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A Preliminary Exploration into the Key Factors in the Development of Electric Vehicles

Ming-Lang Wang [1], *, Yan-Shan Chen[2]
marlon@g.chu.edu.tw[1], *lssss@gmail.com*
[1,2] Department of Industrial Management, Chung Hua University*
30012, No.707, Sec.2, Wu-Fu Rd., Hsinchu City, Taiwan, R.O.C.
**Corresponding author*
marlon@g.chu.edu.tw

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Abstract
As the effects of global warming intensify, the goal of accelerating the reduction of carbon emissions has become an international consensus. Therefore, reducing reliance on traditional fossil fuel has become a key step in improving carbon emissions and has also allowed the development of more environmentally friendly electric vehicles (EVs) to gain international attention and become an important beginning for the international development of electric vehicles. This study explores the key factors related to the development of electric vehicles from the four major constructs of "climate (energy)", "purchase intention", "charging issues" and "maintenance". Through the collection of literature, firstly, we found that the importance of electric vehicles comes from the business opportunities of global efforts to improve carbon emissions. Secondly, the price of electric vehicles and the subsidy policies of governments will significantly affect the purchase intention of electric vehicles. However, the common charging problems of electric vehicles include "the number, specifications, and locations of charging piles" which have become an indispensable factor in the development of electric vehicles. Next, there are the back-end maintenance issues of electric vehicles. "Repair price issues, parts price issues, and maintenance base issues" are also one of the key factors in the development of electric vehicles. Finally, through literature review, it was discovered that Taiwan has many supply chains for electric vehicles (vehicle chips, charging equipment, and other peripheral equipment manufacturers), highlighting that Taiwan has great development potential in this wave of electric vehicles development opportunities.

Keywords: Global Warming Effect, Carbon Emission, Electric Vehicles (EVs), Key Factors.

I. Research Background

In recent years, the rise in international oil prices has had a considerable impact on the global economy. In addition, the goal of reducing carbon emissions has become an international consensus, causing countries to develop alternative energy sources. In the past, humans relied excessively on fossil fuels, which produced a large amount of greenhouse gases and led to the greenhouse effect (Maw-Wen Lin, 2020), which has brought a series of environmental catastrophes to the world, such as: melting ice in the Arctic and Antarctic, rising sea levels, extreme drought, heat waves, wildfires, biological extinction, and food shortages. and other various disasters; reminding the world that we should not underestimate the risks caused by the greenhouse effect. The United Nations Intergovernmental Panel on Climate Change (IPCC) released its latest report in October 2018, stating that global temperatures will exceed the 1.5°C expected temperature increase control value as soon as 2030, leading to an accelerating rate of warming. "IPCC (Summary for Policy Makers) 2018”. It has been repeatedly highlighted that reducing carbon emissions has become the most urgent issue to be solved internationally. However, the first step to reducing carbon emissions must start with reducing the use of fossil fuels, and instead develop more environmentally friendly ones. The use of electric-powered vehicles to replace traditional fuel vehicles that rely on petrochemical energy to reduce greenhouse gas emissions has also become an important beginning for the international development of EVs.

With the international call for reducing carbon emissions and the gradual transformation of petrochemical energy, the sales of EVs have gradually gained favor in the market and become more and more popular in quantity. The development of EVs has attracted the attention of various industry officials and academia. It has become a link that countries are

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rushing to occupy. Take European and American countries as an example: U.S. President Biden announced in August 2021 the policy goal of making EVs account for 50% of new car sales in the United States by 2030. In the same year, he also announced that the U.S. federal government would make federal agency's fleet of 650,000 vehicles has all been replaced by EVs highlighting the U.S. government's determination to develop EVs. In Europe, the number of EVs registered in the EU between 2019 and 2020 has shown signs of substantial and rapid growth, with the number increasing from 3.2% in 2019 (2.1% for pure EVs and 1.1% for plug-in hybrid EVs). The EU automobile market share will increase to 10.5% in 2020 (5.3% for pure EVs and 5.2% for plug-in hybrid EVs). The number of registered electric vehicles in use has reached a milestone of 1.4 million (Heng Liu and Yun-Ting Chu, 2022). Judging from the mainstream trends in the development of EVs in European and American countries, it is clear that the popularization or development of EVs in the future has become a goal that global car manufacturers will compete for in the future.

In 2021, global EVs sales exceeded the 6.5 million mark, an increase of 109% compared to 2020. In terms of sales volume in various regions around the world, 2.92 million vehicles were sold in China, 2.2 million vehicles were sold in Europe, 640,000 vehicles were sold in the United States, 38,000 vehicles were sold in Japan, and 208,000 vehicles were sold in other parts. Annual EVs sales account for 9% of total passenger vehicle sales. Among the brand rankings, Tesla ranked first with a market share of 14%, followed by Volkswagen with a market share of 12%, and SAIC ranked third with a market share of 11%. It can be seen that Tesla EVs are the most favored by global car consumers in terms of brand sales. (Canalys Market research company, 2022)。In fact, nearly 1.4 million EVs were sold in Europe in 2020, surpassing China in quantity for the first time and becoming the world's largest EVs market. This shows that the demand for EVs in Europe is quite strong, and it has become an area that major car manufacturers are rushing to grab enter the vast market of layout.

In response to the global goal of reducing carbon emissions and in order to improve domestic air quality, Taiwan has been actively promoting the development of green transportation for many years, both from government agencies to the transportation industry. At the same time, Taiwan has been actively promoting the development of green transportation in various fields of EVs industry development. In the three key areas of automotive chips, battery development and charging equipment, many relevant manufacturers have made arrangements in advance. In addition, Taiwan itself is a global semiconductor production center. Its technology and market share in the three major semiconductor fields of IC design, wafer foundry, and packaging and testing are all internationally renowned. Therefore, it has a unique advantage in semiconductor chips and is in the global electric field. It can be said that it has a head start in the automobile industry. In view of the global shortage of automotive chips caused by the international epidemic and the surge in demand for automotive chips derived from the booming electric vehicle industry, domestic semiconductor-related companies are also sharpening their knives and waiting to take advantage of this wave business opportunities for the development of EVs. However, Taiwan not only has a complete semiconductor supply chain, but also has a complete upstream and downstream supply chain for other components of electric vehicles, from upstream raw materials, components and modules to midstream subsystems, and even in the key systems: batteries, motors, electronic controls, central control panels, charging piles and charging bases, relevant manufacturers have already invested in the market. This shows that Taiwanese manufacturers have put their efforts into various fields of EVs development, giving full play to Taiwan's unparalleled strong manufacturing industry strength, allowing Taiwan's industry to shine in this wave of global EVs development business opportunities.

II. Literature Review

2.1. Greenhouse Effect Background

The first IPCC report in 1990 pointed out that "human activities may cause increases in greenhouse gas emissions." In 1995, various evidence showed that humans have an identifiable impact on global climate. In 2001, new evidence showed that; in the past five years, the main cause of the warming observed in the past decade is human activities. Most of the global temperature increase observed since the mid-20th century in the past 200 years is very likely due to the increase in anthropogenic greenhouse gas concentrations occurrence, it also proves that the relationship between global warming and human activities is extremely close (IPCC, 2007). Global warming is the most serious comprehensive environmental problem currently faced by human beings. Since the Industrial Revolution, the average surface temperature has increased by 0.8 degrees Celsius over the past 100 years, causing climate anomalies, water shortages, ecosystem collapse and other phenomena. The international community has gradually established a consensus on the causes, impacts and response measures of global warming. However, the issue of global warming is very complex. Countries around the world have actively promoted many education programs on global warming, and have used media propaganda and communication methods to enhance people's understanding of global warming and related principles. Therefore, we hope that many people can seriously face the various environmental issues caused by global warming with a positive attitude.

The "greenhouse effect" refers to the process by which greenhouse gases in the Earth's atmosphere absorb heat from the sun. When solar radiation hits the earth, part of it is absorbed by the earth's surface, while part of it is reflected back into the atmosphere, where it is easily absorbed by greenhouse gases in the atmosphere, thereby retaining the sun's radiant heat and causing the atmosphere to warm. Appropriate greenhouse gases can keep the temperature of the atmosphere constant. However, in recent years, the excessive use of fossil fuels by humans has led to the production of excessive greenhouse gases, which has abnormally intensified the greenhouse effect on the earth and caused global warming. The so-called "warming" refers to the phenomenon that the global average temperature increases due to the greenhouse effect in the atmosphere and oceans on the earth's surface. During the period when the earth's temperature rises, the intensity and frequency of extreme weather will increase, such as heavy rainfall, high temperature heat waves, droughts and other phenomena (Taipei City Government Environmental Protection Bureau, 2018).

2.2. Current Situation of Global Warming

Global warming caused by climate change is becoming increasingly serious, resulting in an increasingly harsh living environment. Since the Industrial Revolution in the 19th century, humans have used a large amount of fossil fuels such as oil, natural gas, and coal, resulting in the emission of large amounts of greenhouse gases into the atmosphere, such as CO2, O3, CH4, nitrous oxide, N2O and CFCs have caused the global temperature to rise abnormally. According to statistics from the National Oceanic and Atmospheric Administration of the United States, the global concentration of carbon dioxide is getting higher and higher. In 2015, the concentration of carbon dioxide exceeded 400 ppm, and the global average land and ocean surface temperatures are higher than the global average in the 20th century (1910-2000). The temperature increased by 0.9° C, making it the hottest year since meteorological records began in 1880. As global warming affects all parts of the world, it has a huge impact. Common examples include: rising sea levels caused by melting ice in the Arctic and Antarctic, frequent floods and droughts caused by extreme climates, desertification, and species decline, etc. Its impact has become an urgent and important issue for mankind around the world.

2.3. Development History of EVs

The development of electric vehicles can be traced back to the 19th century. In 1828, the Hungarian physicist Ányos Jedlik first experimented with an electromagnetic rotating mobile device in the laboratory, and was later developed by the American Thomas Davin. Thomas Davenport successfully manufactured the first DC motor-driven electric vehicle in 1834, which also enabled Thomas's technology to obtain the first patent in the American motor industry in 1837. It also became the leader in the development of electric vehicles in the world. In the 20th century, with the development of oil and the improvement of internal combustion engine technology, electric vehicles gradually lost their original market advantage after 1920, and the electric vehicle market was gradually replaced by internal combustion engine-driven vehicles. The development of the automobile industry has made rapid progress in recent decades. As the times change, fossil resources are dwindling, environmental pollution is intensifying, global warming and other factors have also caused governments around the world to face up to electric vehicles. issues of automobile development. As global warming is gradually intensifying, the mainstream of the world is moving more towards green environmental protection, energy conservation and carbon reduction, and sustainable coexistence, leading the traditional automobile industry to gradually transform and move towards a new era of developing green energy and environmentally friendly vehicles.

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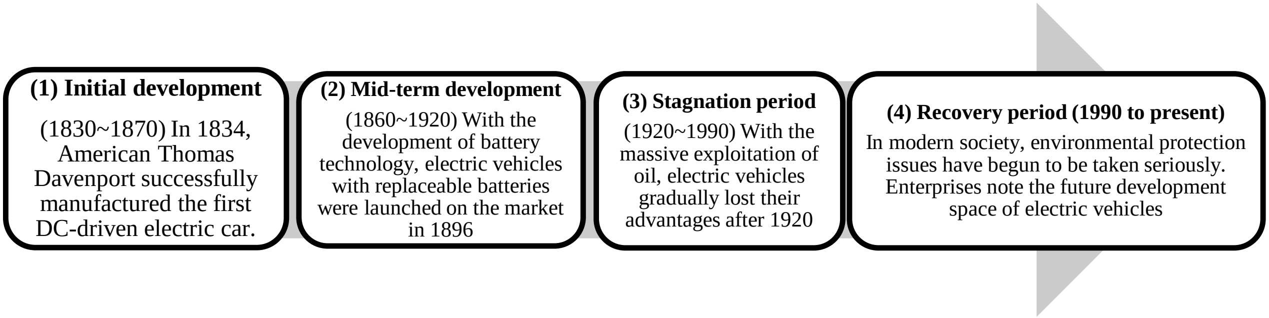

Electric vehicle development and evolution chart Fig. 2-3
Source: Compiled by this study

2.4. Current Status of Global EV Development and Taiwan's EV Development Policy

According to the "EV-Volumes Research Report", the global EV market will grow rapidly in 2021, with EV sales reaching a new high of 6.75 million units, an increase of 108% compared to 2020. At present, European countries have offered high car purchase subsidies to increase the overall willingness to purchase EVs. Germany has launched a pure EV purchase subsidy program, increasing the original subsidy of 6,000 euros to a high subsidy of 9,000 euros; the UK can receive up to 2,500 pounds in subsidies for EVs with a retail price below 35,000 pounds. EVs are not required to pay fuel tax and vehicle consumption tax. France has announced a subsidy policy for environmentally friendly vehicles. Anyone who purchases an EV can receive a government subsidy of 7,000 euros. If you switch from a gasoline or diesel vehicle to an EV, you can receive an additional subsidy of up to 5,000 euros. The United States proposed a domestic investment bill in 2021 to stipulate subsidy measures for EVs, specifically stipulating that EVs must be "made in the United States" before they can apply for tax incentives of up to US$12,500. China has announced that it will terminate subsidies for EVs and gasoline-electric hybrid vehicles at the end of 2022, and the original subsidy measures will be gradually reduced by 30% from the beginning of 2022, and will eventually be completely eliminated by the end of 2022. In order to increase the market's share of EVs in the country, Japan plans to double the original subsidy amount of 400,000 yen for EVs to a maximum subsidy amount of 800,000 yen, while the subsidy amount for plug-in hybrid vehicles will increase by 2.5 times, the subsidy is adjusted to a maximum of 500,000 yen. From the above-mentioned EV subsidy policies in various countries around the world, it can be seen that the development of EVs has become a mainstream trend internationally. (Jing-Dian Chen, 2020).

In response to the global net-zero emissions trend and supply chain carbon reduction pressure, the NDC proposed the "2050 Net-Zero Emissions Path" policy briefing in March 2022, during which it was pointed out that Taiwan is expected to achieve an annual EVs /E-scooters market sales ratio of 100% goal. Preliminary plan of the Executive Yuan inter-ministerial meeting: the market shares of EV/E-scooter in 2030 will gradually increase from the original 30% to 35%, and the market share of EVs will reach the target of 100% in 2040. According to statistics on the number of domestic EVs in 2021, EV sales in 2021 will reach 7,064 units, an increase of 112% compared to 6,257 units in 2020. In terms of domestic EV brand sales in 2021, Tesla, Porsche, and Audi models occupy the top three domestic sales.

There are two categories of EVs in Taiwan: EVs and E-scooters, among which electric motorcycles have the most widespread popularity. The number of E-scooters sold in 2021 will reach 93,106 units. According to the government's plan, newly sold EVs /E-scooters will simultaneously achieve the target of 100% market share by 2040; At the same time, it also plans to increase domestic market demand by offering policy incentives such as electric official vehicles, electric taxis, and subsidies for car purchases (Wen-Ji Tsai, Bing-Huang Wu, 2016). In terms of manufacturing, through a two-pronged approach of policy guidance and subsidies to related industries, the manufacturing of EVs has been able to stay in Taiwan and accelerated the development and production of domestic EV products. Part of the supporting measures is the current plan of the Ministry of Economic Affairs of "Construction of Public Charging Piles". The goal of the "Purchase Plan" is to increase the "number of public charging piles" in Taiwan to up to 7,800 by 2025 to complete the use environment for EVs.

2.5. Factors in the Development of EVs

The development of EVs has become a

mainstream trend for global car manufacturers. As the development of EVs complies with increasingly stringent international environmental protection and energy-saving requirements, "green energy battery development" will become very important. Therefore, the development of EV batteries is closely related to the performance of EVs. Currently, the majority of global EV battery supply is in the hands of Japan, South Korea, and China. Taiwan currently does not have many advantages in electric vehicle batteries; However, domestic battery-related suppliers still include: COREMAX, MECHEMA CHEMICALS, and Advanced Lithium Electrochemistry (KY) providing battery cathode materials. Manufacturers that supply battery anode materials include: CHINA STEEL CHEMICAL (CSCC), GIGASOLAR MATERIALS and Long Time Technology, etc. In terms of battery isolation film suppliers: BenQ Materials, battery core suppliers include: Delta Electronics, CSRC Group, SYNergy ScienTech and other manufacturers. It can be seen from this that even though Taiwan's battery supply industry has no advantages, there are still many suppliers in this field. Therefore, it can be known that Taiwan has a bright future in the field of battery supply chain. The specification, development, and construction of charging equipment such as "charging piles" for charging electric vehicles have also become a key part of the development of electric vehicles. Currently, charging piles in Taiwan are divided into two charging modes: DC fast charging and AC slow charging. In terms of DC fast charging, there are currently four specifications (CCS1/CCS2, CHAdeMO, Tesla TPC). The AC part has three specifications (Tesla TPC, Type1/Type2), which can be said to be a wide variety. Taiwan's charging equipment industry has been waiting for a long time to seize the business opportunities brought by this wave of EV development. Among them, many manufacturers have entered the three major fields of charging equipment (charging guns, charging piles/charging stations, and charging station operations); demonstrates Taiwan's strong charging equipment supply chain lineup.

Affected by factors such as global car manufacturers' rush to attack the electric vehicle market and the current shortage of "automotive chips" in the world, it can be expected that the demand for "automotive chips" in the international semiconductor market will be stronger in the future. Additionally, achievements in the three major fields of traditional battery development, charging equipment, and semiconductor automotive chips, Taiwan's EV suppliers are also heavily involved in other peripheral fields of electric vehicles, such as central control panels, central control computers, and electronic controls. Unit (ECU), automotive electronic chips, transmission system components, constant speed drive shafts, and motor supply. It shows that Taiwan's industry in the EV supply chain covers a wide range of areas, from semiconductor manufacturing to the development of charging equipment and the supply of other peripheral equipment. It demonstrates Taiwan's high-tech industrial strength and enables Taiwan to compete in the international EV industry. It occupies a very important key position in the market.

2.6. Charging Equipment

(1). Charging Equipment Specifications

With the vigorous development of EVs around the world, the setting of charging piles has become one of the key issues in the current development of EVs. At this stage, there are 5 specifications of international mainstream charging piles: Japanese standard CHAdeMO (fast charging), European and American CCS1/CCS2 (Fast and slow charging), China's GB/T (fast and slow charging), Tesla's own specifications TPC (fast and slow charging). EV charging facilities in Taiwan have two modes: "AC alternating current" and "DC direct current". The DC fast charging part currently has four specifications (CCS1/CCS2, CHAdeMO, Tesla TPC), and the AC part has (Tesla TPC, Type1/Type2), the current domestic charging stations mostly use the "CCS1+CHAdeMo" dual-gun configuration. Tesla, which currently ranks first in the Taiwan market, announced that starting from the third quarter of 2021, new vehicles will adopt CCS2 charging specifications. The problem of mixed charging pile specifications around the world has also prompted EV manufacturers to start solving the problem of mixed charging pile specifications under the market mechanism in order to meet the charge needs of various countries; at this stage, the only way to overcome the current multiple specifications is to convert chargers. Kind of question (Andy Chen, 2021).

(2). Number of Domestic Charging Piles

Currently, there are a total of 1,143 charging stations in Taiwan, with more than half of them concentrated in the three major counties and cities including Taipei City, New Taipei City, and Taichung City. The total number of charging stations is 588, accounting for 51% of the total number of charging stations. It is known as a science and technology city. Hsinchu City also has only 27 charging stations. This shows that there is a large gap in the distribution of the number of charging stations in Taiwan. (Marco

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Hu, 2021). In order to increase the number of domestic charging stations, the "Public Charging Pile Construction Plan" planned and promoted by the Ministry of Economic Affairs aims to build 7,200 slow charging stations and 600 fast charging stations across Taiwan by 2025, bringing the total number of charging stations in Taiwan to The target is 7,800 seats (Yi-Jun Shi et al., 2021).

(3). Electric Vehicle Supply Chain

Automotive chips: At present, the majority of global automotive semiconductor suppliers are European and American manufacturers, including Infineon, NXP, STMicroelectronics, Renesas, TI and other major IDM manufacturers, which hold about 84% of the global market share. Since 2020, due to the impact of the epidemic, the rebound of the semiconductor market, and the strong demand for EVs, automotive semiconductors have been in short supply in the international market. At present, most of the global semiconductor automotive chips are developed and produced by European and American IDM (vertically integrated manufacturing) factories, while the proportion of outsourcing is about 20% to 30%, mainly producing MCU (microcontroller). Among them, up to 60% to 70% of the outsourced automotive MCU parts are manufactured by TSMC, making TSMC occupy a key position in global automotive MCU production (analyzed by the Institute of Industrial Intelligence of the Policy Council). However, automotive chip production is mainly based on 8-inch factories, and some use the mature processes of 12-inch factories. In addition to the two major wafer foundries in Taiwan, TSMC and UMC, there are also complete semiconductor peripheral suppliers to share in this wave of global shortages of automotive chips.

Table of domestic automotive chip supply chain manufacturers Tab. 2-1

Taiwan automotive chip supply chain manufacturer	
TSMC	8-inch and 12-inch wafer foundry
UMC	8-inch and 12-inch wafer foundry
Vanguard International Semiconductor Corporation	8-inch wafer foundry
Episil Holding Inc.	6-inch wafer foundry and silicon wafer
MOSEL VITELIC INC.	6-inch wafer foundry
ASX-ASE Technology Holding Co., Ltd.	Automotive logic IC packaging and testing and EMS
Ardentec Corporation	Automotive MCU and power component packaging
TONG HSING ELECTRONIC	Automotive CIS component packaging
Jih Lin Technology Co., Ltd.	Automotive power component lead frame

Source: Compiled by this study

(4). Battery Energy and Charging Equipment Supply Chain

In order to welcome the advent of the era of rapid EV growth and cooperate with the government's promotion of the "Public Charging Pile Construction Plan", Taiwan's demand for charging equipment has surged. Taiwan has developed three major charging equipment fields: "charging guns, charging station/charging pile construction, and charging station operation". There are already relevant supply chain players in Taiwan making arrangements in advance. Among them, Delta Electronics, Inc. began to enter the field of vehicle power supply as early as 2008, and is now actively investing in the charging station/charging pile market. In addition, domestic charging pile companies include TECO, TAI YUE ELECTRIC, PHIHONG TECHNOLOGY and other manufacturers, among which TAI YUE ELECTRIC has even worked with Tesla to build six super charging stations in Taiwan. In addition, PHIHONG TECHNOLOGY has also cooperated with Jaguar and Audi, and will build "Audi high-speed charging stations" across Taiwan in the future. However, in addition to operating in the field of charging equipment, Taiwan's supply chain players are also heavily involved in other EV peripheral fields, such as central control panels, central control computers, electronic control units (ECUs), and automotive electronic chips. In various fields of this wave of EVs supply chain, whether it is semiconductor manufacturing, charging equipment development and other peripheral equipment supply, Taiwan has demonstrated its strong industrial strength to the world, allowing Taiwan to get a share of the international EVs market.

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III. Methodology

The purpose of this questionnaire is to explore the key factors related to the development of EVs. The questionnaire used is the "Key Factors in the Development of EVs-Research Questionnaire" compiled by the researcher as a research tool, and a LIKERT five-point scale is used, which is "strongly agree" and "agree", "Common", "Disagree" and "Strongly Disagree" provide respondents with the opportunity to rate the importance of issues related to EVs development overview. Among them, "strongly agree" is scored as 5 points, and "strongly disagree" is scored as 1 point. Distribution period: From December 1, 2023 to the end of February 2024, a total of 360 questionnaires were distributed, and 309 valid questionnaires were recovered. The effective recovery rate reaches 85.83%.

3.1. Questionnaire Design

The questionnaire items in this study were based on relevant empirical research literature, and four major constructs were used in the questionnaire design, including "climate and energy issues", "purchase intention issues", "charging issues" and "maintenance issues". Provide respondents with answers in a step-by-step manner. The configuration of the questions explores the key factors related to EV development from the perspective of climate and energy, and also includes other key factors that may affect the development of EVs such as: purchase intention issues, charging issues, and maintenance issues. The purpose is to explore the key development factors affecting EV.

3.2. Research Structure

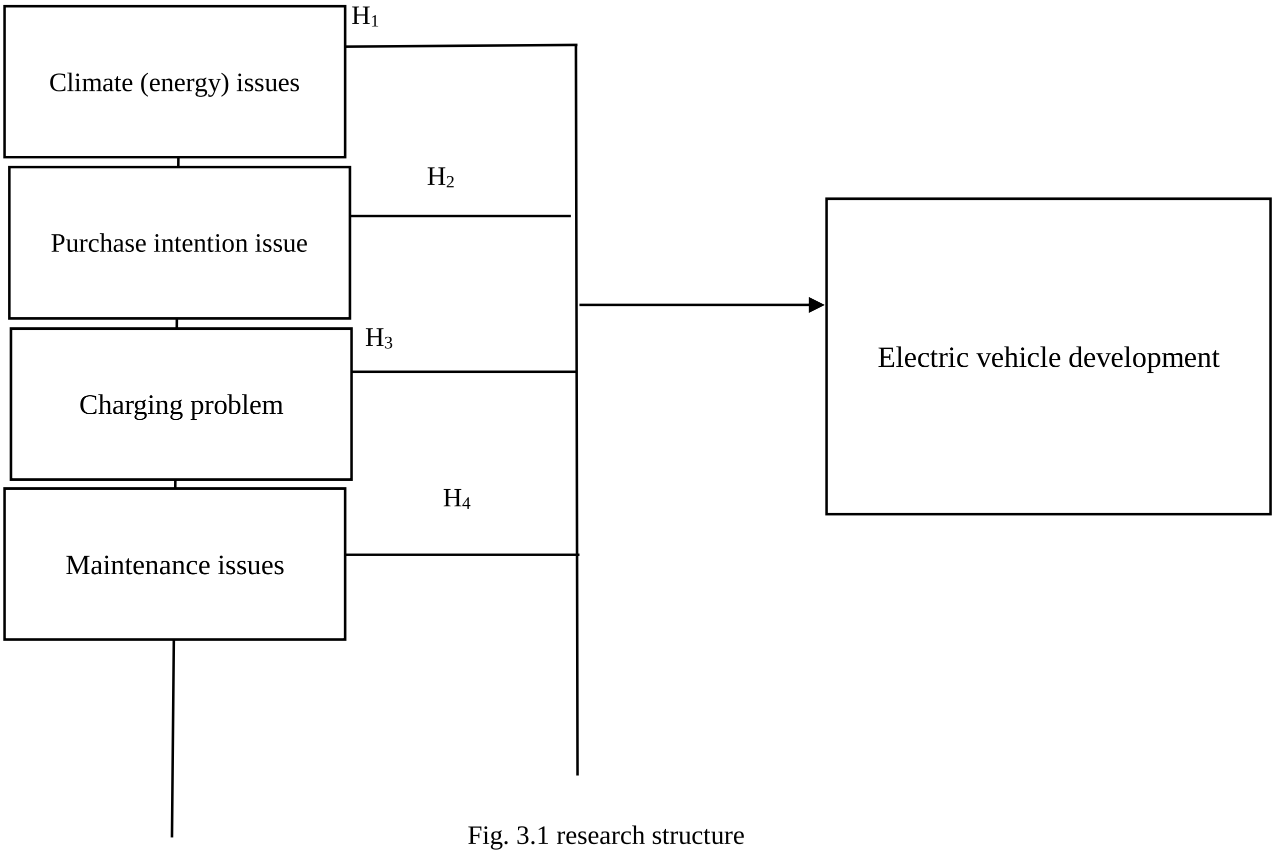

Fig. 3.1 research structure

Based on the research structure of this study, the relevant research hypotheses are proposed as follows:
H_1: Climate (energy) is significantly related to the development of electric vehicles.
H_2: Purchase intention is significantly related to the development of electric vehicles.
H_3: Charging issues are significantly related to the development of electric vehicles.
H_4: Maintenance issues are significantly related to

the development of electric vehicles.

3.3. Research Tool

This study mainly explores the key factors affecting the development of EVs. It uses the "Questionnaire on Key Factors in the Development of Electric Vehicles" as a research tool and adopts a questionnaire survey method. This questionnaire collects relevant literature and the policy directions of international countries, and based on relevant measurement scales made up of modifications. The questionnaire content includes four parts: "climate (energy) issues", "purchase intention issues", "charging issues", and "maintenance issues". The options are "Strongly Agree", "Agree", "Normal", "Disagree" and "Strongly Disagree", measured using a five-point LIKERT scale.

3.4. Data Analysis Methods

3.4.1. Descriptive Statistics Analysis

This research uses descriptive statistics to analyze basic relevant data, and calculates the frequency distribution, percentage, mean, and standard deviation of each variable to understand the distribution of sample data.

3.4.2. Factor Analysis

Factor analysis is to use the covariance correlation coefficient of multiple independent variables to simplify the data structure and find meaningful, independent and common factors that will affect the original data from the relevant and difficult-to-interpret data. Factor analysis is the most commonly used statistical method for validity analysis when doing scale research, and factor analysis is divided into two categories: (1) Exploratory Factor Analysis(EFA), the main purpose is to explore how many potential factors there are in a group of observation variables, and set a group of observation variables to be affected by the same common factor. The most commonly used estimation methods are the principal component method and the principal axis factor method. (2) Confirmatory Factor Analysis (CFA), in verifying the structure data of the scale and confirming the existence of the structure, the main purpose is to measure whether the tool is appropriate for the collected data, so it can only be used for the already developed factors The most commonly used estimation method is the maximum likelihood estimation method (MLE).

This study uses factor analysis, extracts common factors through principal component analysis, and tests the construct validity of brand image and purchase intention. The criterion for evaluating convergent validity is the factor loading, referring to the viewpoint of Hair et al. (1992), which is less than 0.4 the factor loading of is too low, and above 0.6 is high significance, indicating that the scale has good construct validity.

3.4.3. Reliability Analysis

Reliability refers to the consistency, reliability and stability of measurement tools. After factor analysis, in order to understand the reliability and validity of the questionnaire, reliability analysis is usually required. The higher the reliability of the scale, the higher the stability. In 1951, Cronbach proposed the α coefficient, which is the most commonly used reliability test method in scientific research. When the reliability of Cronbach's α coefficient is above 0.7, it means that the reliability of the scale is within the acceptable range. This study uses Cronbach's α coefficient reliability analysis on the brand image and purchase intention questionnaire items. It is generally believed that the Cronbach's α coefficient is above 0.9, indicating that the reliability is very good, and above 0.7 is acceptable. The higher the Cronbach's α coefficient, the higher the reliability.

3.4.4. Analysis of Variance(ANOVA)

Analysis of variance (ANOVA) is a statistical method commonly used in data analysis. Used to test that the independent variable factor is equal to or exceeds the mean difference between the three categories. Calculate the mean square between groups and within the group, and estimate the F value. If there is a significant difference in the F value, then perform a post hoc comparison. In this study, one-way ANOVA was used to verify the differences in the means among the groups. If there is a significant difference, Scheffé's method will be used for post hoc comparison to explore the differences between groups.

IV. Data Analysis Results

4.1. Descriptive Statistical Analysis

4.1.1. Gender

Gender distribution of respondents: 159 were male, accounting for 51%; 150 were female, accounting for 49%.

4.1.2. Age

Age distribution of respondents: 60 people were under 20 years old, accounting for 19%; 142 people were between 21 and 30 years old, accounting for 46%; 32 people were between 31 and 40 years old, accounting for 10%; 32 people were between 41 and 50 years old, accounting for 10%. 10%; 30 people aged 51 to 60, accounting for 10%; 13 people aged 61 or over, accounting for 4%. It is obvious that the majority of the respondents are 21 to 30 years old, followed by those under 20 years old. The two account for 66.5% of the sample. It is speculated that

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20 to 30 years old is the main group, as shown in the table.

4.1.3. Education Level

Educational distribution of respondents: 0 people are in primary school or below, accounting for 0%; 1 person is in junior high school, accounting for 0%; 50 people are in high school, accounting for 16%; 32 people are in junior college, accounting for 10%; 209 people are in university, Accounting for 68%; the institute has 17 people, accounting for 6%. It is obvious that the majority of respondents are in college age, followed by those in high school. High school (vocational), junior college, and university accounted for 97% of the sample.

4.1.4. Living Area

Distribution of respondents' living areas: Taipei, New Taipei City, Keelung, 59 people, accounting for 19%; Taoyuan, Hsinchu, Miaoli, 206 people, accounting for 67%; Taichung, Changhua, Nantou, 24 people, accounting for 8%; Yunlin, Chiayi, Tainan, 2 people, accounting for 1%; Kaohsiung, Pingtung, 5 people, accounting for 2%; Yilin, Hualien, Taitung, 6 people, accounting for 2%; others, 7 people, accounting for 2%. It is obvious that the majority of the respondents were from Taoyuan, Hsinchu and Miaoli, followed by Keelung, Taipei and New Taipei. Taoyuan, Hsinchu and Miaoli, Taipei, New Taipei and Keelung, and Taichung, Changhua and Nantou accounted for 96.3% of the sample.

4.1.5. Monthly Income

Distribution of respondents’ monthly income: 174 people made less than NT$30,000, accounting for 56.3%; 64 people made NT$ 30,001~50,000, accounting for 21%; 53 people made NT$50,001~80,000, accounting for 17%; The above for NT$100,000 yuan are 9 people, accounting for 3%. It is obvious that the majority of the respondents are those with less than NT$30,000, followed by those with NT$30,001 to NT$50,000, and NT$30,000 to NT$80,000 accounting for 43.7% of the sample.

4.2. Factor Analysis

Before factor analysis, KMO and Bartlett's spherical test can be used to judge whether the data are suitable for factor analysis. KMO (Kaiser-Meyer-Olkin) test, according to the sampling suitability quantity proposed by Kaiser (1974), the value of KMO is between 0 and 1, and the closer the value is to 1, the higher the common factors related to the variable are, the more suitable it is conduct factor analysis. A KMO value above 0.9 means excellent results, and above 0.8 means valuable. The KMO value in this study is 0.929, which means that the factor analysis effect of this study is excellent. After Bartlett's spherical test, the significance = 0.000 < α=0.01, Indicates that this study is well suited for factor analysis.

Tab. 4-1. KMO test table

Kaiser-Meyer-Olkin Sampling Suitability Quantity		.929
Bartlett's Sphere Test	Approximate Chi-Square Allocation	5588.195
	Degrees of freedom	465
	Significance	0.000

Source: Compiled by this study

Tab. 4-2. Factor analysis (1)

Factor One	Electric vehicle(EV) charging piles and batteries
Q1	Is the popularization of EVs charging piles a key factor in the development of EVs?
Q2	Is the battery life of EVs a key factor in the development of EVs?
Q3	Will the charging efficiency of EVs be a key factor in the development of EVs?
Q4	Is the safety issue of EVs lithium batteries a key factor affecting the development of EVs?
Q5	Will the consistent specifications of EVs charging piles make it more convenient for you to charge?
Q6	Is the number of EVs charging piles a key factor in the development of EVs?
Q7	Are EVs charging specifications a key factor affecting the development of EVs?
Factor two	EVs carbon emissions and environment

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Q8	Do you think the development of EVs can effectively improve the carbon emission problem?
Q9	Do you think the reason for developing EVs is that EVs can effectively reduce environmental pollution problems?
Q10	Do you think the popularity of EVs can reduce the problem of air pollution?
Q11	Do you think the popularity of EVs can slow down the problem of global climate warming?
Q12	Do you think the popularity of EVs can help improve air quality?
Q13	Do you think the spread of EVs can improve the problem of rising global temperatures?
Q14	Do you think the development of electric vehicles is mainly due to the gradual decrease of petroleum energy?
Factor three	EVs equipment and styling
Q15	Will the interior features of EVs affect your willingness to purchase EVs?
Q16	Will the appearance design of EVs affect your willingness to buy EVs?
Q17	Will the number of EVs charging piles affect your willingness to buy EVs?
Q18	Will the charging time of EVs affect your willingness to buy EVs?
Q19	Will the performance and performance of EVs affect your willingness to purchase EVs?
Q20	Will the safety issues of EVs affect your willingness to purchase EVs?
Q21	Will the price of EVs affect your willingness to buy EVs?
Q22	Will the cruising range of EVs affect your willingness to buy EVs?
Factor four	Parts replacement and maintenance prices
Q23	Do you think the replacement price of EVs is a key issue in maintenance?
Q24	Are you worried about the cost of raising EVs?
Q25	Do you think the replacement battery price of EVs is a key issue in maintenance?
Q26	Are you worried about the overall ownership cost of EVs?
Q27	Do you think EVS battery life is a key issue in maintenance?
Q28	Do you think the number of EVS maintenance bases is a key issue in the development of EVS?

Source: Compiled by this study

Tab. 4-3. Factor analysis (2)

Factor	Factor loading	Eigenvalue	**Explained variation (%)**
Factor One: EVs charging piles and batteries Q1 Q2 Q3 Q4 Q5 Q6 Q7	0.75 0.73 0.71 0.70 0.70 0.64 0.59	11.70	37.748
Factor Two: EV carbon emissions and environmental improvement Q8 Q9 Q10 Q11 Q12 Q13	0.83 0.83 0.79 0.79 0.76 0.76 0.65	3.42	11.057

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Q14			
Factor Three: EV equipment and styling			
Q15	0.74		
Q16	0.74		
Q17	0.70		
Q18	0.67	1.70	5.502
Q19	0.65		
Q20	0.95		
Q21	0.58		
Q22	0.56		
Factor Four: Parts replacement and maintenance prices			
Q23	0.79		
Q24	0.75	1.42	4.583
Q25	0.73		
Q26	0.63		
Q27	0.62		
Q28	0.55		

Source: Compiled by this study

Factor one is mainly composed of factors such as "popularization of charging piles", "battery life", "charging efficiency", "lithium battery safety", "specifications of charging piles", "number of charging piles", and "charging specifications". Its factor loading ranges from 0.59 to 0.75, and its eigenvalue is 11.70, which can explain 37.748% of the variation. Since the first two factor loadings are relatively high, this factor is named "Electric Vehicle Charging Pile and Battery".

Factor two is mainly composed of factors such as "improving carbon emissions", "reducing environmental pollution", "reducing air pollution", "mitigating global warming", "helping to improve air quality", "mitigating the rise in earth temperature" and "gradually reducing petroleum energy". Its factor loading ranges from 0.65 to 0.83, its eigenvalue is 3.42, and its explainable variation is 11.057%. Since the first two factor loadings are relatively high, this factor is named "Electric Vehicle Carbon Emissions and Environment".

Factor three is mainly composed of factors such as "interior equipment", "appearance design", "number of charging piles", "charging time", "performance", "safety issues", "price of electric vehicles", and "mileage". Its factor loading ranges from 0.56 to 0.74, and its eigenvalue is 1.70, which can explain 5.502% of the variation. Since the first two factor loadings are relatively high, this factor is named "Electric Vehicle Equipment and Style".

Factor four is mainly composed of factors such as "parts replacement price", "maintenance cost", "battery replacement price", "holding cost", "battery life" and "number of maintenance bases". Its factor loading ranges from 0.55 to 0.79, and its eigenvalue is 1.42, which can explain 4.583% of the variation. Since the first two factor loadings are relatively high, this factor is named "Parts Replacement and Maintenance Price".

4.3. Reliability Analysis

Based on the scores of the answered questions, the Cronbach' alpha coefficient of each question is calculated. The Cronbach'α coefficient of basic research must reach at least 0.8, and in exploratory research, the Cronbach'α value only needs to reach 0.7. This study conducted a reliability analysis on the questionnaire, and the results showed that the Cronbach'α value was 0.942, and the reliability was greater than 0.7. Therefore, this study conforms to Nunnally's (1978) reliability level, indicating that the reliability level is quite good. The reliability of constructs such as "climate (energy) issues", "purchase intention issue credibility", "charging issues" and "maintenance issues" are all greater than 0.7. Therefore, this study meets the requirements for the reliability level of exploratory research, as shown in the table as shown in Table 4.4.

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Table 4-4. Reliability analysis

Constructs	Cronbach's Alpha value	Number of items
Credibility of climate (energy) issues	0.896	8
Purchase intention question credibility	0.886	9
Charging problem credibility	0.889	8
Maintenance issues credibility	0.872	6

Source: Compiled by this study

4.4. Analysis of Variance
4.4.1 Gender
According to the data, factors such as the number of charging piles, maintenance, purchase intention, and climate warming in order of importance as follows: number of charging piles, maintenance, purchase intention, and climate warming. After step by step F test, the level of attention was tested by gender, and it was found that the significance was > α = 0.05. Therefore, factors such as "number of charging piles", "repair and maintenance", "purchase intention" and "climate warming" are not significant. There are significant differences among different genders.

4.4.2. Age
H_0: It is assumed that age is not positively correlated with the number of charging piles, willingness to purchase electric vehicles, and climate warming.
H_2: It is assumed that age is positively correlated with the number of charging piles, willingness to purchase electric vehicles, and climate warming.

According to the analysis results, it can be seen that factors such as the number of charging piles, maintenance and repair, purchase intention, and climate warming, in order of importance, the number of charging piles, repair and maintenance, purchase intention, and climate warming. Using F tests one by one and grouping them by age, the degree of attention to them was tested. It was found that factors such as "number of charging piles", "purchase intention" and "climate warming" were all <α=0.05, so all three factors will vary depending on age. There is a significant difference. "Number of charging piles" is more important to people aged 31 to 40 and those over 60 years old; "Purchase intention" is more important to people over 60 years old; "climate warming" is also more important to people over 60 years old. H_2 is partially established.
4.4.3 Educational Level
H_0: It is assumed that there is no positive correlation between education level, the number of charging piles, the willingness to purchase electric vehicles, and climate warming.
H_3: It is assumed that education level is positively correlated with the number of charging piles, willingness to purchase electric vehicles, and climate warming.
According to the analysis results, it can be seen that factors such as the number of charging piles, maintenance, purchase intention, and climate warming, in order of importance, are: maintenance, purchase intention, and climate warming. After using the F test to test the degree of attention by age group, it was found that factors such as "purchase intention" and "climate warming" are all < α=0.05, so there are significant differences among the three factors due to different educational levels. "Purchase intention" and "climate warming" are more important to those with a college degree. H_3 is partially established.

4.4.4. Living Area
H_0: It is assumed that residential area is not positively related to climate warming.
H_4: It is assumed that residential area is positively related to climate warming.
According to the analysis results, factors such as the number of charging piles, maintenance and repair, purchase intention, and climate warming are ranked in order according to their importance. Then use the F test to test the level of attention based on age groups; it was found that only factors such as "climate warming" <α=0.05 will vary depending on the area of residence. As for the "climate warming" construct, people living in Yunlin, Chiayi, and Tainan areas pay more attention to it, so H_4 is established.
4.4.5. Monthly Income
H_0: It is assumed that monthly income is not positively correlated with the number of charging piles, willingnessZto purchase electric vehicles, and climate warming.
H_5: It is assumed that monthly income is positively

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correlated with the number of charging piles, willingness to purchase electric vehicles, and climate warming.

According to the analysis results, it is known that factors such as the number of charging piles, maintenance and repair, purchase intention, and climate warming. In order of importance, they are the number of charging piles, repair and maintenance, purchase intention, and climate warming. Then use the F test to test the importance of grouping by monthly income. It is found that the factors such as "number of charging piles", "purchase intention" and "climate warming" are all $<\alpha=0.05$, so all three factors will be affected by the difference in monthly income. , and there is a significant difference. "Number of charging piles" is more important to those with a monthly income of NT$50,001~80,000 and above, while "Purchase Intention" is more important to those with a monthly income of NT$50,001~80,000; while "climate warming" is still more important to those with a monthly income of NT$30,001~80,000 who pay more attention to it. So H_5 is partially established.

V. Conclusion and Suggestion

5.1. Conclusions

Through literature review, this study found that the problem of global warming is accelerating and has attracted great attention from the international community, which has led to the development of electric vehicles. Through the questionnaire responses of the interviewees and subsequent data collection and statistical analysis, after analysis and sorting, the following conclusions are obtained:

According to the results of descriptive statistical analysis, the majority of the respondents in this study are male, the majority of respondents are between 21 and 30 years old, the majority of the respondents have university education, and the majority of the respondents live in the Taoyuan, Hsinchu, and Miaoli areas. The highest monthly income is for those with a monthly income of less than NT$30,000. According to the statistics of the interviewees, regardless of gender, age, education level, area of residence, and monthly income, there are different considerations for the "issue of electric vehicle development". Therefore, if it is necessary to further explore the respondents' views on the "key development factors of electric vehicles", it is necessary to further expand the scope and formulate hypotheses on various possible key reasons to facilitate subsequent research.

The single-factor variance analysis of this study shows that respondents with different ages, education levels, living areas, and monthly incomes will have different views on "key development factors ofEVs". Therefore, taking the "EV issue" into account and evaluating factors such as age, education level, living area, monthly income, etc., and then exploring the "key factors for the development of EVs" is the key direction of this study.

This study sorted out four "key factors for the development of EVs" based on the responses from the respondents: EV carbon emissions and the environment, EV equipment and styling, EV charging piles and batteries, and parts replacement and maintenance prices. In terms of carbon emissions and the environment, for example: whether carbon emissions can be improved, whether environmental pollution can be reduced, whether the rise in earth temperature can be mitigated, etc. The main reason why EVs have attracted attention is that they can reduce carbon emissions and contribute to environmental improvement to a certain extent. The research results show that the equipment and styling of EVs are highly correlated with purchase intention. Therefore, if car manufacturers can put more ingenuity into the exterior design and interior configuration of EVs, they will be abler to win the support of consumers. In addition, it is known from the analyzed data that electric vehicle charging piles and battery performance are the key factors that all consumers pay most attention to when it comes to EVs, such as: battery life, battery charging speed and charging efficiency, and the number of charging piles. The overall performance of EVs is as important as the heart of the human body, which highlights that the battery and charging issues of EVs will become the most critical issues in the subsequent development of EVs. From the analysis results, this study found that parts replacement and maintenance prices are closely related to car owners' expenditures. Therefore, the maintenance costs, parts replacement prices and the number of maintenance bases of EVs have become the key factor to the development of EVs.

5.2. Recommendations

Regarding the key development factors of EVs, based on the above research conclusions, the following suggestions are put forward for the future prospects of EVs:

1. Climate (Energy) issues

It is suggested that government agencies can prioritize the electrification of public transportation equipment in urban areas where domestic air pollution problems are relatively serious, and use subsidies or policy guidance to enable public transportation operators to replace their public transportation vehicles and use green energy. This method seeks to reduce the generation of mobile pollution sources caused by mass transportation and improve the long-term problem of regional air pollution.

2. Purchase intention issue

The price of EVs makes people feel that it is unattainable. It is recommended that car manufacturers try to reduce production costs in the manufacturing part to make the sales price more approachable, so as to increase consumers' willingness to purchase EVs

3. Charging problem

In terms of charging equipment, many large manufacturers in Taiwan have been in operation and exported internationally for many years. Domestic related companies have also made many technological breakthroughs in key areas. Therefore, it is recommended that relevant government agencies can come forward to lead various domestic charging equipment manufacturers and charging equipment operations. businessmen jointly organized the "EVs Charging Equipment Taiwan Team" to lead domestic manufacturers to jointly seize this wave of EVs business opportunities.

4. Maintenance issues

Regarding the maintenance bases for EVs, it is recommended that the transportation authorities can strengthen the guidance for the transformation of original automobile repair and maintenance factories or serve as warranty bases for EVs at the same time to meet the huge maintenance demand brought about by the popularity of EVs in the future.

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