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Evaluation of practicality of wireless charging for electric vehicles in the next 10 years

Zhuoheng Li

Abstract:

As the electric vehicle market is expanding rapidly due to the need for sustainable development; a solution is needed to deal with current problems related to electric vehicles, this includes relatively limited driving range, relatively lack of charging spots during busy season, and the inconveniences of plug-in charging, such as dealing with cables. Therefore, wireless charging technology capable of charging electric vehicles while they are in motion becomes a potential solution. Assessing whether this technology will be mass-applied in the future is crucial. Given the limited current research that evaluates the practicality of wireless charging technology for electric vehicles with a time scale, this article aims to assess the aspects of safety, cost, efficiency, materials, user acceptance and other factors to determine the likelihood of making wireless charging practical for electric vehicles in the next decade. Furthermore, by distributing questionnaires to electric and gasoline car owners to gather participants' opinions and expectations on wireless charging for electric vehicles, statistical analysis of the questionnaire results; interview with a professor at Shanghai University who is an expert in magnets and electricity, conducting secondary research, this article concludes whether wireless charging technology for electric vehicles can be implemented in the decade or not. As an impact, this article includes a time scale by conducting an evaluation instead of implicitly mentioning the time scale.

Keywords: Wireless Charging, Electric Vehicles (EVs), Practicality Evaluation, Charging Infrastructure, Technological Advancements, Market Demand, Safety Regulations, Innovative Materials, Efficiency Improvement, User Acceptance Analysis, Standardization, Future Mobility Solutions, Technology, Electric field

1. Introduction

In recent years, there has been a growing interest in wireless charging for electric vehicles due to its convenience as it can charge vehicles while driving, efficiency and the immense potential of the global wireless charging market, which is projected to reach a scale of at least ten billion dollars in recent years (Xiong, 2022)

One of the biggest obstacles to the promotion of electric vehicles is charging; car owners are worried about running out of power and being trapped away from charging stations. The limited driving range is a significant problem – this factor limits car owners to driving to places that are far away. Furthermore, due to the need for charging spots being significantly greater than the supply, most electric car owners must wait up to hours to charge their cars on highways during holidays. At the end of 2021, zero-emission vehicles account for less than 1% of global car ownership. By 2030, the proportion of global electric vehicles needs to reach 10%-25% to achieve the set goals of the Paris Agreement (Yu, 2022). Therefore, the author intends to find a solution for these issues which could encourage petrol car owners to switch to electric vehicles which contributes to the improvement of the environment, increasing electric car owners' satisfaction in terms of convenience, efficiency, and driving range. Moreover, the core technology of wireless charging for electric cars is now preliminarily mastered; for example, in Japan, roads that are integrated with wireless charging technology have been successfully tested, and this may become a small-scale practical facility by 2025. Thus, this article aims to evaluate the practicality of wireless charging for electric vehicles in the next decade.

This study collected both petrol car owners and electric car owners to gather insights, opinions, and attitudes on current plug-in charging and wireless charging through a questionnaire. Statistical analyses are also carried out for the data collected in the questionnaire which includes Pearson's PMCC and linear regression. Furthermore, an interview is carried out with a renowned expert, professor in this field. Lastly, secondary data are used from articles. The purpose of this study is to evaluate the practicality

and viability of wireless charging for electric vehicles within the next decade, contributing to the understanding of its enormous potential as a solution to the limitations of plug-in charging.

2. Literature Review

2.1 Problems with current charging methods

As mentioned above, one of the biggest obstacles to the promotion of electric vehicles is charging. This is mainly because electric vehicles normally have a short driving range compared to petrol cars and the fact that there is a significantly low supply of available charging spots on highways compared to the great needs. Especially during busy seasons such as vacation periods, many electric car owners must wait up to hours to get a charging spot. Furthermore, if the electric car owners manage to get a charging spot, they will have to wait at least half an hour for the car to charge. Most electric car owners are extremely worried about running out of power and being trapped away from charging sites. There are limitations in both battery capacity where most electric vehicles have a maximum battery capacity of around 90 kWh (Mercedes-Benz Inc., 2022); and limitations in electrical charging facilities. Due to the inconvenience of charging, several customers are not willing to choose electric vehicles. To allow electric car clients to drive over large distances efficiently without any worries, a technology that allows electric vehicles to charge while driving became a solution, and that is wireless charging. Wireless charging can solve problems such as interface restrictions, and safety issues from current plug-in charging; thus, wireless charging is expected to gradually develop into the main way of charging electric vehicles (Xiong, 2022). Therefore, it is meaningful to evaluate the practicality of wireless charging for electric vehicles particularly in the next 10 years.

2.2 Principle of wireless charging

To evaluate the practicality of wireless charging for electric vehicles, it is necessary to first understand it in principle.

In modern days, there are two major ways to perform wireless charging: electromagnetic induction and electromagnetic resonance. Electromagnetic induction works by passing an alternate voltage of the same frequency on both ends of a primary copper coil to generate an alternating magnetic field. An alternating voltage of the same frequency is induced on the secondary coil – this allows the electrical energy to be transmitted from the primary coil to the secondary coil. From magnetic induction, an electrical current will be formed in the secondary coil which is integrated inside the cars. This is the major method that industries use in modern days, especially for phones.

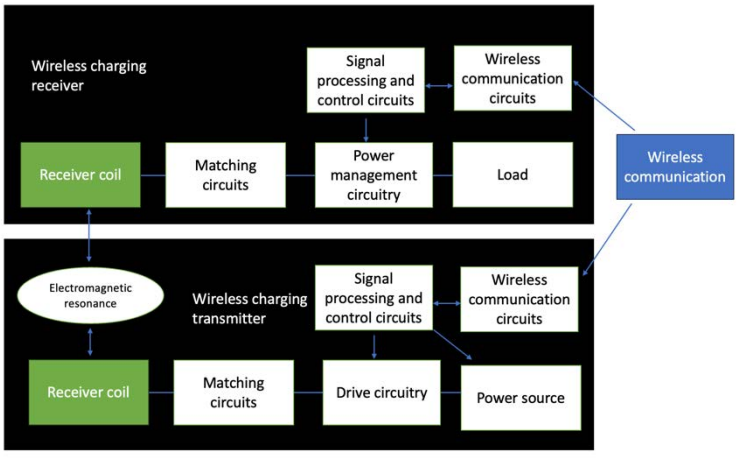

Figure 1 Diagram for the principle of electromagnetic resonance technology between the electric vehicle (receiver) and integrated system in the road or platform (transmitter)

However electromagnetic induction has limitations such as short charging distance, normally from a few millimetres to a few centimetres; this may not be highly practical for electric vehicles since the batteries are normally located on the car chassis which is tens of centimetres above the ground. Thus, electromagnetic resonance technology is being explored. Electromagnetic resonance consists of a transmitter and a receiver, in practice, the transmitter is under the ground and the receiver will be integrated into the car. To transmit energy through resonant coupling, the resonant frequency of the two circuits must be kept the same – this is done by both of their respective matching circuits. This technology maintains a high energy transfer efficiency and higher energy transfer distance – which is up to tens of centimetres (Xiong, 2022)

From above, it is obvious that there are two workable

solutions right now: electromagnetic induction which allows the coil inside the car to form electric current; or transfer the electricity from the ground to the receiver inside the car.

2.3 Current studies on wireless charging

The industry has carried out a series of in-depth research on wireless charging standards internationally. Furthermore, the industries completed the development of wireless charging solutions with research, development, and design from the software protocol to hardware circuits. Therefore, there are several product implementation plans. These accomplishments show that related firms have mastered the essential technology of wireless charging for electric vehicles (Xiong, 2022)

Since 1894, inventor, and scientist Nicola Tesla used alternating electric fields to light a fluorescent lamp – this is the origination of wireless charging technology. Thus, wireless charging is not a topic that has only started to be explored in recent years.

In recent years, there have been breakthrough accomplishments in the exploration of this field. For example, in 2018, wireless charging was installed on a track in Europe. On this track that provides wireless charging, vehicles can reach a speed of up to 100km/h while charging at 20kW (vedecom inc, 2018). This means that if this is implemented throughout the whole standard highway, the electric vehicles will barely lose any power in the battery at a speed of 100km/h; charging at 30kW would be enough to recharge a light vehicle on the highway (telecom inc, 2018) which means it is driving range will have insignificant decreases or even increased after driving through a highway integrated with a wireless charging system that could be tens or even hundreds of kilometres.

In 2023, a 400-metre stretch of wireless charging road will be commissioned in 14th Street, Detroit, USA, which will be renovated so that cars with special receivers installed under the car will be able to charge while driving on the road (Detroit gov, 2023).

From all the information above, the events show that wireless charging for electric vehicles is practical, and governments, companies, and experts have grown interested in this field. This is a sign that the technology could be applied in the next decade as there have been successful small-scale applications in recent years already.

However, there are pessimistic opinions on the practicality of wireless charging for electric vehicles. One of the biggest challenges for the practical of wireless charging within the next decade is safety. Even low-power 5W wireless charging on mobile phones faces a lot of safety issues – especially electromagnetic interference, heat generation, and metal foreign objects. One of the biggest security threats is metal foreign bodies, which absorb electromagnetic energy and generate heat rapidly over an abbreviated period; this may lead to an explosion that significantly damages the user's health. Electric cars charge at about 3.2 kWh, which means the safety risks are much higher. Therefore, in the design, it is necessary to monitor the presence of threatening metal foreign objects between the two ends of the battery (Zhang, 2022).

Another challenge for wireless charging for electric vehicles within the next decade is excessive cost. There are problems with the charging efficiency in wireless charging – where the power transfer efficiency is 85% (Yu, 2022), this means there are necessaries in the breakthrough of high-power transfer efficient materials. However, breakthroughs in high-power transfer materials are not highly possible within the next decade; and this requires a significant amount of financial support to carry out related research on this. When building the roads available for wireless charging, people did not experiment with the natural factors affecting the practicality, such as weather changes. Moreover, "wireless charging also requires the integration of additional charging equipment into the vehicle, which increases the cost of the vehicle." (Rosina, 2022). This means not only the cost of charging equipment that could be integrated under the ground is high but also increases the cost of electric vehicles with wireless-chargeable capability. This means the market for wireless chargeable cars could be limited, restricting the mass application of wireless charging for electric vehicles. Developing a flux guiding material without ferrite which will make the system smaller, lighter, and lower cost to be integrated into the roadway is technically challenging (Nutt, 2021). The coil in the system is a very unstable component, to overcome the coil getting overheated and leading to a potential explosion, there need adjustments in the mechanism – but this needs a significant cost (Zhang, 2022). In terms of cost, it is necessary to strengthen the training and management of charging sites, although it's true that strengthening the training and management of charging sites can improve the use and management efficiency of charging piles and reduce the maintenance and management costs of charging piles (Wang & Huang, 2023). However, there will be a huge gap in skilled workers who can carry out maintenance and management tasks of wireless charging equipment. Especially when this technology is not mature and widely integrated, it will be a significant cost to train enough workers within the next decade.

To add on, the fact that charging site standards are not uniform (Wang & Huang, 2023) is also a challenging obstacle to the practicality of wireless charging within the next decade. The inconsistency of charging site standards may lead to the incompatibility of electric vehicle owners

when using charging sites, affecting the quality and efficiency of charging services.

2.4 Gaps in Existing Research

Regardless of the game-changing accomplishments made, there are also gaps in existing research. For example, there is no current research that's pioneering the practicality of wireless charging for electric vehicles within the next decade. Most of the research made in recent years focuses on background information, technology explorations and challenges. There is no comprehensive evaluation on whether it is possible or not for wireless charging to be practical with a time scale.

In conclusion, it is necessary to evaluate the practicality of mass-scale of wireless charging technology as this is a technology that is practical in modern days with crucial advantages such as convenience and eliminating client's worries of driving range; but there are also obstacles in the development of wireless charging – especially safety concerns and prohibitive cost. Furthermore, it's important to evaluate whether it is practical with a time scale, which this study focuses on in the next 10 years.

3. Methodology

3.1 Overview

The dissertation is a combination of primary and secondary research methods. First, through primary research, and questionnaire was designed and sent out to collect insights, opinions, and attitudes on current plug-in charging and wireless charging participants who own a vehicle – whether it is electric or petrol; statistical analysis was carried out from the results in the questionnaire. An interview with Professor Chou, who is an expert in the field of magnets and electricity was carried out to have an overview of the current development status, challenges and obstacles facing, future development trends of wireless charging for electrical vehicles. Secondly, through secondary research, further background information, technology principles, and related experiments were conducted.

3.2 Questionnaire design

A. Question displayed.

The author designed a questionnaire with a total of 14 questions, using multiple choice and sorting questions, The first question is basic information, asking the participant whether they are an electric car owner or petrol car owner. Due to the consideration of the fact that different types of car owners have different opinions, this question's principle is to decide which set of questions the participants will do depending on whether they are electric car owners or petrol car owners.

The set of questions for petrol cars has 2 questions. These two questions are intended to find out the concerns about driving an electric vehicle and the possibility of these owners purchasing an electric vehicle if wireless charging is widespread.

The level of interest in wireless charging for electric vehicle owners will be assessed. The participants will be asked different questions depending on their level of interest.

B. Data treatments and statistical analysis

The distribution of the questionnaire is done through a software called Questionnaire Star. This article includes statistical analysis for the most critical data including respondents' attitudes toward current charging methods and wireless charging, their concerns with current charging methods and their expectations for wireless charging.

Statistical analyses were mainly done by p-value which shows the randomness of the relationship; comparing the selected option percentage through pie charts; correlation and causal relationship between variables.

Another statistical analysis carried out is linear regression. This is used by having a line of best fit between two variables. It is described by the equation: $\hat{y} = bx + a$ where b shows the gradient of the line and a shows the y-intercept. It allows for testing hypotheses about the relationships between variables and determining the statistical significance of these relationships.

C. Ethical considerations

The questionnaire was carefully designed to ensure ethical fundamentals are protected and applied. The questionnaire did not ask for any personal information including their gender, name, age, or job; and it is carried out anonymously. The questionnaire only focuses on the respondents' attitudes and opinions toward wireless charging and current plug-in charging for electric vehicles. A statement was at the beginning of the questionnaire that explains the purpose of the project, who the author is and basic information about the questionnaire. There is a statement at the beginning.

3.3 Interview design

A. Aim

The author intended to find out the background information, current studies and research, technology explorations and challenges facing, future development trends and the likelihood of practicality of wireless charging for electric vehicles within the next decade based on the expert's opinion.

B. Questions

The interview consists of questions that are opinion-based

on the expert, descriptive questions, and factual and descriptive questions to make an interview that consists of comprehensive information.

This is an opinion-based question that seeks advice from an expert for industry stakeholders, researchers, and policymakers toward the practical implementation and widespread use of wireless charging in the next decade.

3.4 Secondary research

Secondary research was conducted to gather further background information, technology principles, and related experiments. Literatures are mainly from cnki.net, Google Scholar and IEEE. The author tries to cite literature that is based on current, relevant, credible authority, accurate, and non-biased principles.

4. Results

4.1 Questionnaire

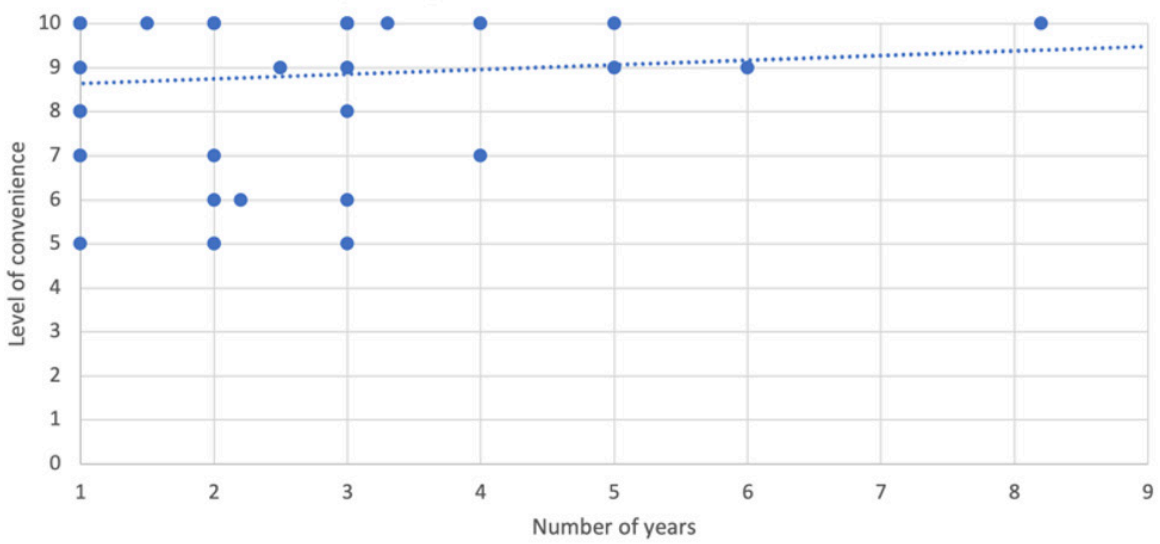

Figure 2a Scatter diagram showing the correlation between the level of convenience of wireless charging participants expect and the number of years participants own an electric vehicle

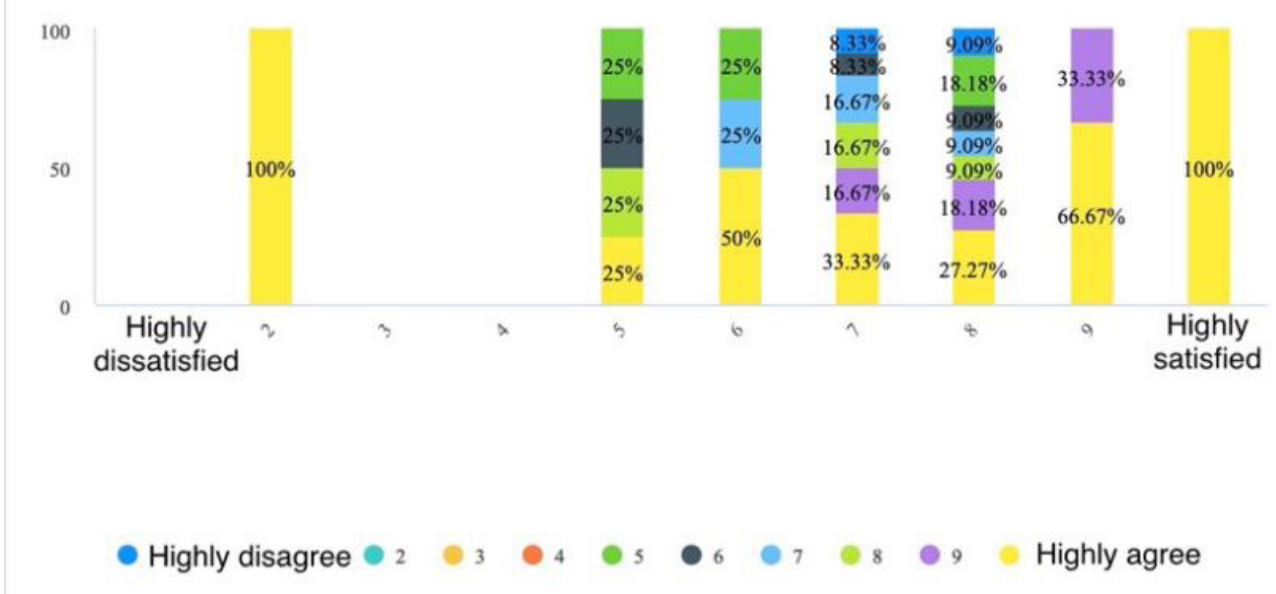

Figure 2b Satisfaction with Plug-in Charging (x-axis) and Agreement on Wireless Charging Convenience (y-axis)

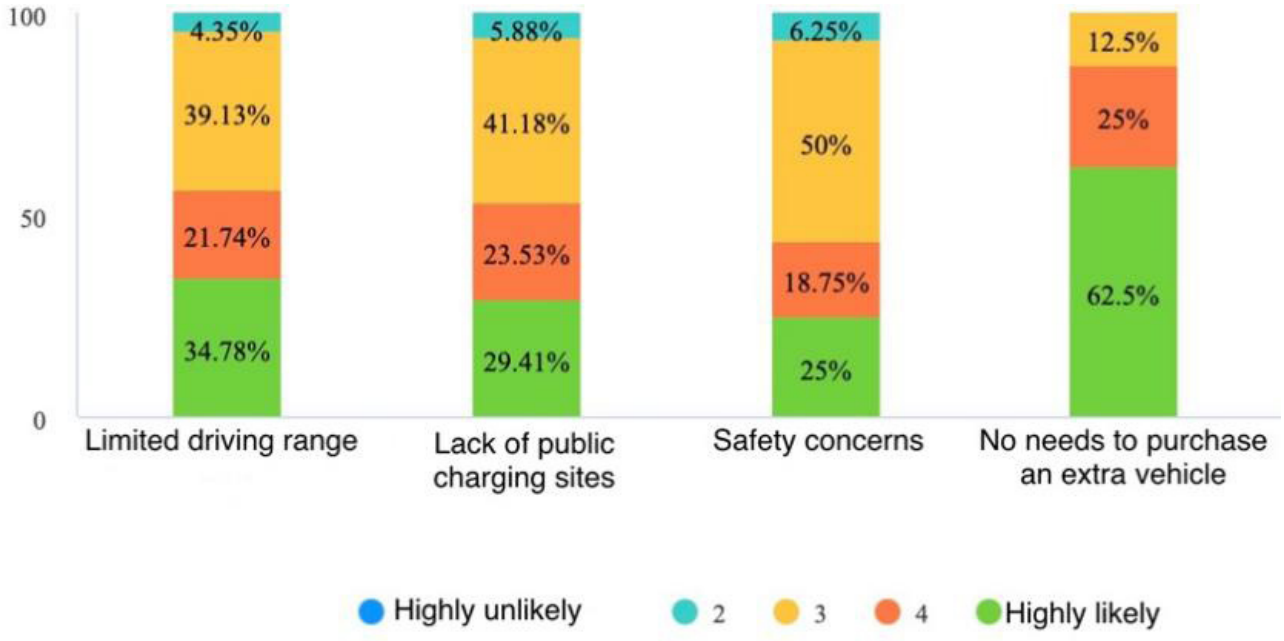

Figure 2c Correlation Between Electric Vehicle Concerns and Willingness to Purchase with Widespread Wireless Charging

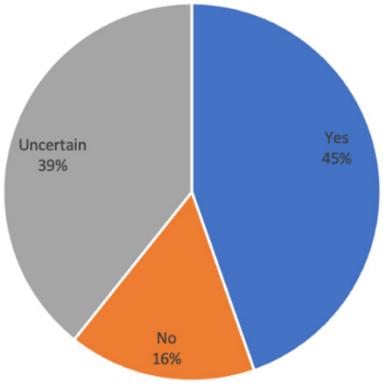

Figure 2d Willingness of electric car owners to pay more for wireless charging

Figure 2a was intended to find out the statistical relationship between the number of years the participant owned an electric vehicle and their expected level of convenience for wireless charging. Pearson's product-moment correlation coefficient value is 0.0866. This means that the relationship between these variables is not linear as the value has a difference of <0.1 to 0. The most striking result to emerge from the data is that there are very insignificant relationship between the two variables, although it's a hypothesis that "the longer the participant owns the vehicle, the higher the level of convenience they expect from wireless charging" is expected since the longer the participant own an electric vehicle, the more experience they have to deal and interact with the plug-in charging, where they can find more disadvantages of plug-in charging and to have a more optimistic expectation for wireless charging. This result can be further proved by the fact that the p-value is 0.533509, where the result is insignificant, indicating that the value is quite random. Through the calculation of linear regression, where (accuracy to 2 significant figures) $\hat{y} = 0.1x + 8.53$. This equation indicates that for every additional year of owning an electric vehicle, the level of convenience the participants expected from wireless charging increases by 0.106 units. This positive gradient suggests that as participants gain more experience with electric vehicles, their expectations for convenience in wireless charging increase. However, this value is remarkably close to 0, indicating a barely significant positive relationship between the two variables. Through the equation, the y-intercept is 8.53, indicating that most of the participants expect wireless charging to be highly convenient (where the level of convenience is highest in 10) as the line starts at 8.53 when x is 0 while having a positive gradient. The value of the gradient is exceedingly small as 75.9% of the participants already choose the level of convenience to be 8-10, where 10 is the highest number; proving that there are elevated expectations for wireless charging in the next decade.

Figure 2b is to find out the relationship between the level of satisfaction with current plug-in charging and the level of convenience people expect for wireless charging. The single most striking observation to emerge after analysing the data is that all the participants who chose value 2 (very dissatisfied) with the current plug-charging agreed that wireless charging is more convenient than plug-

in charging. Furthermore, all participants who are both highly satisfied and highly dissatisfied (choosing the value 9 and above for their level of satisfaction with plug-in charging) either strongly agree or agree that wireless charging is more convenient (choosing the value 9 and above for the level of convenience. These results indicate that for both satisfied and dissatisfied users of current plug-in charging, everyone who participated in this questionnaire agreed that wireless charging is more convenient, strongly proving that there is a high proportion of electric car owners supporting the investigation, research and application for wireless charging technology in the next decade, providing essential factors for the mass application of wireless charging: user, the high expectations and welcoming-attitude from the user. The crucial reason behind this is that wireless charging can charge electrical vehicles while the vehicles are driving, which means that there is no need to wait in line for up to hours to get one single charging spot during the busy season.

Figure 2c shows the correlation between the likelihood of petrol car owners to change to an electric car if wireless charging is being mass applied and their current concerns about purchasing an electric car. Figure 2c indicates that more than half of the people (choosing 4-5 as their predicted likelihood to purchase an electric vehicle where 5 is highly likely) are willing to purchase an electric vehicle if wireless charging is being mass applied – as their concerns about limiting driving range and lack of public charging sites would be solved. This indicates that the fact that wireless charging can charge electric vehicles while driving solves two crucial concerns: the limited driving range of the vehicle and the lack of public charging sites. Therefore, the clients can travel further distances without many concerns. 50% of the participants who thought the safety issues of an electric vehicle were a crucial problem were neutral when deciding whether to purchase an electric vehicle or not. This is because the participants hold an opinion that safety issues are a crucial problem for electric vehicles, such as battery and electronic systems, while these problems cannot be solved through the application of wireless charging in the next decade.

Figure 2d shows the willingness of electric car owners to pay extra to purchase a wireless charging infrastructure or service. The fact that only 16% of the participants do not want to pay extra for wireless charging indicates that wireless charging for electric vehicles is an industry with optimistic expectations for it to perform in the market in the next decade. Furthermore, 45% agreed to pay more for wireless charging. This is positive data to support that wireless charging will be applied within the next decade as people are willing to pay now. This is crucial data since it indicates that the application of wireless charging in the next decade does have unbeatable and game-changing advantages compared to current plug-in charging, such as being more convenient, allowing the car to travel further, and being more user-friendly as there are no needs to deal with plugs and cables.

4.2 Interview

The practicality of wireless charging for electric vehicles in the next decade depends on factors including efficiency, charging speed, standardization, infrastructure deployment, cost, range, safety, and user acceptance. Challenges include solving the crucial problems associated with these factors, for example, wireless charging has lower efficiency than plug-in charging, having more energy loss. The higher efficiency will reduce the cost and environmental impact. Progress is being made to address these issues, and it is likely to overcome most of these challenges over the next decade. There are many ongoing industry initiatives and research for wireless charging, including Qualcomm Halo wireless electric vehicle charging platform and EU projects such as project FABULOS. The concept of dynamic charging will play a crucial role in the practicality of wireless charging over the next decade, where electrical vehicles can be charged in motion, which dramatically enhances driving range. With over-the-air software updates for charging systems, continuous improvements and enhancements can be made without physical updates. Charging infrastructures are expected to evolve in the next decade, adapting to wireless charging by expanding networks, integrating with existing infrastructures, standardizing protocols across vehicles, enhancing user experience, improving efficiency, and promoting sustainability. Smart grid systems can be integrated where charging is optimized based on power demand and grid conditions. The cost and benefits of wireless charging should be weighed on a case-by-case basis from an economic perspective. While there may be an initial cost to adopt wireless charging technology, convenience, scalability, and potential safety benefits may outweigh these costs overall. Policymakers, industry stakeholders and researchers should collaborate, establishing standards, research and innovation funding, infrastructure planning, partnerships, education, and international cooperation to promote the practicality of wireless charging over the next decade.

5. Discussions

The results indicate that there are high market expectations for the application of wireless charging for electrical vehicles over the next decade due to convenience and higher driving range. Combined with previous research results, the interview information and the questionnaire results, this section carries out a deeper reason analysis

of the practicality of warless charging in the next decade associated with multiple factors.

Prior studies highlighted the importance of cost in the practicality of wireless charging. From the questionnaire results, 54% of the participants did not have a definite "Yes" for being willing to pay more for wireless charging infrastructures and services. The cost of wireless charging infrastructure is currently higher than the traditional plug-in charging stations. With further advances in manufacturing processes, material selection and economies of scale, costs should be reduced. Incentives, tax credits and grants can encourage investment in wireless charging infrastructure and accelerate its deployment in the next 10 years. Reducing the cost of wireless charging systems, including charging pads and installation costs, is critical to making wireless charging practical and widespread in the next decade is a key idea from the interview. A possible explanation of this might be the fact that the willingness of electric car owners to pay more for wireless charging depends on the proportion of more payment required for wireless charging experiences than traditional plug-in charging. The findings of these are consistent with those of Wang & Huang (2023), who suggested that it is necessary to strengthen the training and management of charging sites, although it's true that strengthening the training and management of charging sites can improve the use and management efficiency of charging pads and reduce the maintenance and management costs of charging piles.

The present study was designed to determine the safety challenges to overcome for the application of wireless charging in the next decade. According to the interview, some of the issues emerging from this finding relate specifically to funding, technological breakthroughs, and regulatory support. The finding, which also links the wireless charging system software and hardware, supports previous research in this area. The interview acknowledges that advanced systems to align the car and the charging pad are a crucial step for further safety enhancements for wireless charging of electrical vehicles in the next decade. However, in contrast to the interview, Zhang (2022), suggested that one of the biggest threats is metal foreign bodies, which absorb electromagnetic energy and generate heat rapidly over an abbreviated period during charging; it is necessary to monitor the presence of threatening metal foreign objects between the two ends of the battery. This indicates that there needs to be technical advancements in safety fields for the practicality of wireless charging in the next decade for customers to eliminate their safety doubts about the field of electric cars – as from the questionnaire, there are about 50% of the participants' thought safety is an issue when changing to an electric vehicle.

In the future, increased application of technologies such as the integration of photovoltaic panels in electric cars may occur due to the increasing efficiency and decreasing costs of photovoltaic panels (Rizzo, Arsie& Sorrentino, 2010). In addition, the practicality of nuclear-powered cars is being assessed and researched, through small thorium reactors in the car, electricity could be generated through nuclear fission (Durkin, 2012), which then powers the motor and software systems of the vehicle. Lastly, the continuous breakthroughs of higher energy density of batteries are necessary. This means that with the same battery size, batteries with higher energy density could provide more electrical energy therefore allowing the vehicle to travel further.

6. Evaluation

There are advantages to this study. First, no current studies are researching the practicality of wireless charging within the next decade and potential customer expectations, therefore this study gives this evaluation with a precise period in the future. The current studies on the integration of wireless charging for electric vehicles are focussing majorly on researching technologies and innovations instead of giving an agenda for the application, therefore this study filled a research gap of lack of studies on the time needed for the practicality, mass application of wireless charging for electrical vehicles and customer expectations was gathered through questionnaire. Secondly, the interview was well-designed and conducted. A highly authorized professor took part, which answered both comprehensive and specific questions, focusing particularly on the practicality within the next decade, relating to the current research on wireless charging technology, breakthroughs and obstacles, research trends and stakeholders involved.

However, there are limitations to this study. First, the questionnaire involved 85 participants to take part, but this sample size is still relatively small to make a precise evaluation of the practicality of wireless charging within the next decade. The questionnaire was sent out majorly focusing on Tesla car owners, therefore there are lack of responses from other electrical car owners to express their thoughts, opinions and expectations on wireless charging as different electric car owners have different opinions due to differed car-user interface systems, technologies, and user driving habit. Secondly, regional infrastructure and policy differences may influence user attitudes, which are not explored in this China-centric study. Further study should be undertaken to find out an overall representation of car owner expectations and opinions on wireless charging internationally. Third, expert input is confined to only one interviewee as well. Consulting multiple industry and academic specialists could provide greater balance.

7. Conclusion

The findings indicate strong potential for mass practicality of wireless charging technology for electric vehicles by 2034. With optimistic market demand, technological breakthroughs and recent small-scale successful implementations. 88.9% of electric vehicle owners surveyed expect wireless charging to offer superior convenience than plug-in charging, while over 60% of petrol vehicle owners state that it's likely for them to purchase an electrical vehicle when wireless charging is massively integrated. With the capability of dramatically improving the driving range of electric vehicles, enhancing convenience and without the need to wait for a long time to get a charging spot are its profound advantages. It is necessary to lower the cost of wireless charging to meet market expectations, which is a significant step for the application of wireless charging in the next decade. Furthermore, it is proven that safety issues must be eliminated as much as possible for customers to accept the transition from wired charging to wireless charging. These findings enrich the overview of wireless charging technology, customer opinions, and its possibility of practicality within the next decade.

The goal for mass practicality of wireless charging by 2034 is ambitious but attainable through ongoing technical innovation, continuous investments from both government and private corporations, and universal standardization in the vehicle and energy sector. This technology promises a game-changing impact on electric vehicle mobility.

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