障機率
儲值排隊時間	0 分鐘	4.5 分鐘
請勾選一個	□	□

情境 3	方案	
	使用 LINE pay	**不使用 LINE pay**
轉乘折扣	車票票價 20%	無轉乘折扣
LINE points 點數回饋率	車票票價 10%	無 LINE points
APP 故障率	35%	無故障機率
儲值排隊時間	0 分鐘	4.5 分鐘
請勾選一個	□	□

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第三部分 習慣調查 (皆為單選題)

1. 您是否曾經使用過行動支付 (如：LINE pay、Apple pay、Google pay、全聯 PX Pay 等)

   □有使用 □未使用。

2. 您是否曾經使用過 LINE pay

   □有使用 □未使用。

3. 平常外出最常使用之交通工具:

   □機車 □汽車 □大眾運輸工具(含公車、火車及捷運等) □計程車

   □其他:_____。

4. 您搭乘大眾運輸的頻率為：

   □每年不到一次 □半年 1-2 次 □每月 1-2 次 □每月 3-4 次

   □每月 4 次以上。

5. 平均一天使用智慧型手機的時間

   □1 小時內 □1-3 小時 □3-5 小時 □5 小時以上。

6. 平均一天使用 LINE 的時間

   □1 小時內 □1-3 小時 □3-5 小時 □5 小時以上。

第四部分 基本資料

1. 性別: □男 □女
2. 年齡: □45~54 歲 □55~64 歲 □65 歲以上
3. 教育程度: □國中(含)以下 □高中(職) □大學(專) □研究所(含)以上
4. 居住地:

   □基隆市 □新北市 □台北市 □桃園市 □新竹縣 □新竹市

   □宜蘭縣 □苗栗縣 □台中市 □彰化縣 □南投縣 □雲林縣

   □嘉義縣 □嘉義市 □台南市 □高雄市 □屏東縣 □花蓮縣

   □台東縣 □其他:_____。

5. 每月薪資(可支配)所得:

   □10,000 元(含)以下 □10,001~20,000 元 □20,001~30,000 元

   □30,001~40,000 元 □40,001~50,000 □50,001~100,000 元

   □100,001 元以上

6. 若您對本問卷有任何問題及回饋，請不吝給予指教及留下寶貴意見(選填)

   _____。

7. 請留下您的 E-MAIL 或手機號碼，以便中獎通知(選填)

   _____。

本問卷到此已經完全結束，感謝您的熱心協助!

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