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Explore Local Legal System and Induced Legal Issues of Autonomous Vehicles in Taiwan

臺灣自駕車發展之地方法制及其衍生法制議題探討

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碩士論文

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Explore Local Legal System and Induced Legal Issues of Autonomous Vehicles in Taiwan

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ABSTRACT

Recently, many countries have already put effort into the reviews and amendments of the laws and regulations regarding autonomous vehicles (AV). However, in Taiwan, aside from the Unmanned Vehicles Technology Innovative Experimentation Act in 2018, further legislation was not materialized. That is, compared to other countries' aggressiveness, we do have the need to speed up our legislation.

Exploration of the legal system can be divided into a central part and a local part, among them, the former has had a certain amount of research results. Therefore, the research explores the lacking part in terms of local legal issues induced by the introduction of autonomous vehicles. The issues include span from local government and regulatory coherence, autonomous buses, maintenance of roadside infrastructure, a transformation of parking forms, financial burdens of local governments, and urban planning. Besides, to seek the effect of "an adaption of local conditions", several local governments with different economic developments are presented so that the differences between local governments can also be taken into account.

The study utilizes document analysis, comparative research, focus group interview, and thematic analysis. To summarize the potential legal amendments caused by the development of autonomous vehicles, viewing and comparing policies, regulations, and studies including local government-level AVs-related issues are conducted. Subsequently, focus group interviews and thematic analysis are conducted to acquire and analyze comments from professionals in different fields, which are expected to increase the credibility of the study.

Keywords： Autonomous Vehicle, Legal System of Autonomous Vehicle, Regulatory Coherence, Local Regulation, Thematic Analysis

摘要

近年來，許多先進國家皆針對自駕車科技的投入與發展應用進行立法，然而，我國除了 2018 年通過的《無人載具創新實驗條例》以外，有關自駕車科技的法制修訂並未有更多的進展，相較於他國對於自駕科技法制面的積極，我國政府實有加速相關立法的必要。

法制探討層級大致分為中央以及地方，惟前者已有一定程度之研究成果，故本研究欲藉既有自駕車發展之中央法規之研究基礎，探討現有文獻較為缺乏的自駕車發展之地方法規研究。其中，本研究探討之議題包含地方之交通審視(法規調和)、自駕公車、路側設施之保養維護、停車型態之改變、地方政府財政之探討以及都市規劃等議題。此外，為在尋求地方法規建議時達到「因地制宜」之成效，數個經濟發展程度不一的地方政府於此研究亦適當被提出，期望在導入自駕車的過程中，各地方政府之差異亦被顧及。

本研究透過文獻分析法、比較研究法、焦點團體訪談以及主題分析法等。檢視各國政府自駕科技的政策、相關試驗以及文獻對於未來自駕車應用情境影響地方政府之層面等，整理出在自駕車科技進入現今社會時可能需要調整之法規，後將相關資料相互比較，後透過專家座談會廣邀各領域之專業人士發表評論，並以主題分析法分析其內容，使此研究不失公允、提升此可靠度，並彙整研究總結。

關鍵詞：自駕車、自駕車法制、法規調和、地方法規、主題分析

誌謝

雖然在成大交管所的兩年時間課業繁重、來自論文、計畫案的壓力幾乎不曾間斷，不過因為有大家的陪伴、鼓勵，一切難題都能順利完成。

首先要感謝對象的自然是自己的家人，感謝你們支持我繼續攻讀研究所的決定，在財務方面無憂的狀況下獲得成大的碩士學位，這是我可以在離家頗遠的台南唸書最好的基石，另外，溫暖的家庭環境也讓我每每回家就有在精神上充電的感覺，實在萬分感謝；再來便是感謝魏健宏教授以及黃郁雯教授在計畫案以及論文的指導，幾乎每次的開會都使我了解到自己不足的地方，也是因此我才有動力持續精進自己，無論是學術上或是做事能力上，自己皆成長許多；最後，感謝在成大時有幫助過我的每個人，無論是同年級的同學、學長姊、學弟妹，或是在社團、各語言交流會認識的朋友，可以跟優秀的人互動也讓我自己成長很多，沒有你們我在成大的生活便會變得不完整。

賴泓文 謹誌

於成大交管 502 研究室

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CHAPTER 1 INTRODUCTION

1.1 Research Backgrounds

AVs have been developed for years, and the main reason to materialize technology is that the technology is believed to have the potential to reshape people's transport forms. Though the effect varies when different levels of autonomous systems are applied, society is expected to be beneficial by embracing the technology, since some lingering problems like traffic accidents, driving negligence, or even driver shortage are expected to be solved.

1.1.1 Emergence of Autonomous Vehicle (AV)

After years of endeavors in AI and the 5G field, tech companies started to attract people's attention by testing experimental autonomous vehicles. With projects such as the Autonomous Vehicle Tester Program in California, the local authority of the Department of Motor Vehicles administered the whole process of testing the automated driving system (ADS) and launched disengagement and crash reports (California DMV, 2022).

Among them, "disengagement" can occur due to the failure of technology or other emergencies compelling the safety driver to involve, which can be seen as a representation of the maturity of the autonomous vehicle, so consecutive attempts to lower the possibility of "disengagement" is the long-term goal of the industry. Some research also conducts an analysis of it to understand the current headwind (Boggs et al., 2020).

1.1.2 Autonomous Vehicle in Taiwan

In 2018, the Ministry of Economic Affairs (MOEA) first launched Unmanned Vehicles Technology Innovative Experimentation Act[1] to boost the development of unmanned vehicles (including boats and drones).

[1] Unmanned Vehicles Technology Innovative Experimentation Act：wu ren zai jyu ke ji chuang sin shih yan tiao li, translated by Laws & Regulations Database of The Republic of China (Taiwan).

The act included the procedures of applications pertaining to innovative experimentation, the safety and management of experiments, the obligation to hand out the required reports, and the exemption of applicable laws.

Moreover, in Taiwan, the existing research has preliminarily discussed related issues of autonomous vehicles, which includes the central law and regulatory framework (Zhan, 2022; Wei et al., 2022; National Science and Technology Council, 2022), ethical norms (Chang, 2022), and sustainable transportation system (Wei et al., 2023).

Though some topics about autonomous vehicle have already been done, few discuss the issue from the viewpoint of local governments. Hence, the study mainly focus on the upcoming legal issues at the local government level and the potential roles local governments can play while promoting the new technology.

1.1.3 Sustainable Development Goals (SDGs) and Autonomous Vehicle

SDGs, adopted by the United Nations in the year of 2015, provide a shared blueprint by listing 17 different sustainable development goals. With the ever-changing technology, taking advantage of the emergence of the autonomous vehicle might become a potential technic to speed up the entire process, especially for SDG 11 (sustainable cities and communities) and SDG 13 (climate action).

About SDG 11, bus routes with deficits can be improved if driver costs are saved. Some researchers have preliminarily quantified the relevant data and gained a positive outcome during the transition to the full performance of autonomous buses (Abe, 2019).

Furthermore, when it comes to the status quo of autonomous buses, they are deployed around the globe, though not all of them are commercialized and remaining legal issues might hinder the implementation of autonomous buses, the potential benefits still propel companies to launch their pilot programs (Iclodean et al., 2020).

About SDG 13, though some might argue that automation will reduce marginal costs and shift the equilibrium in the transport system towards a state with higher vehicle-kilometers traveled (VKT) (Pernestål et al., 2020), existing research also tried to explore the proper policies to attain to the sustainability of cities (Staricco et al., 2019), which is also a reason why autonomous vehicles attract so much attention in recent years.

1.2 Research Objectives

1. To Establish the Legal System of Autonomous Vehicles at the Local Government Level

   Issues induced by autonomous vehicles have already been widely discussed, including safety, responsibility of drivers, manufacturing standards, security, etc. However, most of the issues mentioned above are at the central level, the local counterpart parts are rarely discussed.

   As a result, the study first collected all issues at the local government level, then integrated them with some projects and regulations promoted by local governments. Subsequently, practical voices from local governments are collected via focus group interviews. Eventually, the study lists the legal amendments highly relevant to local governments, aiming to create a legal blueprint for autonomous vehicles at the local government level.

2. To Provide a Prospective Development Guidance for Local Governments

   Autonomous vehicle, a brand-new form of transformation, can be a game changer. Despite the immaturity of technology at present, society should prepare for the upcoming changes in advance, no matter whether it is positive or negative.

   Now, the existing development of autonomous vehicles in Taiwan is built on the exemption of applicable laws authorized by the Unmanned Vehicles Technology Innovative Experimentation Act. However, when the technology starts to be put into our community, our local governments might have little understanding toward the issue.

   Hence, the study invited experts from central and local governments, autonomous vehicle-related industries, scholars with related backgrounds, and research organizations. Through their interactions, combined with the literature collected, the study ended up presenting several themes our local governments should pay attention to while developing the technology.

1.3 Limitations

1. Data Update

   Dynamic development of the technology can be a headwind to conducting the related study with consistent discourses. Not to mention the unpredictable essence of the business world, the study also needs to consume tons of energy browsing different government policies.

   However, the uncertainty shall not hinder the whole industry's development since the potential benefits of autonomous vehicle technology are worth being paid attention to. So all documents presented in the study are within these years, which increases the entire trustworthiness.

2. Regional Traffic Forms Differ

   From the U.S., Germany, and Japan to Singapore, countries with different geographic environments or industrial foundations are attentive to the development of the autonomous vehicles industry. Not only subsidies, but the legislation of certain related aspects have also kicked off in many countries. However, the status quo of traffic varies from country to country.

   For instance, Taiwan holds first place when it comes to the density of mopeds. Upon the introduction of autonomous buses, it must be considered that the complicated traffic situations in Taiwan might be a latent dilemma. That is, even though some literature is cited in the study, the actual situations remain to be observed.

3. Unpredictable development path of autonomous vehicles

   So far, existing research has extensively envisioned the expected future brought by autonomous vehicles. But even for level 3 autonomous vehicles, the level requiring human drivers to prepare for the possible disengagement that has been promoted by some vehicle makers for years, the autonomous system has not yet been fully commercialized. That is, little confidence can people have to forecast the remaining journey of an autonomous vehicle.

1.4 Research Structure

1. Introduction

   The first part of the research is to depict the reasons for conducting the research by presenting the existing works pertaining to central laws and elaborating on the research gap. Since the research is exploratory research, literature is cited to strengthen the theoretical foundation.

2. Literature Review

   In the year of 2020, the Ministry of Transportation and Communications published Intelligent Transportation System Development and Construction Plan (2021-2024).

   The report indicates that there are five main transportation problems, which include: traffic congestion & pollution, poor record of road safety, poorly planned mobility resources, insufficient capacity in remote areas, and new transportation forms induced by new technology.

   The study believes the rise of autonomous vehicles has connections to all the problems above, and those problems can possibly be solved with appropriate preparation. Hence, under the structure of local government, some related issues are presented.

   From local government and regulatory coherence, autonomous buses, maintenance of roadside infrastructure, the transformation of parking forms, financial burdens of local governments, and urban planning. The issues were subtracted from the existing literature. Though some issues still need bilateral cooperation from the counterparts from central and local governments, the issues chosen include a great amount of proportion that local governments can work on.

3. Methodology

   The research is qualitative research, and document analysis, as well as comparative research, are deemed to be utilized to gain the vital issues in our research. Afterward, focus group interviews are to be used to collect the frontline experts' insights on certain issues. Finally, a thematic analysis will be used to generate a conclusive finding, which also contains some useful suggestions provided by experts.

4. Researching Findings

Based on the responses we collect from the experts attending the focus group interview, the study is to present the recommended version of the amendment of current laws and regulations (enactment of the law is also considered if necessary).

5. Conclusions and Suggestions

With the literature collected and focus interviews held, this study is expected to indicate the potential issues Taiwanese local governments might have to tackle and present a comprehensive potential development direction.

The precise prediction might have difficulty due to the unexpected feature of the development of technology. However, beforehand preparation matters when it comes to the legislation of related laws and regulations, which is also the key research gap of the study. And Figure 1 indicates the research structure of the research.

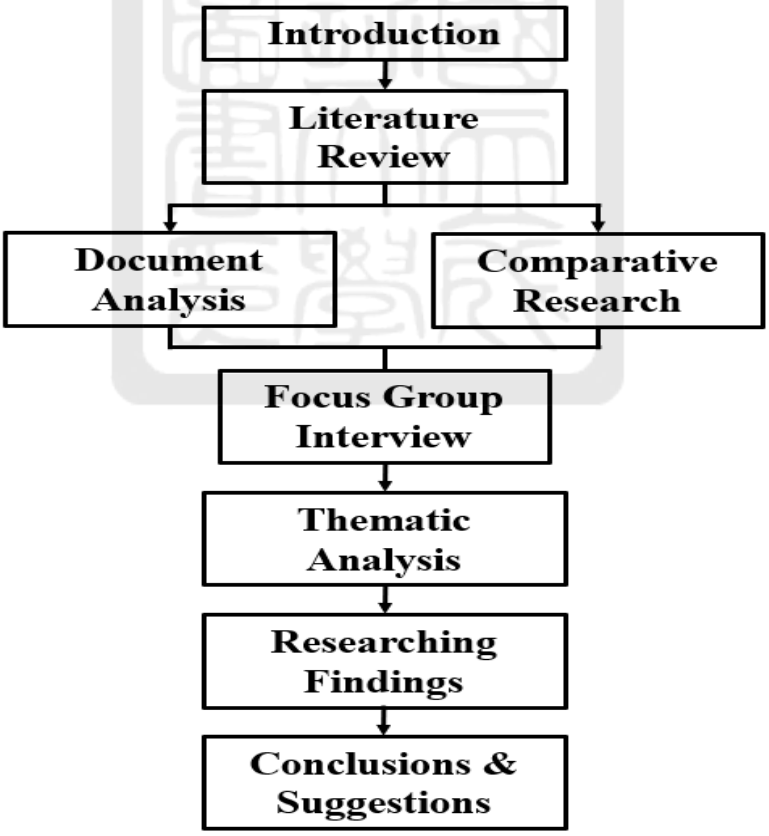


Figure 1 Research Structure

CHAPTER 2 LITERATURE REVIEW

Although we have not yet fully grasped the social changes brought by autonomous vehicles, there is some literature discussing what local governments can focus on in the future (Isaac, 2016), such as road signs, speed limits, and the length of the signal time.

In addition, with the increasing popularity of autonomous vehicles, from the coverage of transportation services, and the choice of vehicle models, to the manpower requirements, will all be different. Subsequently, the relevant transportation departments need to reconsider their shipping services and fee structure, so they can keep it competitive. In short, everything will change with the introduction of autonomous vehicles, so the concept of regulatory coherence should be put in every policymaker's mind.

In terms of the deployment of self-driving systems, autonomous buses are still the mainstay of Taiwanese society today. In Taiwan, the role of autonomous buses in different counties and cities will have to be adapted to local conditions. For example, the autonomous buses in New Taipei City can be used with MRT to help fill the transportation needs of the last mile. Counties and cities with relatively large areas, such as Changhua County and Tainan City, can take advantage of autonomous buses to solve the problem of rural transportation.

The introduction of autonomous vehicles may also have an impact on the existing parking patterns, from the parking demand to the space utilization of the parking lot (Bischoff et al., 2018). In addition, from the perspective of policy sustainability, self-driving technology may also change local government's finances, such as tax revenue, parking revenue, ticket revenue, and other local government revenue, which may be reduced after the popularity of autonomous vehicles.

With all the issues mentioned, the study attempts to discuss the issues with five different sections and integrate the relevant literature with the practical situations in cities and counties in Taiwan. The 2.1 section demonstrate the previous instances of regulatory coherence, and the 2.2 and 2.3 section summarized the autonomous bus tests and the establishment of roadside infrastructures in Taiwan and the referable policies or examples of the US and Japan. Finally, the 2.4 and 2.5 sections explore the issues brought by autonomous vehicles (parking issues, financial burdens, and urban planning), expecting to prepare for them by setting up proper policies in advance. (Figure 2)

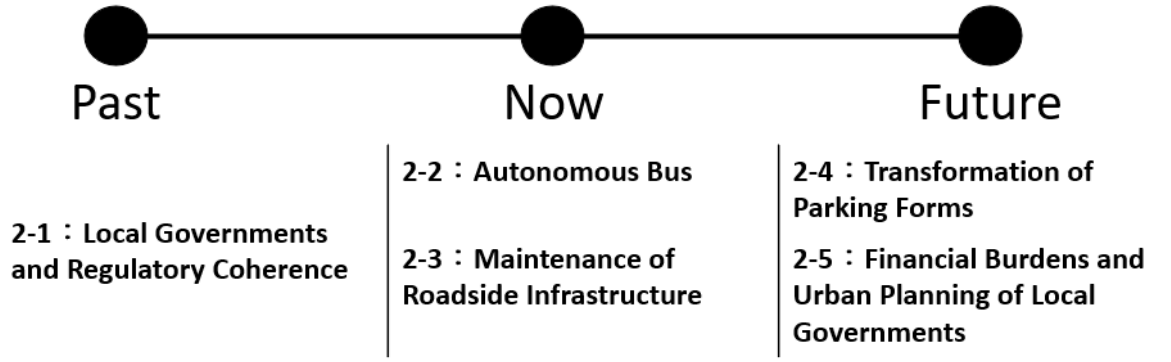


Figure 2 Issues in Chronological Order

2.1 Local Governments and Regulatory Coherence

2.1.1 Existing International Regulation of Autonomous Vehicle

In 2020, the United Nations promulgated UN R157 Automated Lane Keeping Systems (ALKS) as the first binding international regulation for autonomous vehicles. Although its content is mainly aimed at Level 3 autonomous vehicles and its permitted operating field has certain restrictions, it can be regarded as a milestone in the legislation of autonomous vehicles. To increase the scope of application of the act, the United Nations passed the amendment to the Automatic Lane Keeping Assist System (ALKS) in June 2022 (Act Code: UN Regulation No. 157). The amendment raised the speed limit for autonomous cars from 60 km to 130 km to make autonomous vehicle technology applied more broadly.

As autonomous technology develops, the autonomous vehicle will enter our lives. While the Taiwanese government wonders how the autonomous vehicle clauses should be made to apply to its autonomous vehicles, international counterparts shall be referred to, and adjustment to the local conditions is also a need.

In UN Regulation No. 157, with regard to roads other than highways, how should Taiwanese governments comply with chapter 5 "The activated system shall comply with traffic rules relating to the Dynamic Driving Task (DDT) in the country of operation" and formulate self-driving regulations suitable for Taiwan's road conditions (especially those with a higher density of mopeds than other advanced countries). The above work needs cooperation between central and local governments.

2.1.2 Regulatory Coherence： Central versus Local

If we look at previous Taiwanese experiences of introducing new technologies to the transportation environment, both bike-sharing and Uber are instances of " regulatory coherence" in Taiwan. The two instances can be a great model if we are eager to discuss central and local governments' possible reactions to the upcoming autonomous vehicles.

Regarding the definition of regulatory coherence, according to the discourse of the National Development Council, "regulatory coherence" mainly requires governments of various countries to be more transparent and incorporate public opinions in the process of formulation of regulations, to reduce the cost of compliance after the implementation of regulations and promote cross-border trade and investment. Specific items include:

1. Establish a central-level communication mechanism to enhance effective communication across agencies.
2. Encourage all regulatory authorities to conduct regulatory impact assessments, including assessing the necessity of regulatory proposals, reviewing feasibility, and conducting a cost-benefit analysis of plans.
3. In the process of formulating laws and regulations, all agencies should take international and regional development trends into account and establish appropriate mechanisms to provide stakeholders with opportunities to provide opinions.

At this stage, there are precedents for the regulatory coherence related to transportation in Taiwan, and it is the same as the introduction of self-driving systems. They are all changes triggered by the introduction of newly developed technologies: such as UBER (taxi-sharing) and OBike (bike-sharing), as shown in Table 1 below.

Regulatory amendments have been done to help society better adapt itself to the newly developed transport mode. However, comparing UBER and Obike, the former triggered many revisions of central laws and regulations, and the latter only propelled some local governments to take different actions, as shown in the following Table 2.

Table 1 Introduction of UBER and Obike

Company Name	UBER	Obike
Operation Period	2013 - Present	2017 - 2018
Transportation Form	Sharing Taxi	Sharing Bike

Operation Mode	Through vehicle dispatch, consumers can easily enjoy passenger transportation services through the APP. For those who want to use their spare time to make money, UBER's flexible working time provides a new part-time job for this group.	Compared with the existing docked bike-sharing system of YouBike, the dockless version is more flexible. As long as you complete the registration procedures with a specific app, find the vehicle with a map, and scan the QR code to unlock the vehicle, you can start enjoying the services. While returning the bike, you only need to park and lock the car, and that is it.
Social Conflict	**Public sector:** Because UBER originally listed the information service industry as its business project, different from the actual operation. The government had required UBER to comply with the related regulations of business operation, taxation, and insurance in Taiwan for a long time.	**Public sector:** Because of the lack of vehicle management capabilities, vehicle damage, and illegal parking cases, there had been many cases of Obike being reported. The government was forced to consume a lot of administrative resources in the handling of its vehicles.
	Private sector: UBER's new type of vehicle dispatch service has negatively affected the operation of original taxi operators.	**Private sector:** According to Article 131 of the Traffic Safety Regulation[2]: "In places where bicycle parking facilities are not provided, bicycles may be parked in the same way as motorcycles, but not as heavy duty motorcycles", however, the fact that shared bicycles occupy parking spaces in metropolitan areas has made the existing problem of insufficient parking space worse, which induced backlash from the public.

[2] Traffic Safety Regulation：dao lu jiao tong an quan gui ze, translated by this research.

Table 2 Regulatory Amendments of UBER and Obike

Company Name	UBER	Obike
Regulatory Amendment	Value-added and Non-value-added Business Tax Act[3]	Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes[4] (Taipei City)
	Articles 77 and 78-1 of Highway Act[5]	New Taipei City Municipal Self-Government Ordinance on Removal of the Traffic-impeding Bikes[6] (New Taipei City)
	Regulations for Approval and Operation of Taxicab Transportation Service[7]	Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes [8] (Kaohsiung City)

[3] Value-added and Non-value-added Business Tax Act：jia zhi xing ji fei jia zhi xing ying ye shui fa, translated by Laws & Regulations Database of The Republic of China (Taiwan).

[4] Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes： tai bei shi gong xiang yun ju jing ying ye guan li zi zhi tiao li, translated by the research.

[5] Highway Act：gong lu fa, translated by Laws & Regulations Database of The Republic of China (Taiwan).

[6] New Taipei City Municipal Self-Government Ordinance on Removal of the Traffic-impeding Bikes：xin bei shi yi zhi bao guan fang hai jiao tong che liang zi zhi tiao li, translated by the research.

[7] Regulations for Approval and Operation of Taxicab Transportation Service：ji cheng che ke yun fu wu ye shen qing he zhun jing ying ban fa , translated by the research.

[8] Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes：gao xiong shi gong xiang zi xing che fa zhan guan li zi zhi tiao li, translated by the research.

In the beginning, to prevent UBER from impacting the taxi industry, the government strengthens its control toward UBER：

Central Regulatory Amendment：

1. Value-added and Non-value-added Business Tax Act

   Cross-border e-commerce shall apply for taxation registration and pay for the 5% business tax. To deter Uber from operating illegally in Taiwan, the Legislative Yuan amended Articles 77 and 78-1 of Highway Act to increase the fines for Uber and Uber drivers.

2. Regulations for Approval and Operation of Taxicab Transportation Service

   The behavior of "matching drivers and guests" that was not originally included in the terms is defined as "dispatching", so all relevant online taxi service providers must apply for a business license.

Local Regulatory Amendment：

1. Taipei City

   Based on Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes. The Bureau of Transportation has the power to determine the upper limit of the number of shared vehicles, the number of operations shall not exceed the permitted number, and royalty shall be paid to the municipal government.

2. New Taipei City

   Due to the chaos of Obikes, the New Taipei City Government has enacted the New Taipei City Municipal Self-Government Ordinance on Removal of the Traffic-impeding Bikes to deal with Obike vehicles that damage the city's appearance.

3. Kaohsiung City

   The Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes is the first autonomous regulation formulated for dockless shared bicycles in Taiwan, and some of the regulations are formulated for the development of shared bikes in the city.

For example, Article 8 stipulates that "the competent authority may order the operator to provide relevant information such as statistical analysis of riding data, self-management effectiveness, carbon footprint and carbon reduction calculation data, and the operator shall not refuse."

2.1.3 Regulatory Coherence： Taipei City versus Kaohsiung City

It can be found that the introduction of new technology has changed the existing transportation system in our lives, and the scope of its impact is wide. Ranging from individual travel behavior, and transportation operators' business models to regulatory amendment in the public sector, they are all potentially affected by new traffic patterns.

Among them, because the content to be discussed focuses on local governments, the similarities and differences in the attitudes adopted by various local governments when Obike was introduced are particularly worth discussing (this section discusses Taipei City and Kaohsiung City).

Taipei City Government：

Although shared bicycles had the advantage of being no bike docks, they were not completely cost-free for cities. The space used by shared bicycles was shared by citizens. In addition to the cost of pedestrian space, other tangible and intangible costs included the subsequent impact on the city's appearance and public complaints.

In response to the problem of a large number of illegal parking, Taipei City, which currently has more than 8,000 Obikes, launched Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes, which stipulated that the Transportation Bureau can announce the upper limit of the number of various transportation vehicles, and royalties shall also be paid.

Kaohsiung City Government：

Due to the immaturity of the city’s public transportation system, Kaohsiung City Government chose a different direction to introduce shared bikes. Instead of the upper limit, the shared bike is encouraged, and the royalties were also waived.

According to the National Statistics website, in 2016 (the year before the introduction of bicycles), there were 716 mopeds per 1000 people in Kaohsiung City, only second to

Pingtung County. Because the possession rate of mopes is high, reducing the dependency on cars and mopeds through shared bikes is the focus of promoting mass transportation.

For Kaohsiung City, which was actively developing green transportation, dockless bicycles were not only easier to dispatch than the current public bicycle CityBike, but the cost was also relatively lower. The director of the Transportation Bureau of the Kaohsiung City Government also said that the purpose of not charging royalties was to encourage the development of bicycle transportation. "Since Kaohsiung City is willing to build public bicycles, we hope that more people will use shared bicycles.", and the detailed differences are shown in Table 3.

Table 3 Municipal Governments' Position toward Shared Bike

City Name	Taipei City	Kaohsiung City
Time to introduce oBike	2017.04	2017.06
Self-Government Ordinance	Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes	Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes
Government Position	Effective Management	Aggressive Development
The Ratio of Private Transport (from the 2016 National Travel Survey)	42.8%	9.3%

Different contents can be found in the two cities' self-government ordinances：

1. Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes Article 6

   "Business operators who use the service area to provide shared transportation services should present an application to the Transportation Bureau, obtain the permission, sign the administrative contract for the servicing area, pay the royalty and deposit, and finish being designated to the certain serving area by the Transportation Bureau, so it can operate in accordance to the content of the permission." The part of the "royalty" mentioned in this section is not mentioned in the Kaohsiung City Municipal Self-

Government Ordinance on Development and Management of Shared Bikes, which only stipulates the part of the deposit.

2. Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes Article 8

   “the Bureau of Transportation shall publish the upper limit of all types of shared vehicles in the city”, and the Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes did not mention that.

3. Taipei Municipal Self-Government Ordinance on Business Operation of Shared Bikes Article 11

   “The Bureau of Transportation shall send personnel to inspect the use of service areas and the operating circumstances of shared vehicles and may require operators to provide relevant operational information. Operators must not evade, obstruct or refuse.”

   Although based on the Kaohsiung City Municipal Self-Government Ordinance on Development and Management of Shared Bikes, operators are also required to provide their operational information. Through reviewing Article 8 of the ordinance, clause like “The competent authority may order the operator to provide relevant information such as statistical analysis of riding data, self-management effectiveness, carbon footprint and carbon reduction calculation data, and the operator shall not refuse” can be found.

After comparing the two related ordinances, it can be noticed that the two local governments have different attitudes towards the introduction of Obike. This may also be the case when autonomous vehicles are introduced in the future, so this study will discuss this issue by examining the similarities and differences between different cities and inviting experts from different cities.

2.2 Autonomous Bus

2.2.1 Why Choose Autonomous Bus

In recent years, the problem of labor shortage in Taiwan's passenger transport industry has continued to be unsolved. This problem is also related to Taiwan's population structure. According to the National Development Council's 101st committee meeting's content, including population estimation of Taiwan from 2022 to 2070, the reduction of children, the aging society, and immigration, the three major areas are the areas the Taiwanese government is currently working on.

For the low-birth and aging parts, the population of young adults aged 15-64 reached a peak in 2015 and then declined year by year. When it comes to the population above 65, based on medium-variant projection, it will continue to grow until the year 2050. In short, the problems of labor shortage and the aging population will only become more and more serious in the future.

For the immigration (permanent residence) part, the government continues to consider "opening up foreign workers" as a potential solution to the above-mentioned problems. As shown in Figure 3, according to the information from the Ministry of Labor, the number of foreign migrant workers has now reached 700,000, and the contribution of foreign migrant workers has become an indispensable part of our economy. Even under these circumstances, the Ministry of Labor has also developed a "migration and long-term employment plan" in 2022, hoping to open more foreign workers to fill the labor force that is still lacking.

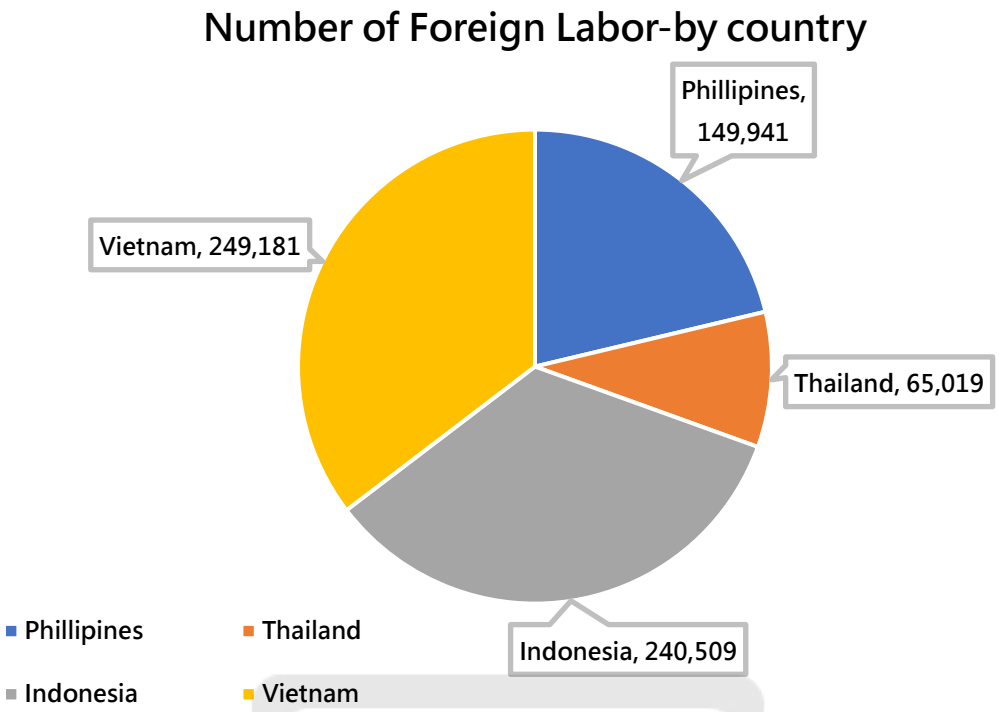


Figure 3 Medium-variant Projection for Taiwan Population

However, for the transportation industry discussed in this study, whether it is proper to open to foreign immigrants may need consideration, because the drivers of the passenger transportation industry need to contact passengers. If there were language or cultural barriers, it may affect the overall operation. When the MOTC recently invite bus operators to discuss the issue regarding the lack of workers in the transportation industry, whether to open pilots like the airline industry was also raised by some bus operators, which made the issue emerge.

Considering the fact that issues like demographic structure, lack of work, and the introduction of foreign drivers are not solved yet, the introduction of autonomous buses is seen to be a relatively feasible method.

On the other hand, if the actual technical aspects of the experimental cases listed in the Unmanned Vehicle Technology Innovation Sandbox are referred to, it can be noticed that the autonomous bus is a relatively feasible research direction.

2.2.2 Current Development of Autonomous Bus in Taiwan

Regarding the development of autonomous vehicles in Taiwan, the division chief of the Science and Technology Advisors Office of the MOTC, pointed out that “Taiwan is facing insufficient driving labor in bus operations, resulting in an insufficient service capacity in remote villages. If autonomous buses can replace human beings, it may be worthwhile for us to gradually focus on this.

However, there are also many public transport options. From this perspective, the current discussion is on the construction of smart roads, thereby improving the safety of operations, and then developing local self-driving industry technology. These will first focus on simpler types of bus lanes to try, and the small scope is relatively easy to handle, which can be used to formulate safety guidelines and verification methods for the development of autonomous buses in Taiwan so that it can get out of the regulatory sandbox.” (Taiwan Artificial Intelligence Wise Agent Network, 2022)

Regarding autonomous vehicle tests in Taiwan, according to the Unmanned Vehicle Technology Innovation Sandbox website of the Ministry of Economic Affairs (MOEA), created in compliance with the Unmanned Vehicles Technology Innovative Experimentation Act, various county and city governments have implemented their own autonomous bus experiments.

Although the main operators are currently dominated by the private sector, local governments still play a vital role in promoting autonomous buses, which have the essence of public transport. To meet the needs of local governments, the study tries to formulate a development strategy suitable to them so only the least social cost will have to be paid. The following Table 4 shows the ongoing experimental cases. Regarding the duration of experiments, in principle, the experimental period lasts for one year. The second year should receive permission from the authority.

Table 4 List of Autonomous Bus Innovative Experiments in Taiwan

Published Date	Applicant	Name of Innovative Experiment	Status Quo
112-02-01	Kingwaytek Technology Corporation Limited	Smart West Coast Expressway Self-Driving Operation Plan	In process
111-11-18	Kingwaytek Technology Corporation Limited	TSMC factory expansion autonomous vehicle connection plan	In process
111-07-22	Automotive Research & Testing Center	Changhua Lukang Autonomous Vehicle Team Public Transport Experimental Operation Plan	In process
109-11-10	Industrial Technology Research Institute	Hsinchu County High-Speed Rail Self-Driving Service Experimental Plan	Ended (1 year)
109-10-05	THI Consultants Inc.	Taichung Shuinan Field Self-Driving Bus Virtual and Real Integration Of Passenger Operation Test Plan	Ended (3 months)
109-05-22	TURING DRIVE INC.	Taoyuan Qingpu Area Self-Driving Bus Innovation Experimental Plan	Ended (2 years)
109-05-18	Kingwaytek Technology Corporation Limited	New Taipei City Autonomous Driving Electric Bus System Test Plan	Ended (1 year)
109-03-31	LILEE SYSTEMS CO., LTD.	Tainan City Autonomous BRT Operation Experimental Plan	Ended (2 years)
109-02-18	TURING DRIVE INC.	Taipei Xinyi Road Bus Lane Autonomous Bus Innovation Experimental Plan	Ended (2 years)
109-01-31	Kingwaytek Technology Corporation Limited	Changhua Lukang Autonomous Bus Sightseeing Shuttle Plan	Ended (1 year)

Source： the Ministry of Economic Affairs

2.3 Establishment and Maintenance of Roadside Infrastructure

2.3.1 Importance of V2X

The V2X (vehicle to everything) technology is expected to make autonomous vehicles run more stably. V2X mainly includes: V2V (Vehicle-To-Vehicle), V2I (Vehicle-To-Infrastructure), V2N (Vehicle-To-Network), and V2P (Vehicle-To-Pedestrian).

At present, the mainstream technologies for V2X (Vehicle to Everything) communication in the world includes DSRC (Dedicated Short-Range Communication), and C-V2X (Cellular-V2X). Taiwan has determined to adopt C-V2X (Cellular-Vehicle to Everything) instead of DSRC (Dedicated Short-Range Communication), and there are also related fields conducting experiments.

Thus, in addition to the device equipped on autonomous vehicles such as radar, lidar, or cameras, the connection with other devices (other vehicles, infrastructure, pedestrians et cetera) is also a part of the development of autonomous vehicles. However, certain parts of V2X still need to have market penetration to a certain extent before it can be effective (such as V2V). At present, V2I is a relatively common application.

2.3.2 Smart Road Classification (SRC)

As mentioned, to build a autonomous vehicle system, the connected units, especially infrastructures, should be carefully arranged. Hence, in the year 2021, PIARC (Permanent International Association of Road Congresses) published a report called “SMART ROADS CLASSIFICATION”, aiming to discuss the cooperation between vehicles and roads while introducing autonomous vehicle technology.

Based on the report, the study introduces some objectives and stakeholders mentioned, so that the competent authorities in Taiwan can have a preliminary understanding of the structure of the autonomous vehicle infrastructure.

Considering the variety of road facilities and connectivity capabilities to come, recent research projects have pointed out the necessity to explore a Smart Roads Classification (SRC) that helps CAVs and users know what to expect from the different road facilities. This information should range from road segments that do not support automation, to road

segments that will even be able to take control of thousands of vehicles at a time to optimize safety and performance in a cooperative way. Table 5 summarizes the objectives.

Table 5 Objectives of Smart Roads

Objective	Description
Safe, operational, and sustainable.	An SRC should increase road safety levels, either by presenting adequate geometry, signage, and pavement condition that prevents most disengagements or by sharing detailed information with connected vehicles.
Universal framework	An SRC should be fully compatible and could be used by any road facility, vehicle, and user.
Flexible	Given the fast technology evolution of Connected and Autonomous Vehicles (CAVs) and the vast road network, an SRC should be resilient to technological changes that affect how users interact with the infrastructure.
Robust and dynamic	To provide coherent information to users, adaptive to changing situations in real-time.
Simple and credible	An SRC should be an easy-to-use tool for all stakeholders, so they can easily interpret what to do. This does not mean simplicity in the data to be shared with vehicles
A fair share of responsibilities between all involved stakeholders	This is of special importance for Road Administrations and Operators, who should set an adequate Smart Road Level (SRL) and look for its maintenance. This SRL is merely informative, being road users responsible for performing accordingly to it and the automation capabilities of their vehicles.

Moreover, the report also lists smart roads' stakeholders, the most important ones are shown in Table 6：

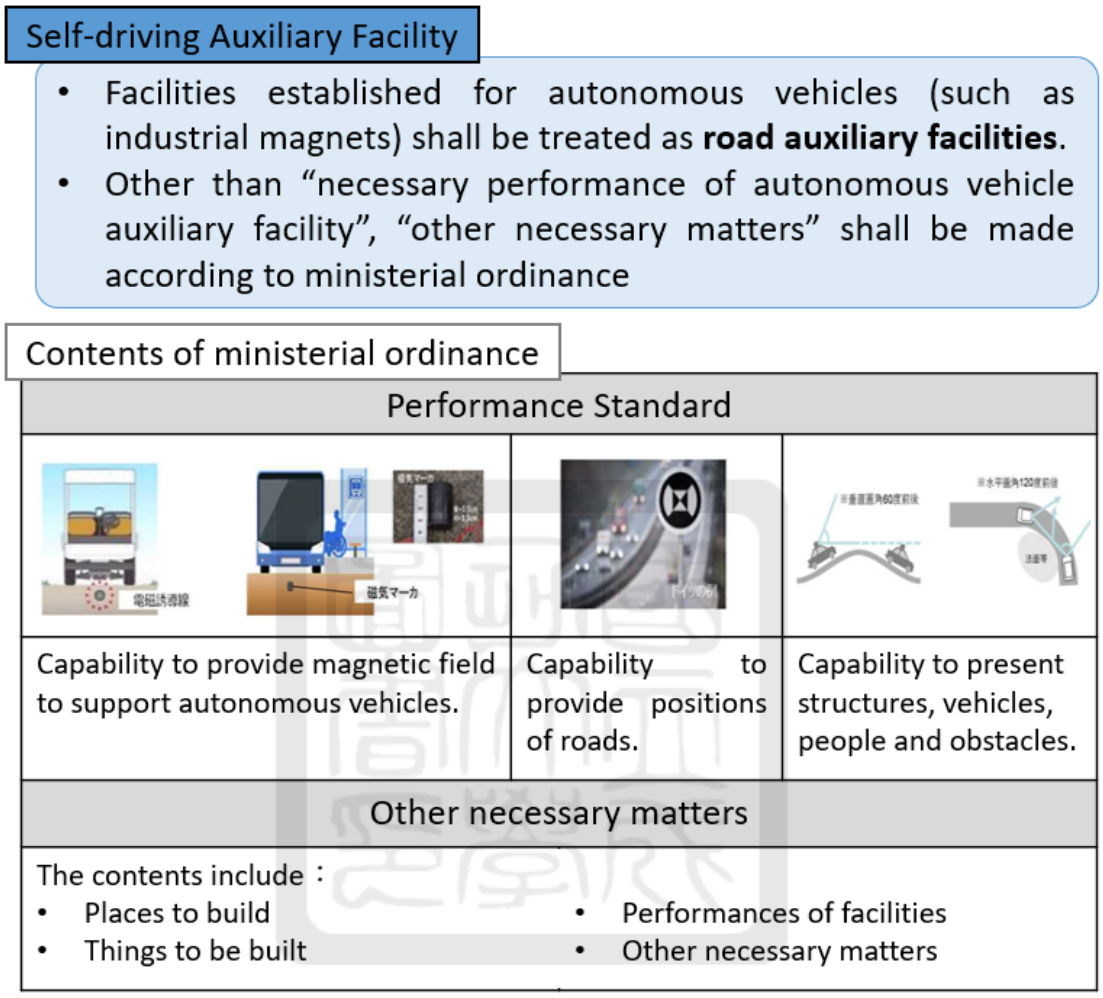
Table 6 Stakeholders of Smart Road

Stakeholder	Description
Road Administrations (RAs)	These own the road infrastructure and are usually in charge of the planning and investment of new facilities.
Road Operators (ROs)	They are in charge of traffic operation and safety management, ensuring adequate conditions for users.
Original Equipment Manufacturers (OEMs)	Automakers and their suppliers (TIER1s) are working hard to expand the capabilities of CAVs. These capabilities are evolving fast and would be gradually expanding where automated vehicles can operate.
Mobile Network Operators (MNOs)	These stakeholders are the providers of wireless connectivity that could serve as a basis for C-V2X communications.
Users	These are the most important agents because they will interact along the road facilities. Tailored information regarding infrastructure and vehicles should be provided to them.
Information Management Providers (IMPs)	Once Digital Infrastructure is available and connected vehicles become a reality, a lot of information related to performance and road maintenance will be shared. There is a necessity to collect, process, and share this information with adequate stakeholders. Information Management Providers cover the stakeholders that will intervene in this process.

The above content envisions the cooperative operation between an autonomous vehicle and infrastructure with the objectives and stakeholders. Subsequently, the following section introduces the practical instance in Japan, in the hope that the neighboring country's advanced legislation can be referred to motivate the autonomous vehicle infrastructure development in Taiwan.

2.3.3 Current V2X Development of Japan

Figure 4 is a schematic diagram of the policy directions of the Ministry of Land, Infrastructure, Transport, and Tourism of Japan.



Source： the Ministry of Land, Infrastructure, Transport, and Tourism

Figure 4 Infrastructure of AVs Mentioned by the Japanese Government

Compared with other countries, Taiwan has not yet revised the regulations regarding the roadside facilities with the function of V2X. If Japanese regulations are referred to, the government has revised Road Traffic Act. Article 2-5 defines auxiliary facilities for the autonomous vehicle; in Article 32, the facilities are allowed to occupy roads; in Article 45-2, the Ministry of Land, Infrastructure, Transport, and Tourism, equivalent to the MOTC of our country, is empowered to define the performance of auxiliary facilities for automatic

driving and in Article 76, it regulates the "road managers" need to report the performance of automatic driving assistance facilities to the higher authorities.

Among them, Article 76 of the Road Traffic Act stipulates the obligation of notification at different levels of government (cities, towns, and villages must report to the prefectures; prefectures must report to the Ministry of Land, Infrastructure, Transport, and Tourism), and the fact that all levels of governments are responsible for the construction of roadside equipment can be understood.

Article 2 of the Highway Act in Taiwan, includes national highways, provincial highways, city highways, county highways, district highways, and country highways, among which, except for national highways and provincial highways, the rest are mostly managed by municipal highway competent authorities or county (city) highway competent authorities.

If we compare it with the road level in Japan, it can be understood that if Taiwan formulates the law of roadside facilities for autonomous vehicles in the future following the legislative context of Japan, the local government will play an extremely important role. To better understand the comparison of the competent authority in the two countries, Table 7 can be referred to.

The above content is about the legal specification and responsibility of supervision pertaining to autonomous vehicles. On the other hand, in terms of the financial aspect of the construction of auxiliary facilities, certain contents were also legislated to promote the future construction of auxiliary facilities of an autonomous vehicle with a “none-interest loan”, which is also the policy direction of our government can also consider whether to follow.

Table 7 Comparison of Competent Authority for Each Road Level

<table>
<tr><th>Country</th><th colspan="2">Taiwan</th><th colspan="2">Japan</th></tr>
<tr><td rowspan="3">Road Level and Competent Authorities</td><td>National Highways, Provincial Highways</td><td>Central Highway Authority</td><td>Expressway</td><td>The Ministry of Land, Infrastructure, Transport, And Tourism</td></tr>
<tr><td>City Highways, District Highways</td><td>Municipality Highway Authorities</td><td rowspan="2">To-Dou-Fu-Ken (Highway)</td><td rowspan="2">To-Dou-Fu-Ken</td></tr>
<tr><td>County Highways, Country Highways</td><td>County (or City) Highway Authorities</td></tr>
<tr><td>Legal Source</td><td colspan="2">Highway Act Article 6
Urban Road Act Article 4[9]</td><td colspan="2">Highway Act (Japanese)[10]
Articles 5, 7, and 8</td></tr>
</table>

Source： the Ministry of Land, Infrastructure, Transport, and Tourism

2.3.4 Current V2X Development of Taiwan

Not like Japan, the Taiwanese government has not legislated auxiliary facilities of autonomous vehicles. However, discussions about related topics have been brought up by various government agencies.

According to MOTC in Taiwan, smart road refers to the road as the main body, the data as the core, and the service as the purpose, and through the collection, analysis, release, and collaboration of road data, a new generation of roads with the purpose of providing smart services for passers-by is realized.

The study cites the report of Cross-domain Data Governance Service-Taiwan's Smart Road Early Research on Digital Development (2021) from the Taiwan Telematics Industry

[9] Urban Road Act：shih cyu dao lu tiao li, translated by Laws & Regulations Database of The Republic of China (Taiwan).

[10] Highway Act (Japanese Law)：translated by this research. source: https://elaws.e-gov.go.jp/.

Association (TTIA), which depicts the current development in the world and Taiwan, the application and inspection, preliminary discussion on operation specification, instances of smart roads, big data information management, and the blueprint of Taiwan.

Among, because the topic of this research is autonomous vehicle-related issues, this section will mainly explore the distinction of relevant policies in Taiwan and present what autonomous vehicle-related efforts and blueprints have been done by different government agencies in Taiwan.

With the development of AI, intelligent traffic systems, and marginalized arithmetic systems, AI-based expert experience will emerge, and real-time computing on roadside equipment will be used to tackle real-time mixed traffic flow and road conditions to help provide people, slow cars, cars, and autonomous vehicles with correct understanding and judgment. And features, such as low latency, higher capacity, and increased bandwidth, of 5G technology is the foundation of the above objectives.

As mentioned, when it comes to the “smart road” in Taiwan, the road is the main body. Hence, the following smart road classification mainly focuses on calculating capability from roadside infrastructures.

Table 8 Smart Road Dervices Recommendations

Level	Degree of intelligence	Explanation	Network Transmission	Roadside AI
5	Fully intelligence	The road has comprehensive vehicle-road-cloud collaboration on the road and real-time transmission of intelligently analyzed information to provide the best mobile decision-making suggestions for passers-by.	5G	Yes
4	Highly intelligence	The road can transmit real-time detection and processing information to passers-by.	4G/5G	Yes
3	Moderate Intelligence	Roads can provide raw or processed information to passers-by.	4G	Yes
2	Partial Intelligence	The road can stably collect the original or processed information required by the traffic application service.	wire/wireless	Yes
1	Preliminary Intelligence	The road uses traffic control facilities to guide passers-by and stores digital information of traffic control facilities.	None	No
0	No intelligence	There are no traffic control facilities on the road, only for pedestrians and vehicles.	None	No

Source： Taiwan's Smart Road Early Research on Digital Development (2021)

When it comes to the current policies about smart roads in Taiwan, though policies or programs might not be exclusively established for connected vehicles or autonomous vehicles, with the successful promotion of these relevant programs, they might be beneficial for the future development of V2X technology.

1. ITS (MOTC)

   In 2021, MOTC promoted the Intelligent Transportation System Development and Construction Plan (2021-2024), attempting to upgrade transportation services and boost the transportation industry.

   Though as early as the 2017-2020 plan, autonomous vehicle was one of the six highlights of the plan, the 2021-2024 plan still include the new technology. Several goals of the new plan contain positioning smart traffic data technology and services, developing the digital infrastructure of the national core road network, combining AI

with traffic applications, and creating an experimental field for innovative traffic technology.

2. HD Maps (Ministry of the Interior, MOI)

   According to High-Definition Maps Research Center in Taiwan, High-definition maps (HD map) refer to static basic base map data, which provide reliable and robust environmental information for the operation of autonomous driving technology. Hence, MOI set up the research center and started boosting the HD maps, paving the foundation of autonomous vehicle development in Taiwan.

3. Smart Electric Bus (MOEA, MOTC)

   On the other hand, the Industry Development Bureau of the Ministry of Economic Affairs and Director General of Highways of the Ministry of Transportation and Communications also have Smart Electric Bus DMIT Plan.

   Based on the plan, cooperation between the electric bus key system and vehicle, construction of a solid-state battery intelligent trial production line, and creation of innovative mobile services for smart self-driving roads are all included. Though autonomous vehicle or connected vehicle may not be the main reasons to develop the program, the establishment of auxiliary facilities of autonomous vehicles can often be found in these programs.

4. 5G Smart pole (MOEA)

   Finally, the Bureau of Standards, Metrology, and Inspection of MOEA also presents the 5G Smart pole system technical specification. 5G Smart Pole is an IoT pole that consists of a streetlight as its hardware, IoT devices with different functions, and an intelligent network interface with 5G communications protocol. (Tung et al., 2022) From the viewpoint of the development of autonomous vehicles, it can be regarded as a necessary auxiliary facility. To sum up, Table 9 summarized the ongoing smart road-related policies in Taiwan.

Table 9 Smart Road-related Policies in Taiwan

Bureau	Name of Program or Specification
MOTC	Transportation System Development and Construction Plan (2021-2024)
MOI	High-Definition Maps Research Center
MOEA & MOTC	Smart Electric Bus DMIT Plan
MOEA	5G Smart pole system technical specification

2.4 Transformation of Parking Forms

Because autonomous vehicles have automatic parking, automatic parking space searching, and other characteristics, people in the future might have a chance to be rescued from the anxiety of parking space searching. From "decreased time cost of user", and "transforming of the method to find parking space" to "parking space design of parking lot provider", the above parking characteristics of autonomous vehicles will have a tremendous impact on modern society.

According to the estimation of Audi Group's Urban Futures Initiative, before 2030, autonomous vehicles are expected to save 60% of parking space. Such a huge change in spatial planning may even have a chance to cause the change of urban planning of local governments (Audi MediaCenter, 2010).

In the existing laws and regulations, Article 30 of Parking Facility Law[11] states that "the competent authority of the municipality, county (city) shall designate a special unit for the planning, construction, operation management and parking violation inspection of parking lots", so it can be understood that in terms of the operation of the parking lot, local governments are the actual competent authority.

[11] Parking Facility Law：shih cyu dao lu tiao li, translated by Laws & Regulations Database of The Republic of China (Taiwan).

For example, the Taipei City Government has formulated the Taipei City Parking Lot Business Registration Regulations[12] in accordance with the authorization of the Parking Facility Law and stated in Article 2 that the competent authority is Taipei City Parking Management and Development Office. Therefore, if one wants to discuss the parking issues derived from autonomous vehicles, it is more appropriate to take the positions of local governments as the starting point.

2.4.1 Decreased Time Cost of User

"User time cost-saving" mainly refers to the cost that the self-driving system can save due to the automatic parking function. In the past, it took extra time to park on the roadside or in the parking lot, but when self-driving technology is maturely developed, this time cost can naturally be saved. Among them, it should be paid attention that the time cost varies city by city.

According to “2018 Q3 China Major Cities Traffic Analysis Report”, it can be observed that if the “economic situation (average salary per person)” is included, congestion cost would be different, and cities with higher economic development tend to have higher congestion costs; even when considering the ratio of congestion costs to monthly average wages in different cities, the more developed cities generally face higher congestion costs, which is indicated by Figure 5 and Figure 6. (Traffic Analysis Report of Major Cities in China, 2018)

[12] Taipei City Parking Lot Business Registration Regulations：tai bei shih ting che chang ying ye deng ji ban fa, translated by the research.

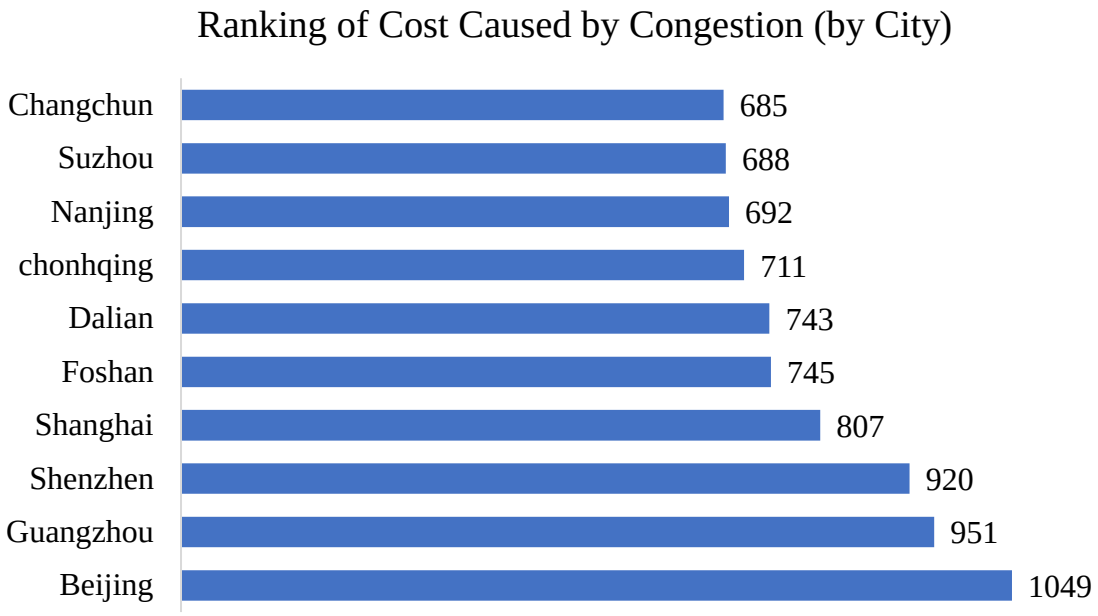


Figure 5 2018 Q3 China Major Cities Traffic Analysis Report (1)

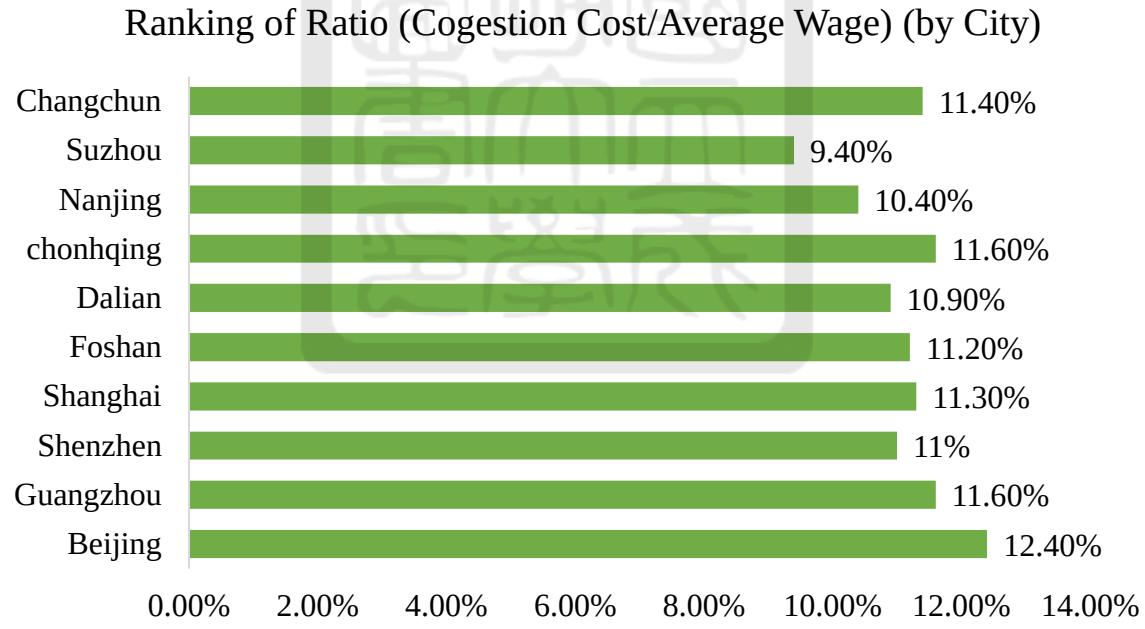


Figure 6 2018 Q3 China Major Cities Traffic Analysis Report (2)

Therefore, in the future, when discussing the automatic parking system of autonomous vehicles (reducing the time to find a parking space) or other functions that can reduce the travel time of users, it can be reasonably estimated that different cities will be affected by

their own economic conditions, therefore, different levels of promoting efforts can also be expected.

To explore local governments' different motives toward the promotion of the autonomous parking system, this study refers to Tom Tom's TOMTOM Traffic Index Ranking 2021, which includes the data collected in 58 countries and 404 cities around the world. Among them, Taiwan has five cities in this ranking (the number is the ranking of congestion), namely Taipei (40), Taichung (51), Kaohsiung (65), Taoyuan (71), and Tainan (82). The study integrates "Time lost per year induced by congestion" from the survey with the data of the "Statistics on the Salary of Employees employed by Industrial and Service Enterprises" published by the Directorate-General of Budge, Accounting and Statistics, as shown in Table 10, to calculate the congestion cost of main cities in Taiwan.

Table 10 Taiwan Main Cities' Congestion Cost Ranking

City and county	Time wasted by congestion (hour/year)	Average Salary (ten thousand dollars/year)	Congestion Cost (dollar/year)	Ranking
Taipei City	80	86.3	7881.2	1
Taoyuan City	71	67.7	5487.1	2
Taichung City	78	59.1	5262.3	3
Kaohsiung City	73	61.9	5158.3	4
Tainan City	69	61.3	4828.4	5

2.4.2 Transformance of the Method to Find Parking Space

Regarding the "transforming of the method to find parking space" brought by autonomous vehicles, some studies have pointed out that, compared with the traditional methods of "finding along the way" or "stop and wait", "parking to spaces designated" are the most effective way, which should be considered as a priority.

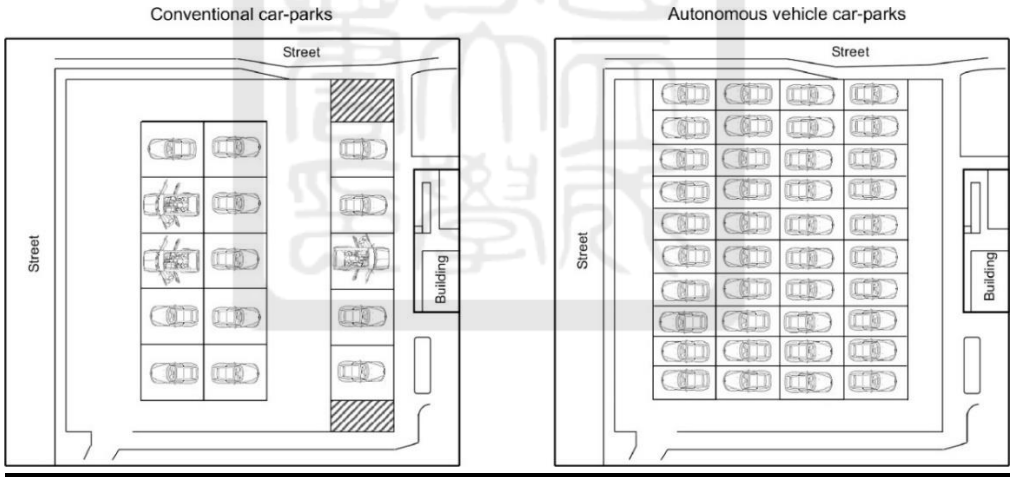
In addition, "designated parking spaces" here can only be achieved in combination with roadside equipment. Regarding the maintenance of roadside equipment and related issues, the content is in section 2.2.

However, some literature also pointed out that if the parking fee in a city is relatively expensive, users of autonomous vehicles may use the cruise to avoid parking fees in the future (Shafiei, 2023), which might increase the possibility of traffic congestion. and there are also practical difficulties to prohibit the cruising of vehicles. Currently, the collection of congestion fees should be a more feasible means.

2.4.3 Parking Space Planning of the Parking Lot Provider

Regarding the "parking space planning of the parking lot provider", it can be said that the layout of the parking lot would be changed to a more efficient version, including the original elevator built for car users or the extra parking space designed for parking vehicles.

For example, most of the past parking lots are shown on the left side of Figure 7. To facilitate people getting on and off, there needs to be a certain space between cars, but with the development of autonomous vehicles, the pattern of such parking lots may no longer exist. The replacement one will be a parking lot enabling vehicles to be parked closely, on the right side of the picture (Nourinejad, 2018).



Source：Nourinejad (2018)

Figure 7 Image of Future Parking Lot Layout

Different cities promote autonomous vehicles with different extents of endeavors because of their economic development. The space planning of the parking lot mentioned here may also be the same. Although it has the effect of saving a certain amount of land for the existing parking lot, due to the economic development and land value of different cities, the promoting intention of different local governments for this will also be different.

As mentioned above, although in general, the relevant policies of local governments may vary due to their own economic conditions, through the introduction of autonomous vehicles and efficient parking, in addition to increasing the capacity of the parking lot, the land saved can also increase the developable space for the city and create more possibilities for future urban planning, so the issue should still be paid attention.

2.5 Financial Burdens and Urban Planning of Local Governments

Article 3 of Urban Planning Law has a certain description of the word “urban planning”： “Within a certain range, facilities relevant to the economy, transportation, hygiene, security, national defense, culture, education, and recreation shall be planned, developed and rationally scheduled.”

And in Article 5, “The urban plan shall be formulated based on the current and past situation, and the development situation within twenty-five years shall also be considered." Considering the significant impact of autonomous vehicles on today's society, the study believes that it is necessary to discuss the induced issues of urban planning and financial urban from the viewpoint of local governments.

If we view it in chronological order, the changes faced can be roughly listed as the following： the decline in parking demand, the congestion problem of the city center, the loss of value of the parking lot built by local governments with debts, and the new opportunity of urban planning formed due to the release of land. And the study divided the above contents into the following three sections.

2.5.1 Decreasing Parking Demand and Congestion

First, the introduction of autonomous vehicles will reduce the parking demand in many urban areas (near destinations), or even eliminate this demand completely. Replaced behaviors will be “finding free parking spaces elsewhere”, “returning to home” or “auto-cruise”, because the cost of these behaviors is lower for the car owner. Some studies used models like the traffic microsimulation model built in downtown San Francisco to conclude that though the introduction of autonomous vehicles will approximately reduce the parking cost by 90%, it also increases the traffic flow by more than two times, which may cause congestion.

In terms of policy, subsidizing “peripheral parking” may be a way to reduce the congestion in the city center, but in the era of autonomous vehicles, this may make the driving cost even lower, so the current existing studies still suggest the congestion charging should be conducted in the city center. Millard-Ball (2019) pointed out that because autonomous vehicles blur the concept of parking and travel, the charging should be classified as "time in the area", "travel distance" or "vehicle energy consumption" as the bases of calculation.

However, the above propositions may vary city by city. For example, if the cost of parking in the city center is already low, for vehicle owners, the motivation to choose to let their autonomous vehicles return to their residence or auto-cruise might be erased, and the above situation is less likely to occur.

2.5.2 Financial Burden

The effect caused by the reduction of parking demand cannot be ignored, especially when the original parking space is changed to other uses, and the existing operation mechanism of the city may be affected.

Although the commercial facilities to be rebuilt in the future may be beneficial to local taxation anyway, the current stage still needs to consider the risk of existing buildings being the idle result of the decreasing demand for parking, which might become a financial burden for local governments (Clerk et al., 2017).

In Taiwan, when local governments build local parking lots, in addition to self-construction and self-operation, the most common construction method is to build in accordance with the BOT and OT cases regulated by the Act for Promotion of Private Participation in Infrastructure Projects[13].

According to the website of the Promotion of Private Participation, Ministry of Finance (MOF), shown in Table 11, between April to September (2022) alone, at least seven local governments have built parking lots in this public-private partnership.

[13] Act for Promotion of Private Participation in Infrastructure Projects：cu jin min jian can yu gong gong jian she fa, translated by Laws & Regulations Database of The Republic of China (Taiwan).

Table 11 The List of Cases Built with PPP Relationship

Item	Project Name	Authority in Charge	Planning Approach	Date of Submission to MOF
1	The operation transfer case of three-dimensional parking lot on Gongan Road, Huwei Town	Yunlin County Government	Government-planned projects-invitation to Tender	2022/09/23
2	The BOT Project of Parking Tower (Parking Lot No.3) in Zhongli District, Taoyuan City	Taoyuan City Government	Evaluation Result-Unsolicited proposal with government land	2022/05/13
3	The BOT Project of Parking Tower (Parking Lot No.4) in Zhongli District, Taoyuan City	Taoyuan City	Evaluation Result-Unsolicited proposal with government land	2022/05/13
4	Xinzhuang Fuduxin Station Green Energy Public Parking Lot and Electric Bus Dispatching and Charging Station	New Taipei City Government	Evaluation Result-Unsolicited proposal with proponent land	2022/05/05
5	Taoyuan City Zhongli District Zhongli Parking Lot No. 3 Multi-purpose Building BOT+OT Project	Taoyuan City	Government-planned projects-invitation to Tender	2022/04/22
6	Operating the Underground Parking Lot of Taichung City Government Park	Taichung City Government	Government-planned projects-invitation to Tender	2022/04/15
7	The BOT Project of the Second Parking Lot in National Taipei University Special District	New Taipei City	Government-planned projects-invitation to Tender	2022/04/06

In recent years, with the Special Act for Forward-Looking Infrastructure[14], local governments have started to obtain the subsidy from the "Urban and Country Development-Parking Problem Improvement Plan" since 2017. Besides, among the clauses, related contents pertaining to the BOT and OT, even the citation of the Act for Promotion of Private Participation in Infrastructure Projects are all included.

Therefore, this study intends to discuss whether the impact of the introduction of autonomous vehicles can be properly considered while parking lots are under construction. Guidelines and Procedures regarding Grants for the “Urban and Country Development-Parking Problem Improvement Plan” are a vital reference to explore the above-mentioned funding, which can be divided into the “overall and feasibility assessment” and “engineering construction”. The former is handled by the local government, the latter adopts the form of a Competitive Grant Program.

The Competitive Grant Program, Zhu (2010) defines as： For policies or plans with funds provided by the central government, willing executors will propose plans through certain procedures. After an open professional selection process, differentiated subsidies will be given to the qualified ones, and the policy or plan will be implemented by the recipients.

This program adopts the form of a Competitive Grant Program, and local governments are supposed to submit applications to the competent authority. Then, the applications will be reviewed by the review and coordination group. The review and evaluation principles include the following items:

1. Whether one of the priority subsidy conditions is met.
2. The ratio of project funds that require central subsidy.
3. Whether there are other off-street public parking lots within 500 meters of the surrounding area, and if so, the parking rate.
4. Those concretely combining the urban and rural construction projects, such as the construction of the heart of the town, the construction of cultural life circles, and the

[14] Special Act for Forward-Looking Infrastructure：qian zhan ji chu jian she te bie tiao li, translated by Laws & Regulations Database of The Republic of China (Taiwan).

"communitization" of campuses, can have priority to be supported, but still need to evaluate and confirm the parking demand in the area to avoid idle parking lots.

It can be seen from the above-mentioned review that the central government has formulated a series of reviewing items to measure future operation of it, it would be more precise if the influence of autonomous vehicles can also be considered.

Compared to off-street parking lots (according to the Parking Facility Law, it refers to a ground, garage, mechanical, or tower-style parking system that is established off the street for parking), the lower sunk cost of the curb-side parking means the financial uncertainty for local governments is not that high. However, the point should also be reviewed, so that everything which might be influence by autonomous vehicles can all be considered.

The maximum subsidy ratio of the proposed case is as follows: Table 12 is based on the latest "financial resources and sub-subsidy ratios of each local government" (only the none-self-financing part will be subsidized)：

Table 12 Percentage of Subsidy from Central Government

Level of Financial Resources	City	Built by civil sector	Built by local governments
Level 1	Taipei City	40%	35%
Level 2	New Taipei City, Taoyuan	73%	68%
Level 3	Taichung City, Tainan, Kaohsiung City	82%	77%
Level 4	Yilan County, Changhua County, Nantou County	84%	79%
Level 5	Miaoli County, Pingtung County, Taitung County	88%	83%

Hence, although the parking-related issues are mainly the responsibility of the local government, it cannot be said that it has nothing to do with the central government.

2.5.3 Urban Planning

In addition to parking space, the introduction of autonomous vehicles in a city may also bring other space savings to the city. Lee et al. (2022) divided the urban element design issues related to autonomous vehicles into “urban road space”, “public space” and “new facilities related to autonomous vehicles：

As shown in Table 13, the necessary width of the street itself is expected to be reduced to provide more opportunities for urban planning, and the saved lanes can be transformed into sidewalks or green infrastructure to enhance the pedestrian environment. Regarding new facilities, research has also pointed out that the existing parking lot might become a place for passengers to get on and off.

Table 13 Image of Urban Planning Induced by Autonomous Vehicles

Components	Description	Specifications
AV-only road	Roads restricted to autonomous vehicle usage only	Lane width: 3 m or less
AV/HV road	Roads for mixed usage (autonomous and regular)	Lane width: 3-3.25m
HV-only road	Roads restricted to regular vehicle usage only	Lane width: 3-3.25
AV pick-up/drop off area	Pitstop to pick up and drop off (shared) AV passengers	Lane width: 2 m
Intermodal transit Station	Station for intermodal transit between AV and public transportation	Island platform, transit shelter

Source：Lee et al. (2022)

2.6 Cities Selected

2.6.1 Variety of Local Governments in Taiwan

In Taiwan, there are 22 subnational divisions (local governments). Among them, 6 of them are municipalities, 11 of them are counties, 3 of them are cities.

With different economic conditions, traffic situations, or even administrative divisions, it would be necessary to present some features of different cities so that future local governments can better envision the feasible application of autonomous vehicles in their cities or counties. Besides, to observe local governments' attitudes on the development of autonomous vehicles, those with autonomous buses cases held are prioritized.

Hence, three cities were selected, which included New Taipei City, Changhua County, and Tainan City. Based on National Statistics and Ministry of Transportation and Communications, Table 14 indicates some information of those cities or counties selected. It can be noticed that even if the same technology of autonomous vehicles is introduced, those cities selected might have their own development strategies based on their own needs.

Table 14 Basic Information of Local Governments Selected

City Name	New Taipei City	Changhua County	Tainan City
GDP per capita (ten thousand Taiwanese dollars)	63.7	51.8	61.3
Municipality (Y/N)	Y	N	Y
Market Share of Public Transport (Stages of Transport)	28.7%	4.7%	4.8%
Autonomous Bus Test (Y/N)	Y	Y	Y
Main Purpose of Autonomous Bus	Last Mile Transport	Tourism & Supplement of Public Transport	Supplement of Public Transport

2.6.2 Efforts Done by Local Governments

Based on the Ministry of Economic Affairs, the three cities and counties selected all have experience developing autonomous bus tests, as shown in Table 15.

Table 15 Selected Local Government and Experiments Launched

Published Date	Name of Experiments	Location
111-11-18	TSMC Factory Expansion Autonomous Vehicle Connection Plan	Tainan City
111-07-22	Changhua Lukang Autonomous Vehicle Team Public Transport Experimental Operation Plan	Changhua County
109-05-18	New Taipei City Autonomous Driving Electric Bus System Test Plan	New Taipei City
109-03-31	Tainan City Autonomous BRT Operation Experimental Plan	Tainan City
109-01-31	Changhua Lukang Autonomous Bus Sightseeing Shuttle Plan	Changhua County

In New Taipei City, the local government has made use of C2X to develop autonomous electric buses. Subsidized by the central government, New Taipei City launched an a-hundred-million-dollar program called “Smart Driving Electric Bus: Multi-Vehicle Service Test Operation Plan (also called second-phase plan)”, with two autonomous vehicles, the length of 2.8 kilometers and 5 stops.

Connecting the surrounding large-scale shopping malls of Danhai New Township and providing shuttle services to the nearby large communities to improve the last mile transport service, the second phase aims to establish a 5G connected vehicle test site, integrating with “Danhai New Town Smart Transportation Field Experimental Research Project” of the Ministry of Transportation and Communications.

In Changhua County, Changhua Lukang Autonomous Bus Sightseeing Shuttle Plan was the first autonomous bus in Taiwan. Based on the website of the Changhua County government, the project could be regarded as a “pioneer” from several perspectives,

including high domestically made rate, the first autonomous vehicle test applied through Unmanned Vehicle Technology Innovative Experimental Act, and the autonomous vehicle test with the longest distance.

On the other hand, Changhua Lukang Autonomous Vehicle Team Public Transport Experimental Operation Plan served as a supplement for the existing public transport, aiming to deploy public transport into those fields with not enough labor force.

In Tainan City, aside from the Tainan City Autonomous BRT Operation Experimental Plan and TSMC Factory Expansion Autonomous Vehicle Connection Plan, which aimed to strengthen the capacity of public transport, the city government also built roadside infrastructures in Tainan Science Park and Shalun.

To achieve so, Tainan City received a subsidy of 20 million from the Ministry of Transportation and Communications and raised 3.6 million to build smart road infrastructure. The infrastructures built included 2 blind spot detection systems, 4 real-time signal control, and the deployment of 13 optical fiber private networks and radio communication equipment with stable and fast transmission signals to verify autonomous driving and smart vehicle technologies.

2.6.3 Future Challenges for Local Governments

The study received some first-hand information from the Transportation Department of New Taipei City Government, the Department of Traffic Affairs of Changhua County, and the Bureau of Transportation of Tainan City Government.

These insights should be highly valued, because they are some of the earliest insights when it comes to the position of local officials on the development of autonomous vehicles. Among them, insights of officials from New Taipei City and Changhua County are collected after consulting with local officials, and insights of officials from Tainan City are from the focus group interview.

Moreover, though Kaohsiung City has not put so much effort to develop the technology of autonomous vehicles, the city's position on the issue is still presented because the local official from the city commented on the issue. Table 16 indicates some upcoming challenges pointed out by these local officials.

Table 16 Challenges Provided by Different Cities' Officials

New Taipei City	● The weight of autonomous vehicles is significantly higher than that of human-driven vehicles, which will require a reassessment of the structural load of parking facilities when densely parked. This will further increase the cost of future parking facility renovations and refurbishments. It is expected that autonomous vehicles will have significantly shorter parking times than fuel vehicles. However, the costs of managing these facilities are difficult to shift onto the owners of human-driven vehicles. Local authorities in the future will face challenges in adjusting the parking fee structure in parking lots. ● As autonomous vehicles continue to increase and gradually replace fuel vehicles, the demand for parking spaces will become fragmented and decentralized. The previous urban planning control measures and legally designated parking spaces in urban areas have already struggled to meet the current demand. In the future, autonomous vehicles will only require smaller urban spaces for parking and charging, as well as more dispersed high-capacity charging needs. The challenge lies in aligning future urban planning control measures with this trend.
Changhua County	● The current tests are all conducted in restricted areas for development and trial operations. Research institutions can proactively propose operational regulations for autonomous vehicles, which can serve as a general version of legal norms for various cities and counties. This will allow local governments to amend relevant local regulations according to their specific circumstances. ● Due to the generally tight financial situation of local governments, they are not proactive in seeking funding for autonomous vehicles issues. It is only after the maturity of autonomous vehicles regulations and technology, as well as the availability of affordable options in the market, that further planning and adoption will be considered.

Tainan City	● Further data or research findings are needed to support the study on the potential increase in localized trips and congestion caused by private autonomous vehicles. However, if policies solely focus on imposing congestion fees or entry fees for autonomous vehicles, it may conflict with the existing cultural and usage habits in Taiwan. This approach could have a detrimental impact on the promotion of autonomous vehicle policies. ● If private autonomous vehicles are widely deployed, they could potentially displace public transportation and exacerbate existing urban traffic congestion. This is especially true in Taiwan, where the usage rate of motorcycles is high. The interaction between motorcycles and autonomous vehicles in urban areas could have mutual impacts.
Kaohsiung City	Technical Challenges: ● Development and positioning of autonomous vehicle technology ● Interdisciplinary collaboration and expertise ● Patents and verification Infrastructure Development: ● High-definition maps ● Roadside equipment and communication networks ● Digital management platforms Public Awareness and Acceptance: ● Improving public acceptance ● Guiding the positive impact of autonomous vehicle on transportation ● Protection of personal information and privacy ● Ethical considerations Service Aspects: ● Integration of autonomous vehicle into public transportation or shared mobility ● Autonomous vehicle services oriented towards Mobility as a Service Regulatory Challenges: ● Compliance with domestic and international standards for connected vehicles ● Compliance with autonomous vehicle verification criteria ● Adherence to cybersecurity guidelines

CHAPTER 3 METHODOLOGY

3.1 Document Analysis

Document Analysis is a research method utilizing the collection of relevant market information, report, or industry dynamics based on certain research purposes or subjects to comprehensively master the research topic. Collected content ought to be ample and broad, so they can be analyzed and organized by their courses, reasons, backgrounds, and meanings afterward. The documents selected can be governmental reports, industry research, document database, corporate data, book in the library, dissertation, periodical, or news article. Four steps included “reading and organizing”, “description”, “classifying”, and “interpretation”.

Owing to the fact that the exploring issues are those induced by autonomous vehicle technology, we need to take its consistent change into consideration. Two main directions of the study whiling collecting literature are “scientific development” as well as “legal system and policy”.

As mentioned in previous chapters, issues regarding local government and regulatory coherence, autonomous buses, maintenance of roadside infrastructure, transformation of parking forms, financial burdens of local governments, and urban planning are explored. Examination of domestic and international legal systems and evaluation of current technological influences are both considered as targets of references within the methods of document analysis.

3.2 Comparative Research

The research methods of comparative education mostly use the “comparative” method to discuss educational phenomena and systems. In the academic world, the comparative method is usually widely used in the following fields, including linguistics, political science, public policy, sociology, medicine, engineering, law, and even architecture. They can all be discussed from a "comparative" perspective (Chou, 2008).

There is no fixed model for the use of comparative research methods, but there are still many scholars who often refer to the four-stage operation model of Berryday's "Comparative Method in Education" to description, interpretation, juxtaposition and comparison. The

following explains the four stages of the comparative study. (National Institute of Education, 2012)

1. Description

   The purpose of the complete description of the research object at first is to ensure the researchers have correct and objective understanding of the research target by systematically stating the related information of the research objective. Three types of data, primary data, secondary data and auxiliary data are included to carefully narrative the research target.

2. Interpretation

   Next, the researcher should explain the research target, which means to have a further understanding of the causes, meaning and influence of various phenomenon. The researcher often needs to comprehend the historical courses then analyze and explain them. The correctness and objectivity of the interpretation are related to the interpretation viewpoint adopted by the researcher and the extent of understanding of the background of the problem.

3. Juxtaposition

   The third stage is to juxtapose and graph the data collected from the descriptions and interpretations of the first two stages. In order to prevent researchers from making incorrect comparisons, it is necessary to emphasize the analysis and judgment from the same point of view based on common facts and problems. Juxtaposition has two purposes. One is to find out the similarities and differences according to the same standard, one is to establish research hypotheses to prove, modify or overthrow, and guide the conclusions of the research.

4. Comparison

   Comparison is the final stage and the key part of comparative research. The researcher conducts comparative research and judgment on hypotheses in accordance with the previous steps to confirm, revise or refute the hypotheses. Researchers need to draw conclusions with an objective attitude, detailed judgment, and qualified analytical ability.

3.3 Data Collection

3.3.1 Focus Group Interview

Depending on the feature of the study, the size of each focus group can be flexibly adjusted. In general, it is maintained between 4 and 12 people. It is more common to form a group of 6 to 10 people. Each group interview lasts between an hour and a half and two hours, and a tape recorder is used to collect information about the group's conversation. After the interview, the audio recording of the interview is transcribed into text material for data analysis (Chou, 1997)

Focus group interviews can be used in the early stages of research to explore relevant information on topics of interest to researchers and can also be used to assist in the development of concepts, tools and plans for preliminary research, and then conduct large-scale quantitative research on this basis. In addition, focus group interviews can also assist in interpreting the results of quantitative statistical data in triangulation studies. Therefore, focus group interviews have direct or auxiliary multi-functional and application value in both qualitative and quantitative research.

Although group focus interviews are a convenient and economical method of data collection, the validity of the interview content and the rigor of the correlation analysis between the data need to be carefully checked. (Chang & Hsu, 2006)

3.3.2 Interview Design

Using the above-mentioned document analysis and comparative research, this study collates and lists different sub-topics on the legal system of local government regarding autonomous vehicle. Then, we also hope to increase the completeness of this research through focus group interview.

Table 17 Interview Questions Design

Interview direction	Question
Local Governments and Regulatory Coherence	In terms of central regulations, the government passed Unmanned Vehicle Technology Innovative Experimentation Act for Autonomous Vehicles in 2018, but local regulations remain to be observed. In the process of introducing autonomous vehicles, if there is any possibility for local governments to develop their own local self-government ordinances.
Autonomous Bus	In recent years, a number of autonomous bus experiments have been implemented in various cities and countries, and some have begun to carry passengers and collect fees. At second stage, we should think about how autonomous buses should drive into existing communities. At this point, do local governments have room to develop their own local characteristics while developing autonomous buses?
Maintenance of Roadside Infrastructure	At present, Taiwan has various policies involving autonomous vehicle's roadside equipment, and some sites have begun to test them. But in fact, the rights and obligations of stakeholders in various roadside facilities have not yet been established. As one of the stakeholders of roadside facilities, what role should local governments play in the construction, maintenance and renewal of roadside equipment and the financial issues (including sources of funds, sources of revenue, and expenditure items)?
Transformation of Parking Forms	According to Parking Facility Law, parking lot-related business is one of the responsibilities of local governments. If future's introduction of private autonomous vehicles is considered, users may order vehicles to turn back or travel around the city to save parking fees, which might cause congestion problem. In this situation, congestion fee potential response? Aside from that, any other suggestions?
Financial Burdens and Urban Planning of Local Government	After the introduction of autonomous cars, due to the change of vehicle operation characteristics and people's daily travel behaviors. In addition to the aforementioned parking lots' financial issues, the scale, location, or even encouraging or restrictive regulations of various land use types will also be affected, which will lead to changes in the current municipal government budget and PPP model. Under this trend, does the local government have room for adjustment in governance? In addition, "urban road space, public space, and autonomous vehicle-related new facilities" is an emerging topic in urban planning. but urban planning is a big deal, and it cannot be accomplished overnight, should it be continuously promoted with short, medium and long-term goals?

3.3.3 Participants of Focus Group Interview

The experts invited for this focus group interview can be classified with their own professional fields, including related industries, government organizations, research organizations, etc., because it is practically difficult to invite all experts to Tainan for a physical meeting, so this research will be conducted online during the focus group interview. Prior to the meeting, the experts will be informed by e-mail of the general structure of the study, and before the actual meeting, a brief description of the general content of the report and the expected questions to be consulted with the experts will be presented. Table 18 indicates some experts invited in the focus group interview.

Table 18 List of Expert Invited

Experts Invited	Service Organization
Representative from Local Government Organization A	Transportation Department, Tainan City
Representative from Central Government Organization B	Vehicle Safety Certification Center
Representative from Academia C	Department of Transportation and Communication Management Science, National Cheng Kung University
Representative from Research Organization D	China Engineering Consultants, Inc.
Representative from Related Industry E	HwaCom Systems Inc.
Representative from Related Industry F	Kingwaytek Technology Co.,Ltd.
Representative from Local Government Organization G	Transportation Department, New Taipei City
Representative from Local Government Organization H	Transportation Department, Changhua City

3.4 Data Analysis

3.4.1 Modes of Data Analysis

Crabtree & Miller (2022) argue that the following four different factors can determine which mode of qualitative research the analyst should use:

(1) Research questions and objectives

(2) The known and emerging knowledge related to the research question is more or less

(3) Methods of data collection

(4) Readers of the research report

In short, if the purpose of the research is to enhance the understanding of the subject of the study, explore new areas, and generate new insights/hypotheses, it would be better to adopt an interpretive-oriented analysis mode. Besides, if there is not much known knowledge or the data has been collected by participatory methods or the researcher's thinking is flexible, creative, and highly savvy, an interpretive-oriented analysis mode should also be used. Interpretive-oriented analysis modes are editing and crystallization analysis style.

On the contrary, if there is a lot of known knowledge, the readers are mostly practitioners, the research purpose is to test the theory, and the researcher's thinking biases to have a fixed structure, in these cases, it is suitable to adopt quasi-statistical analysis and template analysis style. (Chang, 2010)

3.4.2 Thematic Analysis

According to Clarke and Braun (2013), some sort of thematic coding is common across many qualitative methods within the social sciences. Thematic Analysis (TA) as a named approach was first developed by Gerald Holton, a physicist and historian of science, in the 1970s (Merton, 1975), but has only recently been recognized as a distinctive method with a clearly outlined set of procedures for the social sciences (Braun & Clarke, 2006). Since then, it has grown in popularity and is now a recognized, accepted and more widely discussed method (e.g. Howitt & Cramer, 2010; Stainton Rogers, 2011).

Qualitative data were analyzed with thematic analysis, and a tool called MAXQDA (Figure 8) was used in the process. The steps provided by Braun and Clarke (2006) were followed, steps with explanations are shown below (Chawla et al., 2021):

1. Familiarization with data

   This step involves transcribing the data, reading and re-reading the data, and noting down the initial ideas. Major ideas were highlighted and written down for each transcript.

2. Initial coding

   "Coding interesting features of the data in a systematic fashion across the entire data set, collecting data relevant to each code." While translating and transcribing, features were coded as a small phrase or keyword representing a specific idea. Memos were written down to keep track of the condensed information.

3. Searching for themes (and sub-themes)

   "Collating codes into potential themes, gathering all data relevant to each potential theme". The data were read and re-read, and the cycle was repeated several times to narrow down the number of codes and categorized them into identifiable themes. The codes were then analyzed and grouped into several themes as stated in the next section.

4. Reviewing themes

   "Checking if the themes work in relation to the coded extracts at the first level and then the entire data set at the second level, generating a thematic map of the analysis". The complete interview data were re-read to validate the codes. Table 19 shows the relationship between themes and subthemes.

5. Reporting the results

"Selection of vivid, compelling extract examples, final analysis of selected extracts, relating back of the analysis to the research question and literature, producing a scholarly report of the analysis". Compared to literature collected and questions set to be discussed, high similarities can be found in the transcript of focus group interview. Besides, some extended topics are also created due to the participation of experts invited.

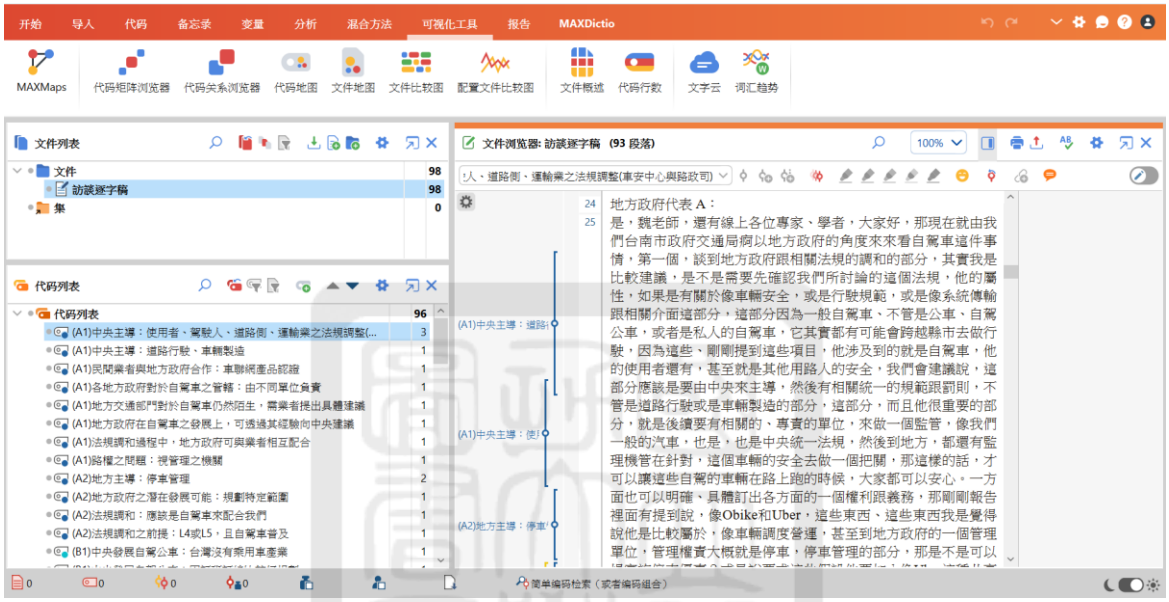


Figure 8 Operation Interface of MAXQDA

In the focus group interview, experts invited took turns to share their insights about the issues collected. Then, through transcript and above processes, themes and subthemes are formed. It can be noticed that almost all the themes can be tracked back to the literature shown in previous chapters.

Table 19 Theme and Subtheme Subtracted from Transcript

Theme	Subtheme
Self-Government Ordinance: should be established cooperatively	1. Local development of AVs: needs cooperation with others 2. Local development of AVs: penetration of AVs matters
Autonomous Bus: a prioritized development item for Taiwan	1. Taiwan is proper for the development of autonomous bus 2. Central and local governments are developing autonomous bus 3. Autonomous bus: should comply with existing traffic rules
Development of RSU: insufficient rules and government's vision	1. Rules and authorities of RSU: to be finished 2. V2X for private AVs: should be provided by government ?
Emergence of Private Autonomous Vehicle: will shared vehicle prevail?	1. Subsidize Sharing Vehicles to Solve the Problem 2. Limited Area for Autonomous Parking at First 3. Willingness to own vehicle after the emergence of private AVs 4. Congestion problem caused by private AVs: still unknown
Changes of Urban Plans Induced by Autonomous Vehicle	1. Designated Area for Autonomous Vehicle Industry 2. Urban Planning for AVs: uncertainty still exist 3. Development order of AVs: public transport first
Potential Financial Scheme for Future Establishment of RSU	1. Potential Financial Scheme of RSU 2. RSU is not merely for AVs 3. Development of RSU: gradually gain attention

As mentioned, MAXQDA was utilized to analyze the content of interview. The study utilizes theme analysis to produce these six themes. In the five steps of thematic analysis, researchers are supposed to conceptualize the content of transcript, which is regarded as initial coding. Then, the data were read and re-read to until identifiable themes were found.

Among them, it would be ideal that no topic is discussed dramatically more than others. With colors representing different themes, Figure 9 shows the different amounts of proportions each theme account for.

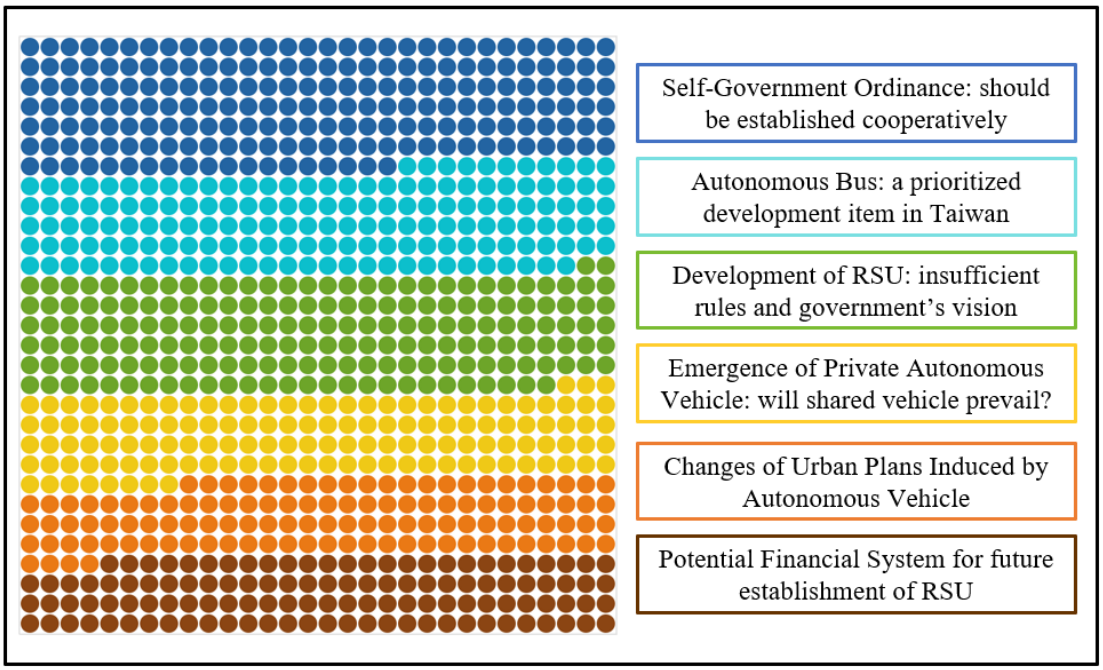


Figure 9 Visualization of Proportions of Themes

3.4.3 Reliability and Validity Check

Since this study is qualitative research, in order to make this study have a certain degree of reliability and validity, the reliability and validity are checked by the following methods. (Chang & Wang, 2017)

Reliability:

Merriam (1988) proposed the following two techniques to improve reliability:

1. Clarify the position of the researcher:

   The researcher must truly understand the assumptions and theories behind the research, then select appropriate information and present the information appropriately in the data collection.

2. Triangulation:

   Triangulation refers to the use of multiple methods to study the same phenomenon and is an indispensable tool in qualitative research (Robson, 1993), which Denzine divides into four types: data triangulation, researcher triangulation, theoretical triangulation and methodological triangulation.

For data triangulation, the study collected contents from some legitimate sources, such as literature, reports or regulations to strengthen the trustworthiness of the study. On the other hand, researcher triangulation was also adopted through regular interaction with scholars from relative fields, such as law and transportation.

Validity:

1. Based on the content of literature review, the first draft of the interview outline of this research was created. To increase the validity, two peers and pre-test respondents are consulted to revise the content with unclear semantics or difficult vocabulary.
2. Then, two experts and scholars with traffic expertise and legal expertise are invited to assess the appropriateness of the problem. Finally, a senior currently working in a self-driving industry was invited to confirm whether the topics are different from the current development of autonomous vehicles.

CHAPTER 4 RESEARCH FINDINGS

4.1 Transition of Themes

In the focus group interview, the research team sorted out several topics using the transcript collected in the focus group interview. For topics set originally based on literature reviewed and topics formed based on interview, most of themes are similar. However, some trivial differences also exist, as shown in Table 20.

Through Table 20, it can be noticed that except for "changes in parking forms", other themes originally set by the research team are similar to those presented by the participating experts. From this, we can understand that the study is representative when it comes to the development of autonomous vehicles in Taiwan.

Beginning from 4.2 to 4.7, this research subtracts content from the transcript and put sentences aside to explain the implications of the various themes collected after the focus group interview.

Table 20 Transition of Themes

Original Themes	Themes Formed in the Interview	Similar Themes (Y/N)
Local Governments and Regulatory Coherence	Self-Government Ordinance: should be established cooperatively	Y
Autonomous Bus	Autonomous Bus: a prioritized development item in Taiwan	Y
Establishment and Maintenance of Roadside Infrastructure	Development of RSU: insufficient rules and government's vision	Y
Transformation of Parking Forms	Emergence of Private Autonomous Vehicle: will shared vehicle prevail?	N
Financial Burdens and Urban Planning of Local Governments	Changes of Urban Plans Induced by Autonomous Vehicle	Y (discussed separately)
	Potential Financial Scheme for Future Establishment of RSU	

4.2 Self-Government Ordinance: should be established cooperatively

Autonomous vehicles might transform the next generation's traffic, with its emergence, should we change the way our society operates first? Or we should require autonomous vehicles to blend into our society first, then change relevant regulations while the penetration rate of it rises to certain levels? The situation setting can also be further discussed.

> 換個角度，我們要思考的就是說，應該是自駕車來融入現在的環境場域，還是我的環境場域要來配合自駕車，所以我覺得在思維上，目前看起來都有一點是我們來因應未來的自駕車，所以我的環境、我的法規要來配合他，可是某種程度自駕車在推動的一開始，應該是他要配合現在的法規跟環境 (D)

When it comes to legal coherence, especially at local government's level, it is emphasized that some fundamental rules, such as vehicle safety or driving rules, should be established by central government first. As a result, local governments can have room to develop other parts.

> 談到地方政府跟相關法規的調和的部分，其實我是比較建議，是不是需要先確認我們所討論的這個法規，他的屬性，如果是有關於像車輛安全，或是行駛規範，或是像系統傳輸跟相關介面這部分，這部分因為一般自駕車、不管是公車、自駕公車，或者是私人的自駕車，它其實都有可能會跨越縣市去做行駛，因為這些、剛剛提到這些項目，他涉及到的就是自駕車，他的使用者還有，甚至就是其他用路人的安全，我們會建議說，這部分應該是要由中央來主導 (A)

> 現行自駕車測試均為限制性場域進行相關開發及試營運，研究單位可先行提出自駕車相關營運規範，供各縣市進行通用版本法令規範，供各縣市政府因地制宜修訂相關地方法規規範。(H)

Once those fundamental rules are set, local governments can start to consider how to adjust their policy to maximize the benefits brought by autonomous vehicles. Among them, it is important to mention that the process can be mutual, or even includes several parties. For example, the autonomous vehicle tests held by the city government and civil sector might end up finding some legal difficulties, which can be presented to the central government for further amendments.

各縣市政府，我覺得他們其實創意會更多啦。就是說，跟廠商合作，那他創意會更多，那從這個過程之中，交通局、經發局他們也更了解說這個產業到底是需要什麼，那交通局這邊知道說，以後法規應該以後要怎麼去跟中央建議，那他要佈建什麼樣的設施？ (F)

4.3 Autonomous Bus: a prioritized development item in Taiwan

For Taiwanese society, there are plenty of reasons to develop autonomous buses, including the absence of a vehicle industry, the aging society, the lack of labor in the bus industry, and potential solutions for last-mile transport.

為什麼台灣會優先挑選公車，主要也是因為台灣比較沒有乘用車的這個這個產業，那優先就是，當然是除了這個巴士的部分，現在也是缺工的問題，然後老年化的問題，還有就是說偏鄉的能力，還有人力的問題，他就是說，可能軌道交通很貴，然後他是不是有可能在娶到、取代軌道交通這一塊的最後一哩路的接駁，我想說這個是縣市政府，其實在就是在交通規劃裡面非常想要用這個自駕車來取代一般軌道交通最後一哩路的原因啊 (F)

The above interview contents mentioned Taiwan's demographic background, making the prioritization of autonomous buses a reasonable choice. On the other side, how public sector measure the issue and adjust its policy? Considering the public's interest, promoting public transport seemed to be the Taiwanese government's decision. If deployed appropriately, it is expected to reduce the use of private vehicles.

交通單位在推的時候，不會先去推私人的自駕車，原因就在這邊。第一個當然就剛剛講的，我們在固定路線上，訂班訂線可能是一個比較好規劃的，第二個是剛剛的前提，他負擔的公眾運輸的公益性，所以這個自然的在經費配置上，在初期啦，都會著重在大客車上的原因是在這邊，那當然我們在探討這個部分的話，其實還會在討論一個問題，就像我剛剛講的，我們希望用這種自駕公車，或來減少私人的運具的使用 (D)

With these backgrounds, both central and local governments are making every effort to boost the development of autonomous bus. For the central government's part, the Ministry of Transportation and Communication has set up a strategy committee, inviting experts to gather professional insights.

> 以交通部的角度，最主要他是希望說部裡面，應該是針對於所謂的固定路線跟對於所謂的，有固定的一個停靠站，以及中大型的車輛，先來做這個所謂的，公共運輸這個部分的一個立場跟想法來做，這樣子的一個運行的一個安全指引，能夠提供，在所謂的，這個封閉場域或公共道路這個試驗的時候，能夠提升所謂的沙盒試驗車輛的一個安全，這樣的一個面向來做，這個計畫的，一個後續的研擬，那交通部當然也召開所謂的自駕車，這個策略委員會、也這個，透過這樣的一個委員會來收集各個委員的一個意見，這是在自駕公車運行，這個部分部裡面，交通部大概有這樣的一個計畫，跟做這樣的一個投入了，這是在自駕公車的部分 (B)

For the local governments, New Taipei City government, cooperating with Kingwaytek Technology, attempted to deploy autonomous buses in its suburban areas and connects them with the existing public transport systems. Tainan City government is, now facing labor shortage, also considering the possibility deploying the autonomous buses in its remote areas.

> 其實當初新北市政府，給我們的要求，就是說，可能地方政府會有一些創意，可能是在標誌標線啊，還是說他怎麼樣營運這個場地？地方政府其實會有蠻多的創意跟想法 (F)

> 以台南市來講的話，有些可能比較郊區的部分吼，或是說像現在疫情以後的一個司機人力不足，我想自駕公車的推動，對於紓解這個公車司機人力，是有很大的助益，這部份我們也是積極來推動 (A)

4.4 Development of RSU: insufficient rules and government's vision

To develop autonomous vehicles, RSU is necessary. At present, National Communications Commission (NCC) was in charge of the application of the 5.9GHz band, the band designed for intelligent transportation. But the work is done by the Ministry of Science and Technology (reorganized as the National Science and Technology Council).

他就會要有相關的申請跟審驗機制，尤其是因為我們從國外進口這個 5.9G 在淡海計畫一期的時候就遇到了很多的障礙,他必須要去做去做,大家有看到頻段的許可,就是我今天要在什麼地方申請這個 5.9G 頻段的許可使用，當初在一期的時候還沒有數位部，以前都是在 NCC，在做執行，數位部現在切出來了，那個頻段的時候，我們要先申請 5.9G，允許使用，才可以在淡海案場去把那樣的產品，就是在現場限制，那現場建置 (E)

However, even though competent authorities are assigned, they sometimes can be not that familiar with the application procedures. Even though at the point, several autonomous vehicle tests are conducted, companies could face problems owing to the absence of standardized processes or clear samples for companies to follow.

跟與會的先進報告，我們當初也很好奇，怎麼可能申請這麼久，然後其實 NCC 也很多東西，都不是很確定、很清楚，在我們詢問的情況之下，我們就反問說，我們國內有很多，車聯網的場域，不管是台南的，或者是自駕車新北、彰化、桃園、高雄都有很多車聯網的自駕車的一個使用的情境,那他們都沒有申請過嗎？他們都沒有一些經驗，因為我們那個時候第一次申請，想要問一下 NCC 有沒有範本可以給我們參考，後來我們才問到，NCC 是針對車聯網這樣子的 case，我們這個計畫案是全台唯一、也是全台第一去申請的，那我就會問 NCC 很好奇說那什麼，為什麼其他家都不用申請，那他們不用申請，是代表都合法嗎?其實 NCC 就跟我們講說，如果沒有這樣子的申請動作，其實理論上都是違法的 (E)

Moreover, because the roadside facility is a massive investment for the public sector, proportionally, how much effort government should make remain a debatable issue. For some public transport like buses, since the system contributes the convenience for the public, governmental support for the roadside facilities is acceptable. But for autonomous taxis or private autonomous vehicles, it is another case.

涉及到我要不要來提供這樣的路側設備，來協助你車輛的運行，剛剛講的公車沒問題，因為這是大眾運輸、公眾需要，但是假設是私人的無人計程車，或者是 uber，那應該由政府單位來提供這樣的一個設備來支援你嗎?還是業者你應該自己想辦法解決來融入我現在的道路環境，所以我覺得這個是公部門在執行的時候，會有一個思維上的一些想法，提供做參考 (D)

While establishing roadside facilities, those built in remote areas might need more attention. Due to insufficient investment in its infrastructure, issues worthy of being concerned might be different.

特別是在偏鄉，或許大家會覺得說偏鄉的道路環境比較簡單，可是相對的、偏鄉的一些道路線型，或是輔助設備相對是不完備的，某種程度他可能要關心的議題，會跟都市在運行的時候，關心的不一樣 (D)

4.5 Emergence of Private Autonomous Vehicle: will shared vehicle prevail?

In Tainan, intelligent parking facilities are built everywhere, so parking-related data can be collected immediately. On top of that, future autonomous vehicles might be able to be connected to the existing facilities, so that congestion problems and redundant traffic flows can be prevented. If necessary, a discount can be considered also.

台南市目前也、近幾年大量設置這個地磁，還有智慧停車柱這些管理設施，可以收集比較即時、而且大量的停車資訊，而且這些資訊也可以透過我們 app 的提供來讓民眾查詢剩餘的位，那我想後續如果自駕車，它有一些資訊的一個吸收，也可以讓自駕車，他自己去搜尋說，哪邊的停車位是符合他的一個，最近的一個停車的空間，或甚至是比較優惠的費率 (A)

To test the autonomous parking function of autonomous vehicles. Currently, some countries have already designated parking demonstration areas for autonomous vehicles. Only certain areas are allowed and a speed limit is also set.

停車場的一個形式，我想就中心觀察，像德國的部分，在 L3 或 L4 的部分，他們對於這個賓士車輛這個部分有所謂的自動停車的一個示範，確實未來在所謂的這個自動停車的部分，我想我們當然非常期待有這個，這個趕快能夠落地啦吼，那事實上，在德國的部分，德國的交通部事實上也訂定有這個所謂的自動車輛的一個停車的一個技術規範，那目前是只限定在特定的一個停車場，然後是在所謂的 10 公里以下可以實現，這個無人自動停車的一個功能(B)

However, other thoughts are also brought up in the focus group interview. Though the congestion problem might happen because of the existence of autonomous vehicles, the question we often discuss is the need to own a car while shared autonomous vehicles are broadly deployed.

> 未來是自駕車的產生，會不會讓車輛的使用，讓道路更擁擠？因為就像剛剛講的，他自己停回家之類的，但是我們目前一般在探討自駕車的話，大概都比較探討的是，另外一個角度，也就是未來的環境，如果有了自駕車，特別是營業用的自駕車，像Uber，未來的無人計程車好了，你還會想擁有車嗎? (D)

Pertaining to the potential changes of drivers' behaviors after the introduction of autonomous vehicles, some literature pointed out that the congestion problems in urban areas might show up. However, some experts believe the issue might need further confirmation.

> 停車形式的轉變，或者是這個相關，相關像駕駛行為的改變，我想這個或許，中心在這個部分比較沒有涉獵，而且我覺得這一天我們當然可以期待，但是這一天或許可能比較務實的想，還有一些時間，我們可以在後續可以再做這個觀察，跟這個再來思考這些問題 (B)

4.6 Changes of Urban Plans Induced by Autonomous Vehicles

Pertaining the potential development courses for autonomous vehicles, local officials with experience promoting autonomous buses provided some suggestions. To smoothly blend the new technology into our cities, public transport which might erase overworking problems and increase traffic safety should be prioritized.

Then, deployments of private autonomous vehicles might worsen the congestion problem in urban areas. Especially with the high density of scooters in Taiwan, traffic safety and mixed traffic flow should also be considered.

> 短中期來講的話，政府應該優先推動公共運輸的部分來推動自駕車吼，包括市區客運跟國道客運，那這部分剛剛有提到說可以減少駕駛員的一個疲勞，增加一個交通安全 (A)

> 長期部分私人自駕車，如果大量發展的話，也可能會排擠公共運輸，那加劇現行市區交通壅塞的情形，尤其在台灣的機車使用率非常高，那他們機車族的使用的一個

習慣比較會鑽吼，那對於市區的自駕車，可能會產生一個安全上的一個影響，那後續如何在兼顧自駕車發展跟交通運輸品質之間取得一個平衡，我想這個是地方政府也未來需要關注的一個課題 (A)

Compared to projects promoted by the Ministry of Transportation and Communications, urban planning has a tendency to lag behind it. Thus, how to make sure the competent authority of urban planning can cooperate with the Ministry of Transportation and Communications smoothly is the key issue.

一開始一定是交通部會先動，會很快，那都市計畫通常都是，就是就是都市計畫會跑很慢，那我們都市計畫要怎麼去配合？怎麼去追上這樣的進度，去跟交通部去做一些協調，就是說，我比較會擔心的是自駕車，他上路了之後，但是跟都市計畫，我們怎麼樣去做協調、因為常常都市計畫就會很慢，這個是，是我自己的親身感受，所以我會比較急的就是會是，到底我們都市計畫可以做什麼？我們可以怎麼去配合交通部？去怎麼去配合這些先進的科技？ (C)

因為都市計畫他是法規，那他也有法規，他也有他的程序要走，那我怎麼怎麼去 push 他們，讓他們可以，可以提早配合交通部，然後去做這樣的、新的交通行為、新的交通流，然後去解決問題，而不是等到問題發生之後，才去做解決，以上大概是我的，我會比較 care 或比較擔心的問題 (C)

Some features of autonomous vehicles also need to be paid attention, such as the electrification of vehicles or distributed charging demands. The new features brought by the new technology will influence how charging system-related regulations are established.

隨著自駕車日益增加持續取代燃油車，停車空間需求將零碎化分散化，過往都市計畫管制手段與都市空間合法停車空間原本就追趕不上目前的需求，未來自駕車只需要更零碎的都市空間停車充電、更分散的高電量充電需求，如何讓未來都市計畫管制措施能夠符合潮流，如老舊社區如何合法依照法令、修築安全的充電設備，也是未來挑戰。(G)

4.7 Potential Financial Scheme for Future Establishment of RSU

To materialize the deployment of autonomous vehicles, roadside facilities are regarded extremely important. Hence, several tests launched have equipped those facilities. Especially in New Taipei City, certain areas are designated for the standardization of specifications and the test of V2X.

> 我們呢負責是場域相關的一個，不管是標準、還是有測試的側向的推動，那我們其實主導的就是車聯網的發展，那剛剛其實前面很多先進都有提到自駕車其實有一塊很重要的就是路側設施要能夠跟自駕車做互動 (E)

> 我們其實在一期的時候，就已經就是車聯網的一些設施、設備在淡海案推動，也就是 D-City 在推動上面，那就是做了蠻多，像是標準開始，然後建了相關的一些試驗環境 (E)

As for who should bear the financial burden of autonomous vehicle's roadside infrastructure? Traditionally, both central and local government should take the responsibility of the building of infrastructures.

However, with the promotion of PPP (public-private partnership), its application on the establishment of autonomous vehicle's roadside infrastructure is frequently brought up. Currently, some 5G smart poles are built by civil sectors, though they might not merely for autonomous vehicles, the financial system of autonomous vehicle's infrastructure might follow suit.

> 至於就是說，這些設備應該是誰來建？誰出經費？那應該是說，現在各個縣市政府，其實他們也是逐漸在把這個以前的交通桿讓他更聰明，可能讓他加上 5G 智慧桿，然後聯網，然後可以看人流，可以看車流，其實各地交通局其實一直都在努力這件事情，其實他們也是有一個意識到，就是說這個，其實未來就是要逐漸汰換這個部分，這些交通桿的部分，因為他們可以達到的目的不是只有給自駕車使用，它其實還是可以給很多，剛才講緊急車輛，這個救護車輛、消防的車輛，他可以優先有路權出來 (F)

On the other hand, in 2020, mobile operators spent more than 100 billion Taiwanese dollars securing 5G spectrum. Originally, huge proportion of funding is spent on 5G Technology Development Program (TDP). However, an expert invited also mentioned the potential of allocating some of them to the establishment of roadside infrastructures of autonomous vehicles.

> 是不是有可能是因為每個電信公司在爭取 5G 頻段的時候，其實都有給政府蠻多錢的嘛。那這些錢現在都是拿來當 5G 科專的不同應用，那是不是就是有可能，有一部分是配合某一個場域去把大量的、這個這個 5G 的這個交通桿去做一些置換，這個可能也是有一個好的方式 (F)

4.8 Themes corresponding to laws and regulations

During the focus group interview, experts directly or indirectly indicated those laws and regulations related to those issues discussed, though the precise ways to amend the clauses still need more discussions, the collections of those laws and regulations mentioned can be helpful preparing for the legal study of autonomous vehicle.

To establish the legal system of autonomous vehicles at the local government level and provide a prospective development guidance for local governments, the study collects all the related acts and regulations based on different themes, as shown in Table 21.

Table 21 List of Related Laws

Themes Formed in the Interview	Name of Act/Regulation
Self-Government Ordinance: should be established cooperatively	Highway Act
	Road Traffic Safety Rules
Autonomous Bus: a prioritized development item for Taiwan	Regulations on the Administration of Automobile Transportation Industry[15]
Development of RSU: insufficient rules and government's vision	Highway Act
	Urban Road Act
	Telecommunications Act[16]
Emergence of Private Autonomous Vehicle: will shared vehicle prevail?	Parking Facility Act
Changes of Urban Plans Induced by Autonomous Vehicle	Design Specifications for Highway Alignment[17]
	Design Standards of Urban Roads and Accessory Works[18]
	Condominium Administration Act Building Administration Division[19]
Potential Financial Scheme for Future Establishment of RSU	Act for Promotion of Private Participation in Infrastructure Projects

[15] Regulations on the Administration of Automobile Transportation Industry：qi che yun shu ye guan li gui ze, translated by this research.

[16] Telecommunications Act：dian xin fa, translated by Laws & Regulations Database of The Republic of China (Taiwan).

[17] Design Specifications for Highway Alignment：gong lu lu xian she ji gui fan, translated by this research.

[18] Design Standards of Urban Roads and Accessory Works：translated by Laws & Regulations Database of The Republic of China (Taiwan).

[19] Condominium Administration Act Building Administration Division：translated by Laws & Regulations Database of The Republic of China (Taiwan).

CHAPTER 5 CONCLUSIONS AND SUGGESTIONS

5.1 Conclusions

In these years, the development of autonomous vehicles has been rapid, and research pertaining to the issue are also conducted. But considering the development of autonomous vehicles' legal issues from local governments' viewpoint is scarce.

The study explores the legal issues induced by autonomous vehicle. During the process, the study not only partitions the items supposed to be supervised by local governments but presents the latest status quo of these items.

With the collections of problems that local governments might face in the future, questions and issues discussed in the focus group interview were created. In the focus group interview, representatives from local government organizations, central government organizations, academia, research organization, and related industry are invited.

Originally, three local government officials with experience promoting autonomous vehicles are invited. However, only the government official from Tainan City attended, hence, the research attempts to improve the problem by looking up the recent projects promoted by local governments and contacting relevant bureaus for alternative personnel.

With professional insights shared and thematic analysis, insights of stakeholders are analyzed and classified into six different themes. From these themes, stakeholders can envision the local government's role in the upcoming introduction of autonomous vehicles.

First, the introduction of cutting-edge technology like autonomous vehicles, our society is forced to adapt itself to the newly formed traffic environments. Cooperations within various sectors are continuously emphasized. Without the requests and communications from the civil sectors, local officials do not know how to conduct the procedure, and without local governments' experience sharing, the central government also does not know how to set up the corresponding legal systems.

Autonomous bus, a prioritized form of autonomous vehicle to be developed in Taiwan. With the society's demographic background, both central and local governments have high expectations toward the tremendous benefits brought by it. Hence, several projects have been launched in these years.

To boost autonomous vehicles, the roadside facility is considered necessary to deploy them to smoothen the entire operations of autonomous vehicles. However, the application of 5.9 GHz band is lengthy, sometimes it can cost a company more than one year to do so, even in test fields. Thus, competent authorities in Taiwan urgently need to fix to problems.

About some congestion problems mentioned in the literatures, solutions like integration with current parking facilities and subsidies for shared autonomous vehicles are brought up. Meanwhile, some experts also mentioned another problem about the need to purchase one's own vehicle, which should be further explored.

Though it is indicated that urban planning would tend to be slow, some preliminary suggestions are still presented. For example, public transport should be prioritized in the short term, due to its contribution toward public interests. For the long term, those areas with mixed traffic flows are then considered.

Finally, to chase the sustainability of policy while establishing roadside infrastructures, aside from PPP, experts provide some potential solutions for the problem, including allocating the funding of the Technology Development Program (TDP) to the establishment of roadside facilities or charging bus operators who use roadside facilities.

5.2 Suggestions

In addition to Unmanned Vehicles Technology Innovative Experimentation Act, there have been few legal changes in the development of autonomous vehicles in recent years. Although the central government, local governments and related companies have promoted several autonomous vehicles experiments, the current form of autonomous vehicles on the road is still mainly based on experimental cases.

And according to the content of the expert interview of this study, when promoting autonomous vehicle experiments, stakeholders still often have little understanding of autonomous vehicle laws and regulations, or think that there are things worth improving. This indicates that Taiwan's the legal development of autonomous vehicles is still incomplete.

In addition, this study also discusses the issues that may happen when developing autonomous vehicles in the future. Although not only Taiwan, but even the international community is still unable to accurately assess the future of autonomous vehicles, by

collecting the insights of experts in Taiwan, this research has the ability to provide the direction of relevant legal revisions in the development of autonomous vehicles in Taiwan from the perspective of local governments.

When this study provides legal advice on autonomous vehicles for local governments, it is mainly divided into two parts. The first section discusses what strategies the government of our country should adopt to promote the development of autonomous vehicles under the current circumstances:

- The central government should lead local governments

Although this study mainly discusses the legal issues of autonomous vehicles in local governments from the perspective of local governments, such as the role that autonomous vehicles can play in different counties and cities or the solution to parking problems caused by autonomous vehicles in the future, etc.

But in practice, since autonomous vehicles are likely to move across cities and counties, many issues cannot be resolved by an individual local government. For issues such as vehicle safety or driving regulations, if the central government does not have a unified regulation, local governments are very likely to have problems promoting autonomous vehicles.

- Communications between local governments should be strengthened

Although according to the website of the Ministry of Economic Affairs, there are no less than ten self-driving bus experiments in Taiwan, and many cities and counties have related plans with different experimental purposes, such as the promotion of city sightseeing, the supplement of the last mile transport or as a new form of transport for rural areas.

However, the examples mentioned above may not apply to all counties and cities. Some regions may face challenges such as insufficient administrative resources or other factors, making it difficult to envision the practical implementation of autonomous vehicles even if there is a need for their deployment.

Therefore, this study suggests that mutual cooperation among local governments is also crucial in the development of autonomous vehicles in Taiwan. Particularly for cities and counties facing similar transportation challenges, determining how to collaboratively introduce autonomous vehicles while leveraging their distinct resources becomes a prioritized direction for local governments to pursue.

- Local government should prioritize the development of autonomous buses

Considering Taiwan's social background, the declining birth rate and aging population in our society have gradually affected our employment market. The shortage of labor force has gradually emerged in recent years. Many industries, such as bus industry, often face problems recruiting drivers. At this time, autonomous buses are an effective solution.

In addition, because autonomous buses run on fixed routes and are beneficial for the public, they are considered more suitable for the government to give priority to than ordinary autonomous vehicles.

The second section is about the issues that our country is likely to face in the future after the technology of autonomous vehicles matures in the future:

- Shared autonomous vehicles should be further discussed

At present, Taiwan's autonomous vehicles are basically running on the roads in the form of experimental cases, and they are all in the form of fixed routes. Regarding the development of autonomous vehicles in the future, there are currently different research opinions. Some say that future autonomous vehicle technology may lead to increased traffic flow, which will cause road congestion; some say that future autonomous vehicle technology may mostly appear in the form of shared autonomous vehicles, making the whole society more sustainable.

Because at this stage, it is still impossible to predict what form the autonomous vehicle technology will take when it matures, this study suggests that the public sector should always evaluate which method is most in line with the public interest and manage the development of autonomous vehicles with appropriate policies.

- Urban planning induced by autonomous vehicles should be prepared in advance

As the content mentioned above, the participating experts also mentioned that when thinking about urban development, autonomous vehicles with the nature of public transportation should be promoted first. Hence, the study believes that whether to designate lanes for autonomous buses is an issue that local governments can consider.

In addition, when autonomous vehicles hit the road in the future, most of them will appear in the form of electric vehicles. In the future, the demand for charging may be more fragmented and will increase urban electricity consumption. Local governments also need

to prepare for the upcoming challenges.

- Financial mechanism of roadside facilities should be established

In terms of the current autonomous vehicle technology, roadside facilities are necessary preparations before the promotion of autonomous vehicles, but how to build such a huge infrastructure is a thorny issue. Traditionally, the construction of infrastructure such as roads is completed through government budgeting, but projects such as roadside equipment for autonomous vehicles are expensive and require high technology. In reality, it may be difficult to do so.

Therefore, as mentioned by some experts, PPP may be a very important mechanism for the implementation of roadside equipment for autonomous vehicles in the future, but as mentioned in this study, there is no clear regulation on the competent authority for roadside facilities for autonomous vehicles, and the standardization of roadside facilities is still in progress.

Therefore, this study suggests that the government should at least clarify and regulate the competent authorities of roadside facilities and the equipment specifications of roadside facilities so that subsequent local governments will have room to think about the feasibility of PPP.

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APPENDIX I Matters Concerning Focus Group Interview

國立成功大學交通管理科學研究所

臺灣自駕車發展之地方法制及其衍生法制議題探討

一、會議主持人、助理主持人

會議主持人：國立成功大學交通管理科學系 魏健宏 教授

助理主持人：國立成功大學交通管理科學系 賴泓文 碩士研究生

二、會議內容

根據經濟部無人載具科技創新實驗資訊揭露平台，截至2023年2月，我國「無人載具科技創新實驗計畫」已核准15件上路實驗，並且帶動新台幣五億元以上的投資，顯見我國在自駕車之發展上已取得初步進展。

然而，若欲使自駕車科技走入現有社會，除探究科技發展外，為避免自駕車科技與現有社會運作產生衝突，適時的法規修訂亦十分重要，故本研究預計探討未來導入自駕車時，各方機構應如何因應由此產生之各項法制議題。

本次專家座談會則聚焦「地方法規」之討論，現在台灣雖然自駕車相關之實驗案正在蓬勃地發展，惟尚未完整規劃未來自駕車若駛入現有交通環境時，吾人應當如何應對，尤以地方政府之角度出發之研究更是缺乏討論。

故本研究將地方政府需要面對之議題以發生時序列出，並蒐集相關資料逐一討論；又因臺灣各縣市經濟發展程度不同，對於自駕車之推動方向、推動意願可能亦有出入，故在專家座談會時亦邀集不同縣市之交通專業官員，使本研究亦兼顧各方觀點。(詳見五、專家名單)。

本次會議討論主題分為五大項，分別為地方政府和法規調和、自駕公車、周邊基礎設施之建造及維護、停車形式之轉變、地方政府財政負擔與城市規劃等項目，皆為與地方政府相關之主題，會議進行時，希望諸位專家：

(1) 審閱研究成果後，給予回饋

(2) 討論研究團隊提出之「討論議題」

三、會議時間

2023/04/19 15:30-17:10 (預計約100分鐘)

四、討論議題

章節	欲詢問之問題	原因
2.1 地方政府和法規調和	於中央法規面，政府於 2018 年通過《無人載具科技創新實驗條例》，惟地方法規面仍待觀察。 在導入自駕車之過程中，地方政府在地方自治法規上，有何發展地方自治法規之可能?	在法規調和的議題上，自駕車性質不像過去的 Uber 或是 Obike （在法規的修訂上，前者偏向中央；後者偏向地方），中央以及地方皆需要修訂法規以順應自駕車的發展。
2.2 自駕公車	近年來，多件自駕公車實驗案已在各縣市實施，部分開始進行載客、收費之行為，次階段應該思考自駕公車應如何駛入現有社區。 於發展自駕公車時，地方政府有無發展具備自身地方特色之空間?	雖然台灣的自駕車實驗相關立法早在 2018 年就啟動，已領先很多國家，但是如果要談及我國政府對未來自駕車之發展方向，似乎並沒有很明確的宣示。
2.3 周邊基礎設施之建造及維護	目前台灣已有各項政策涉及自駕車之路側設備，也有部分場域開始試驗之，但實際上各路側設施相關利益人之權利義務尚未確立。地方政府身為路側設施之利益相關人之一，在 RSU (路側設備)之建置、維運、更新，以及過程中之財務課題(含經費來源、收入來源、支出項目)中，應扮演何種角色?	雖台灣車聯網產業協會(TTIA)與美國 OmniAir 認證組織簽署合作備忘錄，相關產業亦在淡海新市鎮實驗場域導入車聯網，驗證標準環境及測試，但未來走出實驗場域時，我國要如何建置此系統仍然是未知數。
2.4 停車形式之轉變	根據《停車場法》，停車場相關業務是地方政府職責之一。若考量未來私人自駕車之導入，使用人為節省停車費，可能命其車輛自行折返或在周圍繞行，造成都市擁塞。 擁擠費是否為潛在之應對?除此之外還有其他建議嗎?	雖然目前自駕車要距離要進入私人自駕車的階段可能還有一段時間，不過已經有文獻提及此可能情況，且地方交通、停車問題為地方政府之主要施政重點之一。
2.5 地方政府財政負擔與城市規劃	導入自駕車後，由於自駕車改變車輛運行特性、人們日常旅行行為，在地方政府之財務議題上，除了前述之停車場(建物)外，各種土地使用類型之規模、區位，甚或鼓勵或限制性法規亦會被影響，進而導致現行之市政府預算、PPP 模式 （民間參與公共建設)之改變，請問地方政府在此趨勢下，是否在施政上有調整空間? 另外，「城市道路空間、公共空間和與自駕車相關的新設施」為城市規劃中之新興課題，但城市規劃茲事體大，非一蹴可幾，對此是否應以短中長期的目標持續推動?	自駕車雖帶來諸多益處，但亦對現有體制帶來許多不確定性，如現有公共建設之財務規劃機制是否需做修改等，故需特別探討；雖然自駕車尚未普及，惟因探討範圍大、各項硬體需要即早規劃，且《都市計畫法》中亦有提到 25 年之規劃長度，故現階段討論此議題應屬合適。

五、專家名單（依照發言順序）

單位性質	服務機構
政府機關（地方）	新北市交通局
	彰化縣交通處
	臺南市交通局
政府機關（中央）	財團法人車輛安全審驗中心
學術單位	國立成功大學交通管理科學系
研究機構	財團法人中華顧問工程司
相關產業	華電聯網股份有限公司
	勤崴國際科技股份有限公司

六、會議流程（約 90 分鐘）

議程項目	內容	時間
開場	1. 開場及專家介紹 2. 簡述會議之流程	15:30-15:35
研究成果簡報	研究成果簡述	15:35-15:45
地方政府意見回饋	以地方政府角度，討論研究議題	15:45-16:05
中央政府意見回饋	以中央政府角度，討論研究議題	16:05-16:15
學術單位意見回饋	以學術單位角度，討論研究議題	16:15-16:25
研究機構意見回饋	以研究機構角度，討論研究議題	16:25-16:35
相關產業意見回饋	以相關產業角度，討論研究議題	16:35-16:55
問題與討論	由專家自由討論、補充	16:55-17:10

APPENDIX II Focus Group Transcript

To protect the privacy of experts, the full version of the transcript is not presented, and it might be available upon requested.