Potential for New Development of Conventional Fossil-fueled Vehicles

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***Abstract*—Nowadays, alternative energy vehicles, particularly electric vehicles, develop rapidly and become highly favored by consumers, even having the tendency to replace the fossil-fueled vehicle market based on their unique advantages such as environmentally friendliness, low energy use costs, high intelligence level, fast acceleration, and so on. However, alternative energy vehicles also have their defects that cannot be ignored such as charging issues, limited battery performances, limited range, and lower safety level. Under such circumstances, whether fossil-fueled vehicles have future development potential becomes an important question. In this paper, we explore the development potential of fossil-fueled vehicles, based on the automotive performance analysis, the questionnaire, and the review of information and literature. These lead to the conclusion that as long as fossil-fueled vehicles face up to and improve their shortcomings, at the same time retain their advantages, they do have the chance to regain a foothold in the automotive market. To be specific, from the aspects of improving energy efficiency, developing sustainable automotive fuels, enhancing emissions control, and promoting public awareness, the fossil-fueled vehicle market does have consistent potential for future development.**

***Keywords*—fossil-fueled vehicles, alternative energy vehicles, industrial development, market analysis**

I. INTRODUCTION

The automotive industry holds a pivotal role in modern society by facilitating transportation and connecting people. However, the widespread adoption of fossil-fueled vehicles has led to a surge in greenhouse gas emissions, exacerbating the global greenhouse effect. Reducing greenhouse gas emissions has then become one of the top priorities for the development of human beings society. In this sense, governments worldwide are actively seeking ways to reduce greenhouse gas emissions from conventional fossil-fueled vehicles and lessen reliance on finite gasoline resources (Olabi *et al.*, 2022). The promotion of alternative energy vehicles, including electric vehicles, hybrid electric vehicles, etc., has emerged as a crucial goal in this context (International Energy Agency, 2022), as they can utilize renewable energy (e.g., electricity from solar or wind power), (International Renewable Energy Agency, 2020) thus reducing greenhouse gas emissions, lowering down dependence on imported oil, and enhancing energy supply stability and security (International Energy Agency, 2021).

Under these circumstances, an increasing number of environmentally conscious consumers are demanding more energy-efficient and eco-friendly transportation options, which has sparked a rise in the interest in alternative energy vehicles. Moreover, continuous innovations in alternative energy vehicle design and functionality have garnered favor among some consumers (Olabi *et al.*, 2022). These vehicles offer unique advantages, including lower carbon emissions, quieter driving experiences, reduced energy cost, and superior performance in congested urban conditions, catering to the needs of those seeking cleaner and more efficient means of travel (Aguilar & Groß, 2022). Furthermore, the formulation of supportive policies by various countries and regions, such as subsidies for alternative energy vehicle purchases and tax reductions or exemptions, along with the implementation of stringent fuel efficiency and tailpipe emission standards, has fostered the application of clean energy and facilitated the transformation of the automotive industry. Consequently, numerous automotive manufacturers, technology companies, and energy firms have intensified their investments in electric vehicle research and development, leading to significant advancements in the entire industry chain.

The robust development of electric vehicles is evident in the Chinese auto market, where sales of electric vehicles have exhibited impressive growth rates. Conversely, fossil-fueled vehicles face significant challenges as some governments discourage their development through measures like fuel license plate restrictions and traffic limits in major cities. In China, the largest vehicle market around the world, more than 10.4 million alternative energy vehicles have been sold in 2022, with a high penetration rate of more than 27.6% (Baidu, 2023; He *et al.*, 2022). Another example of the rapid development and deployment of electric vehicles is Norway, whose plans to ban the sale of fuel vehicles also signal a significant shift away from traditional vehicle manufacturing and oil industries. In Norway, more than 80% of consumers choose to purchase alternative energy vehicles, especially battery-electric vehicles (International Energy Agency, 2019).

Despite the rapid growth of alternative energy vehicles, it should be noted that fossil-fueled vehicles remain dominant in the global automotive market due to established infrastructure, longer driving ranges, and shorter refueling times. Their affordability and the industry's extensive experience in manufacturing fossil-fueled vehicles make them attractive to price-sensitive markets (Middela *et al.*, 2022). Besides, alternative energy vehicles, particularly electric vehicles, exhibit some disadvantages that might impede their further development (Ayevide *et al.*, 2022). For example, consumers usually show range anxiety when driving electric vehicles, which can't achieve a long range due to the limited energy storage capability of batteries. Other factors such as lower safety levels, longer energy supplementing time, etc. are also major challenges facing alternative energy vehicles, leading to an uncertain future. The coexistence of alternative energy and conventional

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fossil-fueled vehicles raises questions about the future of the automotive industry. Will fossil-fueled vehicles have the potential for development in the future? Can fossil-fueled vehicles adapt and implement greener technologies to remain relevant in an era of increasing environmental consciousness? Is there room for both alternative energy and fossil-fueled vehicles to thrive in the market, catering to diverse consumer preferences and driving needs?

Addressing these complex issues requires a deeper examination of market dynamics, technological advancements, government policies, and environmental considerations. While current mainstream academia focuses heavily on the development of alternative energy vehicles and technological breakthroughs, there exists a research gap concerning the future development of conventional fossil-fueled vehicles. This study aims to address this research gap by analyzing the technical characteristics and experiences of both alternative energy vehicles and fossil-fueled vehicles through data and questionnaires, to explore whether there is still potential for the development of fossil-fueled vehicles. Additionally, this research seeks to propose reasonable solutions for firms involved in fossil-fueled vehicle production. By addressing this research gap, the study contributes valuable insights into the automotive industry’s sustainable evolution and guides key stakeholders navigating the transition towards a greener and more efficient future. Here we show that based on promoting the aspects of energy management, marketing, and other performances to raise the strengths and avoid the weaknesses, fossil-fueled vehicles do have consistent potential for future development.

II. Literature Review

A. Reasons for the Rapid Development of Electric Vehicles

The accelerated growth of the alternative energy vehicle sector is primarily motivated by the imperative background of rising global environmental concerns. Data provided by the International Energy Agency (International Energy Agency, 2023) underscores the alarming surge in total greenhouse gas emissions from the energy industry, with the automotive sector assuming a substantial share of this burden. In response to the urgent exigency of global warming, the burgeoning electric vehicle market has been devised to embody great attributes of heightened environmental protection, diminished pollution, and reduced emissions. Crucially, policy measures have emerged as an extremely important role in the development of electric vehicles in the past few years.

Taking China for example, central to the policy mechanisms in China is the strategic implementation of government subsidies, which wield significant transformative influence over the total cost of ownership of electric vehicles, engendering their enhanced financial appeal to discerning consumers (Cai *et al.*, 2012; Liu *et al.*, 2021). An example of this approach is China’s comprehensive subsidy policy, which encompasses robust support for research and development initiatives, production endeavors, and the acquisition process of alternative energy vehicles. By judiciously alleviating vehicle purchasing taxes and enterprise income taxes, while concurrently fostering the expansion of charging infrastructure, these subsidies have unequivocally instigated a favorable proclivity among a burgeoning cohort of consumers towards the widespread adoption of electric vehicles.

Furthermore, the consequential ascendancy of the double credit policy, as expounded by Yin (2022), serves as a seminal impetus in galvanizing automotive manufacturers to intensify their production of electric vehicles. This policy ascribes negative points to manufacturers entrenched in conventional fossil-fueled vehicles, particularly those with a high energy consumption rate, while conversely, endowing positive points to those actively engaged in the production of alternative energy vehicles. In this policy, manufacturing electric vehicles with long ranges and advanced battery technologies is encouraged with a high positive credit. Finally, entities accruing negative points are inherently mandated to procure credits from their positive-point counterparts to ameliorate their deficit standings. This salient policy dichotomy effectively compels traditional automotive manufacturers to bolster their production of alternative energy vehicles, concurrently furnishing electric vehicle enterprises with a profitable avenue through the trade of points. This duality thus precipitates a paradigm shift, optimizing manufacturers’ profitability while propelling the overall proliferation and transformative advancement of the burgeoning electric vehicle industry (He *et al.*, 2020).

B. Challenges Facing Fossil-fueled Vehicles

The development of conventional fossil-fueled vehicles is expected to be challenged by electric vehicles, whose significant advantages have expedited their market expansion. Foremost, electric vehicles epitomize an environmentally friendly transportation option (Hao, Mu, Liu & Zhao, 2018; Wang *et al.*, 2022). Gasoline-powered vehicles contribute significantly to climate change (e.g., global warming), emitting approximately 890 million tons of carbon dioxide and other greenhouse gases annually. In contrast, electric vehicles emit substantially lower greenhouse gas emissions. According to the Energy Information Administration (Energy Information Administration, 2023), the adoption of electric vehicles can reduce carbon dioxide emissions by approximately 230 million tons per year, thus mitigating their negative impact on the environment.

Moreover, the adoption of electric propulsion systems in electric vehicles provides them with high operation efficiency, rapid responsiveness, and seamless integration with diverse intelligent control technologies, providing a robust foundation for achieving intelligent vehicles (Joshi *et al.*, 2022). Notably, the electronic control and information capabilities of electric propulsion systems outpace those of conventional fossil-fueled vehicles. Advanced battery management systems and motor control units enable precise power distribution and response, while connectivity and communication technologies, such as GPS and Bluetooth, facilitate seamless integration with the internet, enabling real-time access to traffic information, and weather forecasts, and providing convenient navigation, entertainment, and service functionalities. Additionally, electric vehicles are characterized by advanced driver assistance systems, encompassing features such as adaptive cruise control, autonomous emergency braking, lane-keeping assistance, and blind-spot monitoring. Leveraging sensors, cameras, and artificial intelligence algorithms, these systems continuously perceive the surrounding environment in real-time, thereby delivering safety warnings and facilitating assisted driving functions, thereby enhancing overall driving safety and convenience. All these point to an important advantage of electric vehicles: the ability to be intelligent vehicles, helping drivers and improving safety, and the ability to keep improving the intelligence level, through the Over-The-Air (OTA) technology.

From the perspective of energy management and intelligent charging technology, electric vehicles boast intelligent energy management systems that continuously monitor battery status and energy utilization, facilitating dynamic adjustments to improve energy efficiency and maintain battery life. Further, the intelligent charging technology enables remote control and intelligent optimization of charging time and power, offering a more convenient and efficient charging experience for users. Additionally, electric vehicles exhibit enhanced user-friendliness and intelligence through their thoughtful design, including appealing appearance design, interior space layout, and the application of touchscreens and voice assistants in human-machine interfaces.

Perhaps most significantly, electric vehicles offer a considerable cost advantage over conventional fossil-fueled vehicles, particularly in the use process (Wassiliadis *et al.*, 2022). Research by Feigenbaum (2022) indicates a significant reduction in battery costs, making electric vehicles less costly for consumers and further leading to a reduced total cost of ownership. Besides the potential to achieve a lower purchase price, energy use cost has been the source of the cost advantage of electric vehicles. Nominal electricity prices in the context of Norway, for example, are markedly lower than petrol prices, rendering electric vehicle charging a more economically viable option. By way of illustration, a representative electric vehicle model, the VW E-Up 2019 version, incurs substantially lower charging costs, approximately 1.7 NOK per 10 kilometers, compared to the cost of petrol consumption for a gasoline vehicle, approximately 7.9 NOK per 10 kilometers (Feigenbaum, 2022; Hao *et al.*, 2020; International Energy Agency, 2020). Moreover, electric vehicles typically incur fewer maintenance costs due to their fewer mechanical parts and obviation of conventional maintenance needs such as oil replacement or exhaust system upkeep.

Furthermore, electric vehicles tend to exhibit superior acceleration performances owing to their electric motors, which deliver high torque output at the start stage of vehicles, enabling instant power response without waiting for an engine speed increase or gear shifting completion. Therefore, it is easy for an electric vehicle to achieve a similar acceleration time to a super sport car, bringing superior purchasing experiences to more consumers (Picatoste *et al.*, 2022).

In summary, the advantages of electric vehicles, encompassing low emissions to achieve environmental friendliness, advanced technology integration, enhanced intelligence features, efficient energy management, cost-effectiveness, and improved acceleration performance, have been important to their rapid market growth and widespread acceptance. Continuous improvements in these advantages will further make electric vehicles an attractive option for consumers. Under these circumstances, the conventional fossil-fueled vehicle market is faced with significant challenges.

C. Opportunities of Fossil-fueled Vehicles

While rapid development has been seen for electric vehicles, they still show many disadvantages, which might significantly impact consumers' purchasing experience, further proving opportunities for fossil-fueled vehicles. The first among these disadvantages is the charging problem. The construction of battery charging facilities necessitates substantial financial investment and technological support. Challenges in technology, equipment, and operational management contribute to the high costs associated with establishing and maintaining charging facilities and networks (Li *et al.*, 2021). Additionally, the existence of different charging standards and interface types creates interoperability difficulties among different charging facilities, adding complexity and cost to the development of electric vehicle infrastructure (Gnann & Plötz, 2015). Fast charging modes at public stations, while expedient, present drawbacks, such as higher working voltages compared to the battery voltage, resulting in accelerated electronic flow and increased battery heat generation, placing undue strain on the battery. Similarly, slow charging modes at private residences can overload residential transformers and strain the power grid, causing potential damage.

Furthermore, battery-related issues present notable concerns. Over time, the battery pack experiences degradation due to factors such as voltage, internal resistance of cells, temperature fluctuations, and electric quantity, leading to reduced battery capacity and diminished vehicle range. Extreme weather conditions, particularly low temperatures, can hinder chemical reactions inside the battery, impede the migration of electrons and ions, and lower the battery's discharge efficiency, necessitating more electrical energy to release the same amount of energy in cold climates, thereby increasing energy consumption (Viswanathan *et al.*, 2022). Additionally, the need for preheating processes in cold temperatures consumes additional electrical energy, reducing overall efficiency in converting battery electrical energy into mechanical or thermal energy for driving and heating.

Electric-vehicle consumers also suffer from the lower travel range of electric vehicles compared to those of fossil-fueled vehicles. While some electric vehicles have a limited range, most fossil-fueled vehicles show much longer endurance trips. For instance, an ID.3 Pro Performance with a battery capacity of 58 kilowatts may last for a 408-kilometer journey (Wassiliadis *et al.*, 2022), whereas typical fossil-fueled vehicles often achieve endurance trips of around 600 kilometers. Low performances of electric vehicles in the range might make them less attractive to consumers, especially those who often drive a long way to different cities.

Safety concerns also surround electric vehicles due to their reliance on high-capacity battery propulsion systems (Xu *et al.*, 2022). Overcharging, over-discharging, and overheating can compromise battery performance and even lead to internal fires or explosions, necessitating stringent safety protocols. Moreover, the safety of charging infrastructure poses a critical issue for electric vehicles, as the presence of low-quality or uncertified charging facilities, especially in aging communities, may give rise to electrical faults, leakage, or fire hazards (Lu *et al.*, 2021). In contrast, fossil-fueled vehicles benefit from the mature industrial chain developed, with a higher safety performance compared to electric vehicles.

In summary, while electric vehicles offer substantial advantages, including environmental friendliness and cost-effectiveness, they still face significant challenges related to charging infrastructure, battery-related issues, limited travel range, and safety concerns. These challenges provide conventional fossil-fueled vehicles with great potential for maintaining competitiveness in the vehicle market and achieving further development.

III. Method and Results

In this study, we aimed to investigate consumer attitudes towards fossil-fueled vehicles in the current vehicle market. To achieve this, we conducted an online questionnaire using the "Wenjuanxing" application to collect feedback from respondents. The questionnaire included three types of questions: those designed to analyze the reliability of the results (Q1–2), identify the most influential factors affecting consumer choices (Q3–8), and understand consumer attitudes towards the future development of fossil-fueled vehicles (Q9–10). All questions in the online survey are provided in the Appendix.

A. *Gender Distribution*

Fig. 1 presents the gender distribution of the respondents, which indicates the reliability and credibility of the results. The total number of participants is 256. Based on the results, there are 131 male respondents (49%) and 125 female respondents (51%) who participated in the investigation, resulting in a nearly equal representation of both genders. This balanced gender distribution ensures the credibility and representativeness of the survey, avoiding gender bias and strengthening the validity of our conclusions for further analysis.

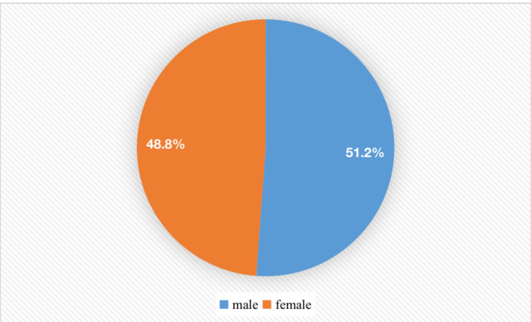

Fig. 1. Gender distribution of the respondents.

B. *Age Distribution*

Fig. 2 illustrates the age distribution of the respondents. The majority of participants (119) fell within the 40 to 50 age range, followed by 94 respondents in the 30 to 40 age range. They accounted for 46.5% and 36.7% of all respondents, respectively, which suggests that our results and conclusions are highly related to the opinions of 30–50 aged consumers. Young adults and middle-aged individuals accounted for 21 and 12 participants, with a share of 8.2% and 4.7%, respectively, while respondents below 18 and over 60 years old constituted only a small percentage, imposing a marginal impact on the results and conclusions in this study. Given the higher purchasing power of individuals aged between 30 and 50, it will be commonly accepted that the results and conclusions in our research represent the idea of the mainstream consumers in the market, who are important to vehicle manufacturers as they contribute most to vehicle purchases in the market.

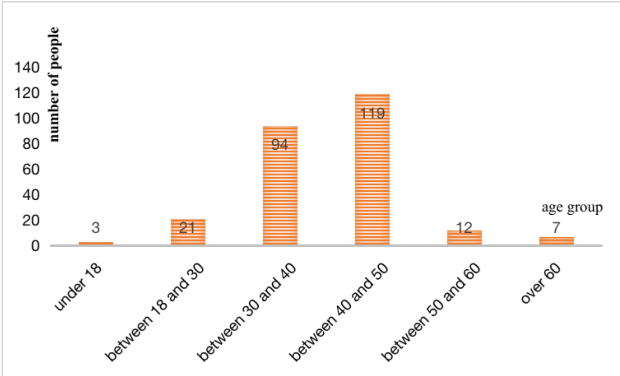

Fig. 2. Age distribution of respondents.

C. *Vehicle Ownership*

Fig. 3 displays information regarding whether the participants own vehicles. Among the 256 participants, 84.8% (235 respondents) reported owning a car, as illustrated by Fig. 3. These car owners can provide valuable insights based on their real experiences and feelings about using vehicles, which will be instrumental in the analysis of both fossil-fueled and alternative-energy vehicles. Additionally, the preferences and perspectives of non-vehicle owners are also valuable for our research, which represents the ideas consumers hold when they are purchasing their first car. Generally speaking, the results in this research can present the perspectives of the consumers who have already owned a car, thereby the disadvantages of electric vehicles might show less significant impacts on consumer choice, especially when the first car of a consumer is a fossil-fueled vehicle.

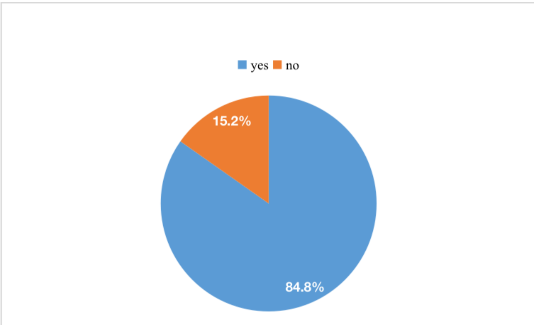

Fig. 3. Whether respondents own cars or not.

D. *Types of Vehicles Owned by Respondents*

Fig. 4 presents the distribution of the types of vehicles owned by the respondents. Fossil-fueled vehicles constituted the majority with 165 owners, with a relatively high share of 70.2%, followed by 52 respondents owning electric vehicles, which accounts for 22.1% of all participants who own cars, and a small percentage owning hybrid electric vehicles (7.7%). This indicates that, despite the rapid development of alternative energy vehicles, especially battery electric vehicles, fossil-fueled vehicles still dominate the market. However, electric vehicles have also gained a significant market share. In comparison, hybrid electric vehicles are less popular among respondents. It should be noted that the results are close to the case in China's overall vehicle market (i.e., 20–30% penetration rate of alternative energy vehicles, with electric vehicles accounting for 70% in alternative energy vehicles). Therefore, the reliability and credibility of this research are further proved. Besides, as mentioned above, a high proportion of fossil-fueled vehicle ownership indicates that consumers tend to exhibit a high tolerance for the disadvantages of electric vehicles, thereby the results will be more friendly to electric vehicles, which has to be considered in conclusions.

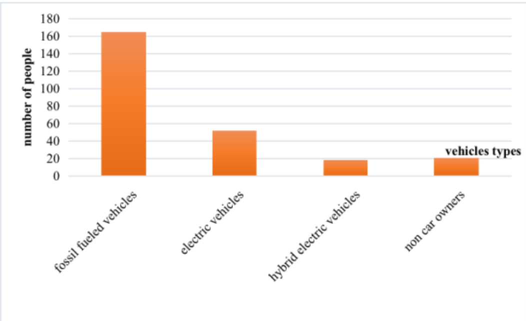

Fig. 4. Distribution of car types owned by respondents.

E. Preferred Vehicle Types

Fig. 5 highlights respondents' preferences for vehicle types. Approximately half of the respondents (128 with a share of 50.0%) expressed a preference for electric vehicles, while 74 individuals (28.9%) still favored fossil-fueled vehicles, and 54 participants (21.1%) preferred hybrid electric vehicles. This indicates a general acceptance and recognition of alternative energy vehicles, particularly electric vehicles, among the public, with fewer individuals inclined towards fossil-fueled vehicles. However, considering that a large share of the respondents have already owned a vehicle, the majority of whom own fossil-fueled vehicles, the high preference for electric vehicles is foreseeable. Besides, since there are 15.2% of the respondents didn't own vehicles, the result that fossil-fueled vehicles are preferred by 28.9% of the respondents can still indicate that they have not been abandoned by consumers, with potential for further development.

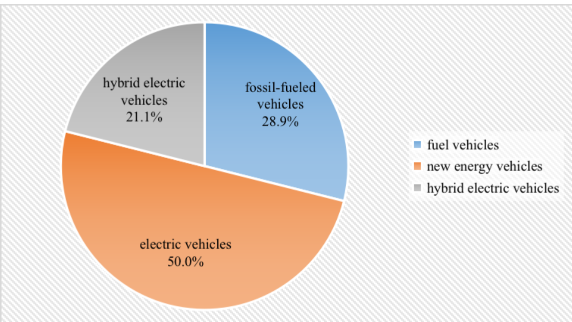

Fig. 5. Distribution of car types that respondents would like to choose.

F. Factors Influencing the Choice of Alternative Energy Vehicles

Fig. 6 depicts the distribution of factors influencing the choice of alternative energy vehicles among respondents. The most significant factor is the low cost during use, selected by 207 respondents (80.9%), attributed to the high efficiency of battery electric propulsion and relatively lower electricity fees for charging alternative energy vehicles. Environmental friendliness is the second most influential factor, with 149 respondents (58.2%) opting for alternative energy vehicles due to their low carbon emissions. This is an unusual result as the environmental impact should be the focus of governments, not consumers in most cases, suggesting that environmental friendliness will promote vehicle sales in the future. The high degree of intelligence inside alternative energy vehicles attracted 113 respondents, with a share of 44.1%. Acceleration abilities and avant-garde aesthetic designs also played a role, selected by 70 (27.3%) and 75 (29.3%) respondents, respectively.

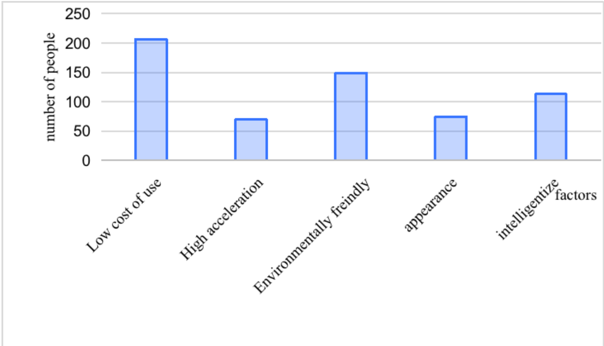

Fig. 6. Distribution of factors causing the choose of new energy vehicles.

G. Factors Affecting the Choice of Alternative Energy Vehicles

Fig. 7 presents the data on factors affecting the choice of alternative energy vehicles, including charging efficiency, battery life, continuation, safety index, and performance in extreme weather conditions. Respondents' opinions are distributed evenly across these factors. The leading concern is the inability of alternative energy vehicles to conduct long-range missions compared to fossil-fueled vehicles, with 186 respondents expressing this concern, which accounts for 72.7% of all respondents. Battery life degradation over time is a close second, with 178 respondents (69.5%) worried about this issue. This is because the state of health of vehicle batteries will decrease due to battery life degradation, leading to a significant reduction in the ranges of electric vehicles. Additionally, 171 respondents (66.8%) are concerned about the extended charging time for alternative energy vehicles due to low charging speed, not to mention that consumers usually have to wait for a long time to use the charging infrastructure. Safety hazards related to batteries in extreme temperatures trouble 152 respondents (59.4%). Furthermore, 125 respondents (48.8%) highlight issues related to endurance in extremely cold weather regions, where the heating system relies entirely on batteries so the energy consumption rate will increase significantly. In fact, in extremely hot weather, such circumstances will also happen, since the air conditioner in vehicles consumes a large amount of energy.

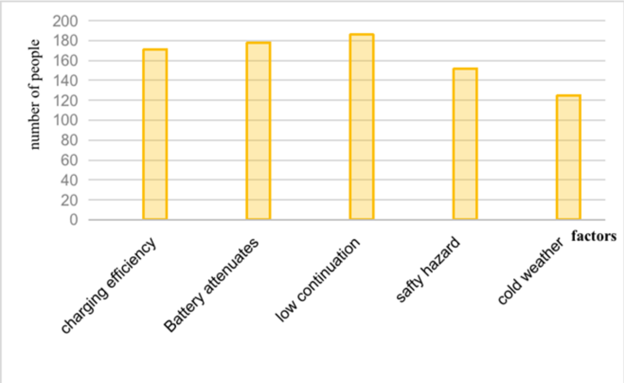

Fig. 7. Distribution of factors distracts the choice of new energy vehicles.

H. Factors Influencing the Choice of Fossil-fueled Vehicles

Fig. 8 represents the distribution of factors influencing the choice of fossil-fueled vehicles, focusing on continuation, reliability, and retention rate. Among respondents, 211 (82.4%) consider fossil-fueled vehicles' ability to conduct long-range trips as the primary factor. The trust in the mature technologies and long development history of fossil-fueled vehicles led 180 respondents to choose them, which accounts for 70.3% of all respondents. However, the relatively high retention rate of fossil-fueled vehicles, maintaining their performance over time, is not a significant influencing factor on consumer choice, with 81 respondents (31.6%) choosing this option.

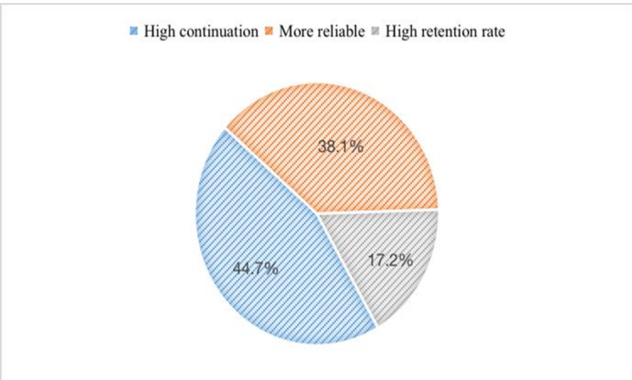

Fig. 8. Distribution of factors causing the choice of fuel vehicles.

I. Main Disadvantage of Fossil-fueled Vehicles

Fig. 9 shows the main issue regarding fossil-fueled vehicles, as identified by respondents. The high cost of gasoline is deemed the most significant hindrance to the development of the fossil-fueled vehicle market, with 209 respondents expressing this concern, which accounts for 81.6% of all respondents. This situation might be worse due to the recent Ukraine-Russia war. Only a smaller proportion of respondents (15, accounting for 5.9%) are concerned about acceleration performance and other issues related to pollution and intelligence, which indicates that dynamic performances are not the focus of major consumers. High energy use cost is one of the major challenges facing fossil-fueled vehicles, to which conventional vehicle manufacturers should pay much more attention.

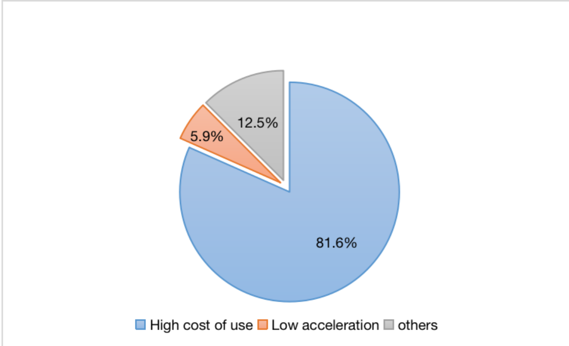

Fig. 9. The biggest disadvantage identified by respondents.

J. Expectations for the Future

Fig. 10 displays respondents' expectations for the future development of the fossil-fueled vehicle market. Approximately half of the respondents (i.e., 125) expressed confidence in the future of fossil-fueled vehicles. On the other hand, over 37% of respondents (95) believe that alternative energy vehicles, particularly electric vehicles, have a brighter future. The remaining respondents are reported to be unsure about the future direction of the market. In general, consumers still have positive expectations for the future development of fossil-fueled vehicles.

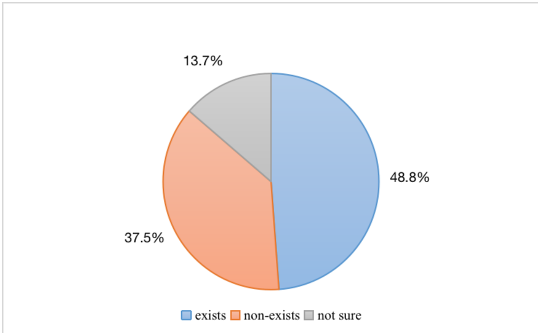

Fig. 10. Distribution of whether fuel vehicles still have development space.

Overall, the results of this research provide valuable insights into consumer attitudes toward fossil-fueled vehicles in the current vehicle market and their future development. The balanced gender distribution, diverse age representation, and clear preferences for vehicle types contribute to the credibility and relevance of the results. Factors influencing the consumer choice of electric vehicles and fossil-fueled vehicles are highlighted, which can support further analysis of the development potential of fossil-fueled vehicles in this research.

IV. Discussion

A. Potential Lying in Fuel-powered Vehicles

Fossil-fueled vehicles still exhibit the potential for further development. Based on the findings derived from the questionnaire survey, approximately 49% of respondents hold the idea that there is still potential for the fossil-fueled vehicle market to develop. From my perspective, while fossil-fueled vehicles indeed exhibit certain limitations that hinder their development, these drawbacks can be overcome through the development and implementation of corresponding technologies. Furthermore, it should be noted that fossil-fueled vehicles possess distinct advantages that electric vehicles lack, and the fuel vehicle market should strive to consolidate its technological advantages over electric vehicles to maintain competitiveness.

Among the respondents, the foremost drawback of fossil-fueled vehicles is attributed to their elevated operation costs, mainly stemming from high fuel prices and low energy efficiencies. Addressing this critical concern is imperative. Achieving a higher energy efficiency of engines is a key solution. To enhance engine efficiency, manufacturers should focus on optimizing lubrication performance within the engine to minimize kinetic energy loss arising from friction. Moreover, improvements to crankcase ventilation and cleaning processes are necessary to ensure optimal intake and exhaust efficiency. Utilization of artificial intelligence in developing an advanced engine system is also necessary. For example, the efficiency loss can be avoided by using a more intelligent engine management system, based on related technologies such as machine learning.

Another pivotal solution to reduce carbon emissions and help with carbon neutrality objectives is the development of sustainable automotive fuels (Liu *et al.*, 2023; Liu *et al.*, 2022). These fuels can be derived from diverse sources such as waste oil, energy crops, agricultural and forestry residues, or urban waste. Compared to conventional gasoline, sustainable automotive fuel demonstrates the potential to reduce carbon emissions by 50% to 80% across the entire lifecycle, encompassing cultivation or collection of raw materials, processing, transportation, storage, utilization, and maintenance. Although sustainable fuels are currently more prevalent in the aerospace industry due to relatively higher production costs, collaborations between vehicle manufacturers and oil companies like Saudi Aramco, Royal Dutch Shell, Chevron, etc., could contribute to driving down production expenses through dedicated research and development efforts. Such collaborations might also facilitate the transition of fuel companies to energy companies, given the non-renewable nature of oil as an energy source. This transition appears viable and has the potential to foster consumer and government support for fuel-powered vehicles in the future, owing to reduced usage costs and a more environmentally friendly profile.

In terms of advancements in intelligence, fuel-powered vehicle manufacturers can substantially improve the intelligent performances of fuel-powered vehicles, to catch up with the progress made in electric vehicles and narrow the gap, by embracing telematics and smart connectivity. These technologies enable fuel-powered vehicles to connect to the Internet, facilitating real-time exchange of information and data sharing between vehicles and infrastructure. This leads to access to valuable services like real-time traffic information, navigation support, remote diagnostics, and maintenance capabilities. Additionally, integrating advanced driver assistance system, encompassing features like Adaptive Cruise Control (ACC), Automatic Emergency Braking System (AEB), Lane Keeping Assist System (LKAS), etc., enhances driving safety and convenience by offering functionalities like Vehicle Stability Control (VSC) and Traffic Sign Recognition (TSR), alongside Automated Parking (AP). These will further make fuel-powered vehicles attractive to consumers.

Furthermore, by incorporating intelligent driving and automated driving technology, facilitated by sensors, cameras, radar, and LIDAR, fuel-powered vehicles can achieve automated driving assistance and even highly automated driving, alleviating the burden on drivers and bolstering driving safety. Moreover, integrating user-friendly human-computer interaction interfaces and voice control mechanisms, such as touch screens and voice assistants, empowers drivers to interact more seamlessly with the vehicle, adjusting settings for seats, audio, navigation, and air conditioning systems. Consequently, fuel-powered vehicles are expected to attain a comparable intelligence level to that of electric vehicles, narrowing the performance gap.

One distinctive area of making breakthroughs in fuel-powered vehicles lies in energy management and intelligence performance optimization. As discussed above, artificial intelligence is a key approach to achieving this target. Leveraging intelligent algorithms and data analytics systems, energy management in fuel-powered vehicles can be fine-tuned to enhance energy efficiency, and performance, and minimize environmental impact. For instance, intelligent route planning, coupled with monitoring and optimization of driving behavior, can significantly reduce energy waste during trips, effectively increasing the vehicle’s range.

Therefore, the fuel-powered vehicle market still harbors promising prospects for development, despite the limitations it currently shows. By strategically addressing shortcomings, capitalizing on unique advantages, advancing technological features, and embracing intelligent solutions, the fuel-powered vehicle industry can pave the way for a more sustainable and intelligent automotive future.

B. Market Analysis

Considering markets, the truck and long-range vehicle markets present unique challenges to electric vehicles, demanding vehicles that can withstand harsh road conditions and environments with the ability to maintain a long range. Fuel-powered vehicle manufacturers can distinguish their products in these markets by highlighting qualities such as durability, reliability, and adaptability, thus positioning them as a trustworthy and enduring choice. Customized solutions tailored to the specific requirements of different users in these markets can be a significant draw for fuel-efficient vehicle manufacturers, enhancing their appeal and market share.

To users in the truck and long-range vehicle markets, promoting the energy efficiency advantages resulting from improved energy management becomes paramount. Establishing a comprehensive maintenance and after-sales service network that offers responsive, efficient, and reliable technical support can instill confidence and trust in the quality and support of fuel vehicle products. Effective marketing strategies involve active participation in industry exhibitions, product demonstrations, test drives, and collaboration with local partners. Advertising, promotional activities, and direct sales targeting these markets further reinforce market presence and reach.

In the context of the racing industry, fuel-powered vehicles play a significant role, primarily from a vehicle culture perspective. Organizing fuel-powered vehicle races, including car racing competitions, cross-country rallies, and long-distance endurance races, can raise public awareness of vehicle performance and technology, strengthening brand recognition and influence. Supporting professional racing teams and drivers through sponsorships enables fuel-powered vehicle manufacturers to showcase their technological strengths and build brand image in the motorsports arena, captivating racing enthusiasts and consumers alike.

Promoting high-performance technologies derived from racing cars and integrating them into production models elevates the performance and driving experience of fuel-powered vehicles. This demonstrates the expertise, innovation, and leadership of fuel-powered car brands in the market. Furthermore, highlighting craftsmanship and engineering in the manufacturing process fosters consumer recognition of the quality and value of fuel-powered vehicles. Encouraging safe driving techniques and equipment through motorsport culture not only builds a socially responsible image of fuel-powered car brands but also enhances consumer trust and recognition.

In conclusion, to obtain the potential for future development, fuel-powered vehicles must address their shortcomings by developing sustainable fuel solutions, enhancing intelligence levels, and increasing consumer identification through effective marketing and cultural cultivation. Maintaining advantages like high retention rate, continuation, and reliability will also enable fuel-powered vehicles to regain market competitiveness successfully.

V. Conclusion

This study is based on the rapid development of new energy vehicles to the extent that there is a replacement of fuel vehicles under the background, to explore whether there is a new potential space for the development of fuel vehicles, in the form of questionnaires to investigate the consumer market for the current automotive market views and choices, combined with the receipt of 256 feedback and further review of the literature in the form of that fuel vehicles based on the mature development of technology, can play its unique advantages and make up for some of the shortcomings in the use experience through technological improvement. The following are some recommendations based on the findings of the study.

Five strategy suggestions are analyzed and summarized for automotive manufacturers to achieve further development of fuel-powered vehicles.

- Improve energy efficiency: implement stricter regulations and standards to promote fuel efficiency in conventional internal combustion engines. Encourage the development and adoption of hybrid technologies to reduce emissions and dependence on fossil fuels.
- Explore sustainable automotive fuels: promote the use of cleaner and sustainable fuels. Support research and development efforts to make these alternatives more viable and accessible.
- Enhance emissions control: strengthen emissions control measures to mitigate air pollution from traditional fuel vehicles. Mandate the use of advanced emission control systems and encourage regular maintenance to ensure vehicles remain environmentally friendly.
- Collaborate with multiple industries: foster partnerships and cooperation between automotive manufacturers, energy providers, government agencies, and academia. Create a collaborative environment to share knowledge, resources, and expertise for the sustainable development of traditional fuel vehicles.
- Educate and promote public awareness: increase public awareness about the environmental impact of fuel-powered vehicles and the benefits of greener alternatives to gasoline. Launch educational campaigns to inform consumers about vehicle choices and encourage sustainability.

Conflict of Interest

The author claims that no conflict of interest exists.

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