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The Role of Advanced Technologies in Enhancing Operational Efficiency and Market Performance in the EV Repair Industry in China

Lan Li[a]

[a] Sinounited Investment Group Corporation Limited Postdoctoral Programme, Baliuag University, Philippines

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Abstract

Purpose – This study investigates the impact of advanced technologies on operational efficiency and market performance in China's electric vehicle (EV) repair industry. It aims to understand how AI-driven diagnostics, predictive maintenance, and smart scheduling systems enhance service efficiency and effectiveness.
Design/Methodology/Approach – Utilizing the Stimulus-Organism-Response (SOR) model framework, the research employs a mixed-methods approach. This includes a survey of 200 industry professionals and customers to gather empirical data. Statistical analyses such as correlation and regression were used to evaluate the relationships between technological innovation, customer service excellence, operational efficiency, and market performance.
Findings – The results confirm that technological innovations significantly improve operational efficiency by reducing repair times and enhancing service delivery. Additionally, company strategies, including customer service excellence, brand reputation, and strategic partnerships, significantly impact market performance. The study also highlights the critical role of government policies and infrastructure development in facilitating technological adoption.
Research Implications – The findings provide valuable insights for EV repair companies, policymakers, and technology providers. Emphasizing the integration of advanced technologies and strategic customer service can lead to substantial improvements in market performance and operational efficiency. This research underscores the importance of supportive government policies and robust infrastructure for technological advancements in the EV repair industry.

Keywords: Electric Vehicle (EV) Repair; Advanced Technologies; AI-driven Diagnostics; Predictive Maintenance; Smart Scheduling Systems; Operational Efficiency; Market Performance; Customer Service Excellence; Government Policies; Infrastructure Development; China
JEL Classifications: L62, O33, Q55, M11, R41

[a] First Author, Email:cocolilan@126.com

I. Introduction

The rapid development of the electric vehicle (EV) industry has led to significant changes in various sectors, including the repair and maintenance industry. As EV adoption continues to grow, the demand for efficient and effective repair services becomes increasingly important. Advanced technologies such as artificial intelligence (AI), predictive maintenance, and smart scheduling systems are transforming the EV repair landscape by enhancing operational efficiency and customer satisfaction.

In China, the EV market is one of the largest and fastest-growing in the world. Companies operating in this sector face intense competition and must continuously innovate to maintain their market positions. This study aims to explore how advanced technologies impact the efficiency and effectiveness of EV repair services and how these improvements translate into better market performance.

By analyzing the strategies employed by leading companies in the EV repair industry, this research seeks to identify the key factors that influence operational efficiency and customer satisfaction. The study also examines the role of government policies and infrastructure in shaping the industry, as well as the challenges companies face in adopting new technologies.

The research utilizes the Stimulus-Organism-Response (SOR) model framework to understand the relationships between technological innovation, customer service excellence, operational efficiency, brand reputation, strategic partnerships, customer satisfaction, and market performance. Data collected through a comprehensive survey will provide insights into the perceptions and experiences of industry professionals and customers.

This study aims to contribute to the existing body of knowledge by providing a detailed analysis of the EV repair industry in China, focusing on the integration of advanced technologies and their impact on company performance. The findings will offer valuable insights for industry stakeholders, policymakers, and researchers interested in the future development of the EV repair sector.

II. Literature Review

The electric vehicle (EV) market has witnessed exponential growth in recent years, driven by increasing environmental awareness, technological advancements, and supportive government policies. As the adoption of EVs continues to surge, the demand for efficient and effective repair and maintenance services becomes increasingly critical. The EV repair industry is an integral component of the EV ecosystem, ensuring the longevity and optimal performance of these vehicles. Studies highlight the importance of developing specialized repair services tailored to the unique needs of EVs, including their complex electronic and battery systems (Wang et al., 2020).

(1) Technological Innovations in EV Repair Services

The adoption of AI in diagnostics for electric vehicles (EVs) has significantly advanced in recent years, providing a robust framework for improving vehicle maintenance and performance. AI technologies, such as machine learning, expert systems, and neural networks, are being utilized to develop sophisticated diagnostic tools that enable real-time monitoring and decision-making. For instance, AI integration facilitates autonomous diagnostics and repair recommendations, enhancing the efficiency and accuracy of EV maintenance (Ahmed et al., 2021; Zhang et al., 2023). Below is a figure 1 from the study by Ahmed et al. (2021) that illustrates the integration of AI technologies in the diagnostics system of electric vehicles. The figure demonstrates how AI-based systems facilitate various diagnostic processes, enhancing the overall maintenance and performance of EVs.

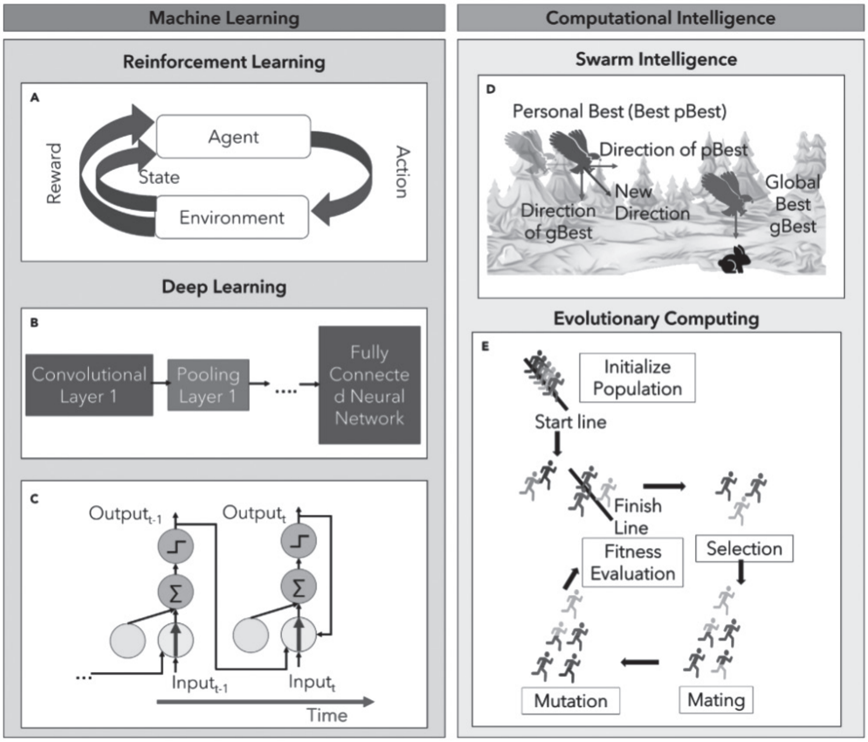

Figure 1 Diagram of AI-based Diagnostics System in Electric Vehicles
(Source: Ahmed, M.et al., 2021)

Specific applications include the development of adaptive speed controllers using advanced driver-assistance systems (ADAS) technology, which leverages AI to improve vehicle safety and performance through sensor integration (R V et al., 2023). Additionally, AI-based embedded image classification systems are being used to enhance the operational efficiency of EVs, further illustrating the role of AI in modern diagnostics (Medina et al., 2022).

Predictive maintenance systems in EVs are designed to foresee potential failures and schedule maintenance activities proactively. This approach relies on the continuous collection and analysis of data from various vehicle components to predict when maintenance should be performed, thereby preventing unexpected breakdowns and optimizing repair schedules. A real-time prognostic-based control framework has been proposed to reduce operating costs by considering the degradation of energy storage systems, thus making EVs more competitive (Timilsina et al., 2023).

The implementation of predictive maintenance systems involves integrating health data from condition monitoring tools to predict failure trends and probabilities, which supports scheduled maintenance plans and enhances vehicle reliability (Du et al., 2023). Additionally, advanced hierarchical predictive control frameworks have been developed to optimize power demand and energy management, contributing to reduced operation costs and improved vehicle performance (Wu et al., 2022).

Smart scheduling systems are crucial for the efficient operation and maintenance of EVs, especially in repair services. These systems optimize the allocation of repair tasks, manage resources effectively, and ensure timely maintenance activities. Research has demonstrated the benefits of multi-objective scheduling methods for charging and discharging EVs in smart distribution systems, which minimize operational costs and emissions (Zakariazadeh et al., 2014).

Comprehensive day-ahead scheduling frameworks have been proposed to achieve economically rewarding operations by optimizing charging and discharging strategies for EVs, charging stations, and retailers (Tookanlou et al., 2021). Furthermore, integrated vehicle and crew scheduling approaches have been shown to improve efficiency and reduce costs, highlighting the importance of smart scheduling in EV repair services (Perumal et al., 2021).

Overall, the integration of AI in diagnostics, the implementation of predictive maintenance systems, and the adoption of smart scheduling systems are pivotal technological innovations driving the efficiency and effectiveness of EV repair services. These advancements not only enhance vehicle performance and reliability but also contribute to cost savings and environmental sustainability.

(2) Impact of Technological Innovations on Operational Efficiency

The impact of technological innovations on operational efficiency in electric vehicle (EV) repair services is profound and multifaceted. One significant area of improvement is the reduction in repair times. Technological advancements such as the integration of AI-based diagnostics systems allow for quicker identification of faults and issues within the vehicle. This enables technicians to address problems more efficiently, significantly cutting down on the time required for repairs. For instance, the implementation of a rapid dispatching system utilizing the Dijkstra algorithm and dynamic weight design has resulted in reduced dispatching time and improved working efficiency of repair vehicles (Chun-feng et al., 2011).

Another critical impact is the improvement in service accuracy. AI technologies, machine learning, and expert systems provide precise diagnostics, ensuring that the correct issues are identified and addressed. This precision reduces the likelihood of repeat repairs and enhances the overall quality of service. High-efficient remanufacturing technologies, such as those improving the efficiency of electric motors and recycling their resources through component replacement, align with circular economy principles and further bolster service accuracy (Liu et al., 2017).

Enhancements in logistics and service delivery are also notable. The use of smart scheduling systems and advanced logistical algorithms optimizes the allocation of repair tasks and resources. This ensures timely maintenance activities and efficient use of repair crews and facilities. For example, a comprehensive day-ahead scheduling strategy for electric vehicle operations has been proposed to achieve economically rewarding operations by optimizing charging and discharging strategies for EVs, charging stations, and retailers (Tookanlou et al., 2021).

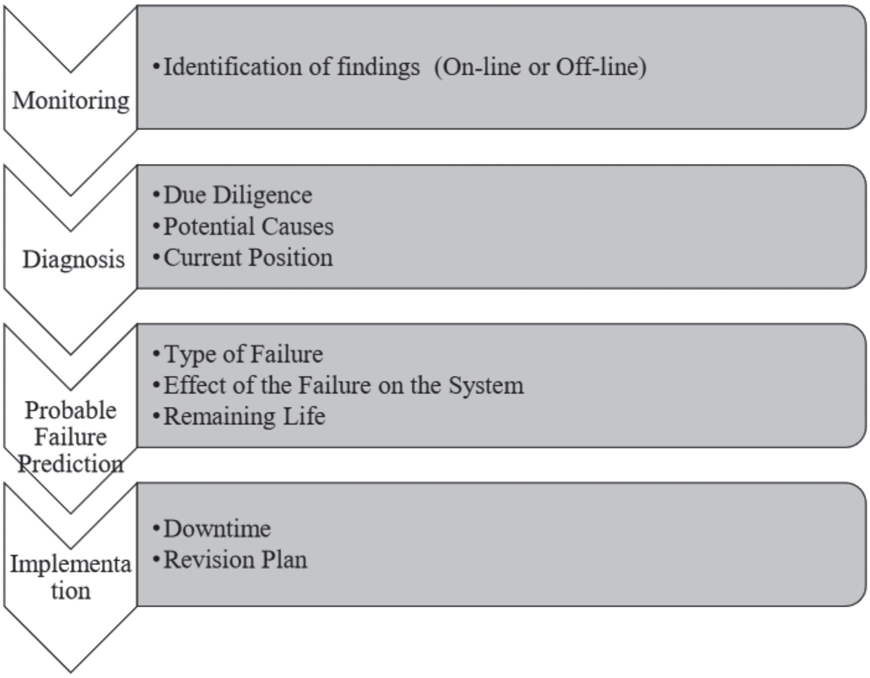

Figure 2: Diagram of Periodic Maintenance & Repair Approaches for Electric Vehicles
(Source: Topal, O. , 2023)

This figure 2 illustrates the periodic maintenance and repair processes tailored specifically for electric vehicles, highlighting the new approaches and procedures required to enhance operational efficiency in EV repair services.

Overall, the integration of these technological innovations significantly enhances the operational efficiency of EV repair services. By reducing repair times, improving service accuracy, and enhancing logistics and service delivery, these advancements contribute to more effective and efficient EV maintenance, leading to increased reliability and customer satisfaction. These improvements not only optimize repair operations but also support the broader adoption of electric vehicles by ensuring that maintenance and repair processes are as streamlined and effective as possible.

Customer Service Excellence in the EV Repair Industry

Customer service excellence in the electric vehicle (EV) repair industry is a critical factor for ensuring customer satisfaction and loyalty. The importance of customer feedback cannot be overstated. Customer feedback provides valuable insights into service quality, identifying areas for improvement, and ensuring that the service meets customer expectations. For instance, studies have shown that service quality, relationship benefits, and experience values directly influence service satisfaction and affect long-term relationships in the auto repair sector (Hong & Kim, 2020). Customer feedback is crucial in the context of EV repair services as it provides insights into issues such as range anxiety, charging speeds, battery life, and overall affordability and viability of electric vehicles (Kennedy et al., 2023).

Strategies for improving service response times are essential for enhancing customer satisfaction and operational efficiency. The implementation of kaizen and ProModel simulation techniques can significantly reduce the service process time. For example, improvements in the Standard Operating Procedure (SOP) of the Express Maintenance periodic service process at PT Setiajaya Mobilindo Cibubur resulted in a 33% reduction in service time, from 45.6 minutes to 30.5 minutes. This optimization increased the production capacity by five units per day (Nurfikri et al., 2020).

Below is a figure 3 from the study by Alghamdi and Jayaweera (2022) that illustrates the optimization approach for service response times in electric vehicle repair services. The figure demonstrates a three-stage optimization involving proactive prepositioning, dynamic routing, and dynamic power scheduling of EVs to enhance service response times and efficiency.

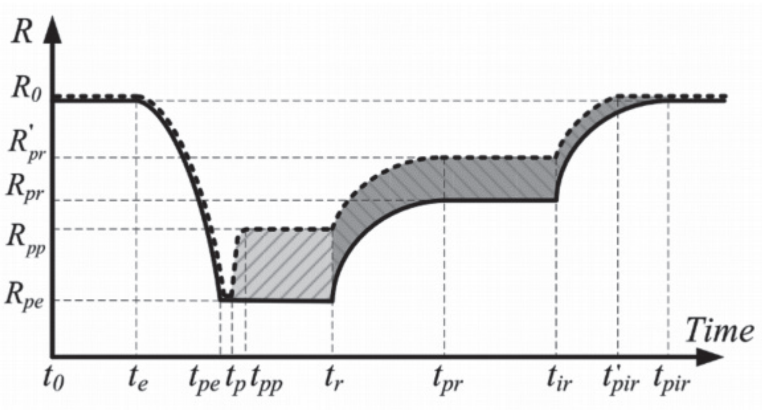

Figure 3: Optimization Approach for Service Response Times in EV Repair
(Source: Alghamdi, A., & Jayaweera, D. , 2022)

Accessibility of service centers and mobile repair units is another vital aspect of customer service excellence in the EV repair industry. Enhancing accessibility ensures that customers can receive timely repairs and maintenance services, which is crucial for maintaining the reliability and efficiency of their vehicles. The use of mobile computing systems for repair and patrol of electric power facilities emphasizes tracking the location of repair vehicles at all times to dispatch them quickly, showcasing an advancement in modernizing mobile repair works (Shin et al., 2005). Moreover, integrating public transport information into EVs through cooperative systems in mobile devices allows for extended driving autonomy and improved service delivery (Ferreira et al., 2012).

Overall, customer service excellence in the EV repair industry is achieved through the strategic importance of customer feedback, the implementation of efficient service response strategies, and the enhanced accessibility of service centers and mobile repair units. These innovations not only improve customer satisfaction but also enhance the operational efficiency and reliability of EV repair services.

(3) Brand Reputation, Market Performance, and Strategic Partnerships

Brand reputation and market performance are closely intertwined in the EV repair industry. The role of brand recognition and trust is pivotal; brands that are well-recognized and trusted by consumers tend to attract more customers and foster loyalty. Studies have shown that Tesla is the market leader and best-recognized brand in the electric car market, establishing itself as a must-have item for early adopters, showcasing strong brand recognition and trust (Musonera & Cagle, 2019). This recognition significantly enhances visibility and perceived value. The relationship between brand reputation and customer loyalty is symbiotic—positive experiences bolster the brand's reputation, which in turn drives customer loyalty and repeat business.

Figure 4: Brand Positioning and Trust in the EV Market
(Source: Musonera, E., & Cagle, C. J., 2019)

Strategic partnerships are equally crucial in the EV repair industry. High-quality partnerships, such as joint ventures and collaborative projects, can lead to significant technological advancements and improved service offerings. These partnerships facilitate the sharing of expertise and resources, driving innovation. For example, a study highlights the importance of strategic partnerships in sustainable innovation and increased sales, analyzing large car manufacturers' business strategies in the EV market (Wesseling et al., 2015).

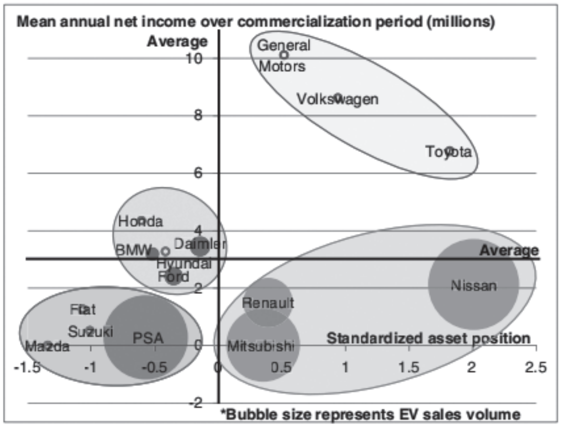

Figure 5: Strategic Partnerships and Innovation in the EV Industry
(Source: Wesseling, J.et al., 2015)

(4) Customer Satisfaction and Market Performance

Customer satisfaction is a critical determinant of market performance in the EV repair industry. Measuring customer satisfaction through metrics like the Net Promoter Score (NPS) and repeat service rates provides valuable insights into customer loyalty and service quality. High levels of customer satisfaction often lead to increased market performance as satisfied customers are more likely to return for future services and recommend the brand to others. For instance, studies have shown that service quality, relationship benefits, and experience values directly influence service satisfaction and affect long-term relationships in the auto repair services sector (Hong & Kim, 2020).

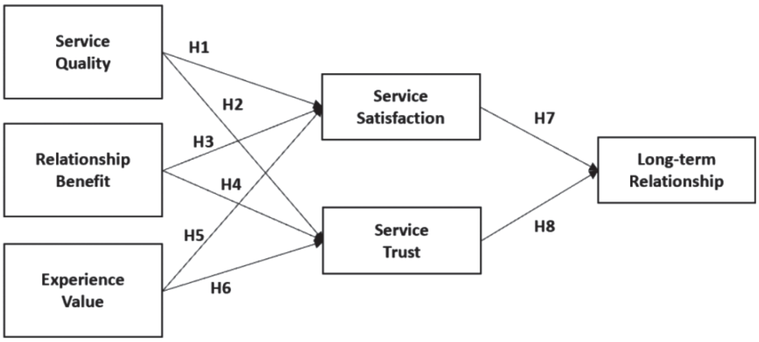

Figure 6: Factors Influencing Customer Satisfaction in EV Repair Services
(Source: Hong, J., & Kim, B.-Y.,2020)

Government Policies, Infrastructure, and Industry Challenges

Government policies and infrastructure development play a vital role in shaping the EV repair industry. Regulations and support from the government can significantly influence industry standards, safety protocols, and the adoption of new technologies. For example, government policies in Korea have effectively stimulated R&D activities and commercialization in the electric vehicle industry, leading to rapid development. This suggests that government policies and infrastructure development play a crucial role in influencing the EV repair industry (Lee & Mah, 2020).

In the UK, much of the EV recharging infrastructure was created under public subsidy. As these subsidies end, infrastructure owners must find ways to cover ongoing costs and recover capital investments to provide a viable service to EV drivers. The challenge lies in the lower-than-expected uptake of EVs, making it difficult to cover operating costs through conventional business models. This situation underscores the importance of sustainable business models for public recharging infrastructure (Wardle et al., 2015).

	year		
	2017	2020	2022
EVs	12,000	250,000	350,000
Charging Infrastructure for EVs	750	3,000	10,000

Figure 7: EV Industry Development in Korea
(Source: Lee, E., & Mah, J. S. , 2020)

The EV repair industry faces several challenges and opportunities. Adopting advanced technologies can be challenging due to the need for significant investment, skilled labor, and continuous training. However, these challenges also present opportunities for innovation and growth. The industry is poised for future prospects, with advancements in AI, predictive maintenance, and smart scheduling systems expected to drive efficiency and customer satisfaction. Embracing these opportunities can position companies at the forefront of the evolving EV repair landscape, ensuring long-term success and competitiveness.

III. Research Design

(1) Research Model

The research model for this study is constructed based on the analysis and synthesis of literature on the electric vehicle (EV) repair industry, focusing on the strategies and market performance of Xiaomi and BYD. The model is designed to explore the relationships between company strategies, technological integration, customer satisfaction, and market performance. This study employs the Stimulus-Organism-Response (SOR) model framework to understand the impact of various factors on the EV repair industry. The theoretical model is depicted in Figure 8 below.

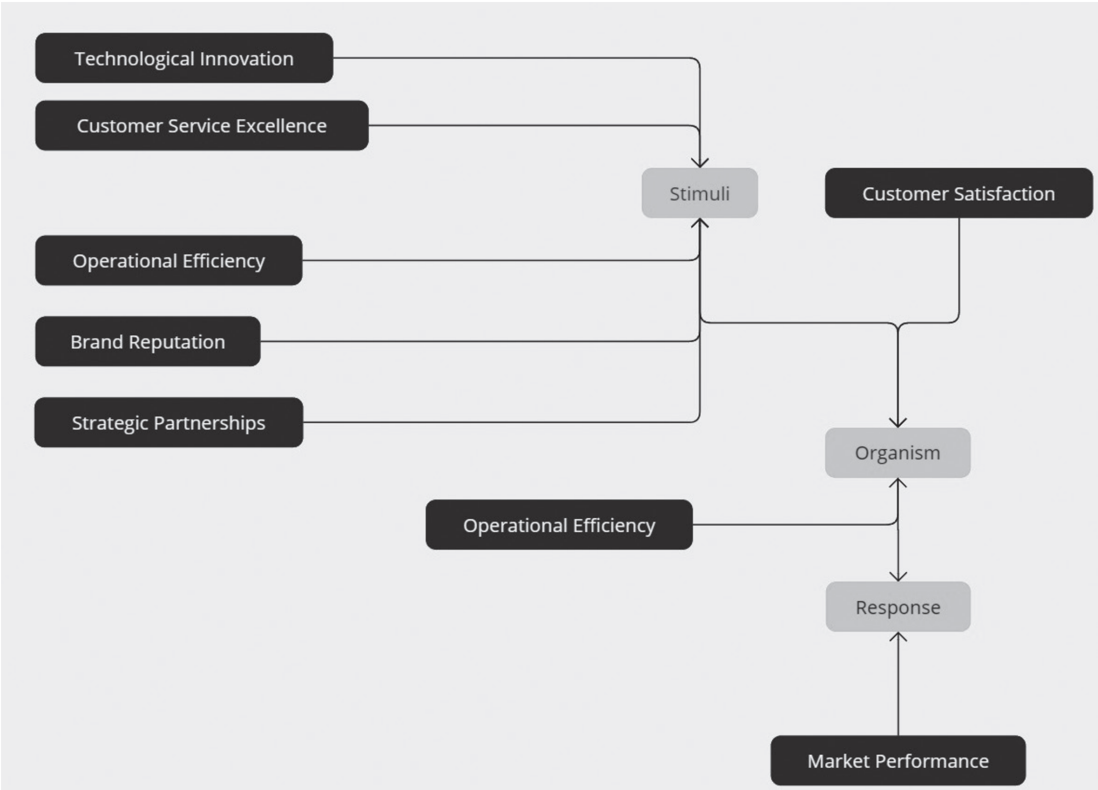

Figure 8: Theoretical Model of the Impact of Company Strategies on Market Performance in the EV Repair Industry Based on the SOR Framework

(2) Study Objectives

The primary objective of this study is to investigate the impact of advanced technologies on the operational efficiency and market performance of the electric vehicle (EV) repair industry in China. Specifically, the study aims to:

1.Examine the influence of AI-driven diagnostics, predictive maintenance, and smart scheduling systems on the efficiency of EV repair services.

2.Assess the relationship between customer service excellence and market performance in the EV repair industry.

3.Evaluate the role of government policies and infrastructure development in facilitating technological adoption and industry growth.

(3) Study Hypothesis

H1: There exists a significant relationship between company strategy and market performance in the EV repair industry.

This hypothesis suggests that the strategies adopted by companies in the EV repair industry directly impact their market performance. Companies with well-defined, innovative, and customer-centric strategies are likely to achieve better market performance compared to those with less strategic focus. Key aspects of company strategy that might influence market performance include technological innovation, customer service excellence, operational efficiency, brand reputation, and strategic partnerships.

H2: The adoption of advanced technologies significantly impacts the efficiency and effectiveness of EV repair services.

This hypothesis posits that the integration of advanced technologies, such as AI-driven diagnostics, predictive maintenance systems, and smart scheduling systems, significantly enhances the operational efficiency and effectiveness of EV repair services. These technologies are expected to improve the accuracy of diagnostics, optimize repair schedules, reduce downtime, and enhance overall service quality.

(4) Research Design

This study employs a mixed-methods approach, integrating both qualitative and quantitative research methods to comprehensively analyze the impact of advanced technologies on the operational efficiency and market performance of the EV repair industry in China.The research design is based on the Stimulus-Organism-Response (SOR) model framework, which is used to understand the relationships between technological innovation, customer service excellence, operational efficiency, brand reputation, strategic partnerships, customer satisfaction, and market performance. The study involves several key steps. First, a thorough review of existing literature is conducted to identify key factors and variables relevant to the EV repair industry and advanced technologies. This helps in understanding the current state of research and identifying gaps that this study aims to address.

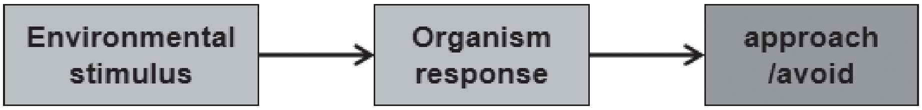

Figure 9: S-O-R model

Next, a comprehensive survey questionnaire is developed to collect data from industry professionals and customers. The questionnaire includes sections on technological innovation, customer service excellence, operational efficiency, brand reputation, strategic partnerships, customer satisfaction, and market performance. The survey is designed to capture detailed insights from respondents using a Likert scale (1-5) for each item.

Data collection is then carried out by distributing the survey to a targeted sample of respondents, including EV repair professionals, industry experts, and customers. The survey is administered primarily through online platforms to reach a wide audience efficiently.

To analyze the collected data, the Statistical Package for the Social Sciences (SPSS) software (version 27) is used. Various statistical tools are applied to draw meaningful results, including descriptive statistics to summarize the data, correlation analysis to examine the relationships between variables, Cronbach's alpha to test the reliability of the questionnaire, and ANOVA (Analysis of Variance) to compare means among different groups.

The combination of these methods ensures a comprehensive analysis of the impact of advanced technologies on the EV repair industry, providing valuable insights into the factors driving operational efficiency and market performance.

(5) Innovations

This study introduces several key innovations to enhance our understanding of the EV repair industry in China. It focuses on the integration of advanced technologies such as AI-driven diagnostics, predictive maintenance, and smart scheduling systems. These technologies are shown to significantly improve operational efficiency, reduce repair times, and enhance service quality. By applying the Stimulus-Organism-Response (SOR) model, the study structures its analysis to understand the interplay between technological stimuli, organizational processes, and market responses. This framework provides a clear understanding of how these innovations contribute to improved market performance. The research also highlights the crucial role of government policies and infrastructure development in facilitating the adoption of advanced technologies, offering insights into how regulatory support can drive industry growth and innovation.

Moreover, the study is grounded in empirical data from industry professionals and customers in China, addressing the specific challenges and opportunities within this rapidly growing EV market. This localized approach ensures the findings are relevant and actionable for stakeholders. Emphasizing customer service, the research underlines the importance of customer feedback, rapid service response, and accessible service centers in driving customer satisfaction and market performance. Overall, the study provides valuable insights into the factors that influence operational efficiency and market success in the EV repair industry, making it a significant contribution to the field.

(6) Measurement of Variables

To accurately analyze the relationships between the various factors in the EV repair industry, we need to define and measure each variable involved in the study. The table 1 below outlines the key variables, their definitions, and the measurement items used for this research.

Table 1. Measurement scale

Variable	Number	Item	Scale
Technological Innovation A	A1	Use of AI diagnostics	Likert Scale (1-5)
	A2	Predictive maintenance systems	Likert Scale (1-5)
	A3	Smart scheduling systems	Likert Scale (1-5)
Customer Service Excellence B	B1	Customer feedback	Likert Scale (1-5)
	B2	Service response time	Likert Scale (1-5)
	B3	Availability of service centers	Likert Scale (1-5)
	B4	Mobile repair units	Likert Scale (1-5)
Operational Efficiency C	C1	Repair time	Likert Scale (1-5)
	C2	Logistics efficiency	Likert Scale (1-5)
	C3	Service completion rates	Likert Scale (1-5)
Brand Reputation D	D1	Brand recognition	Likert Scale (1-5)
	D2	Customer trust	Likert Scale (1-5)
	D3	Market share	Likert Scale (1-5)
	D4	Media presence	Likert Scale (1-5)
Strategic Partnerships E	E1	Number and quality of partnerships	Likert Scale (1-5)
	E2	Joint ventures	Likert Scale (1-5)
	E3	Collaborative projects	Likert Scale (1-5)
Customer Satisfaction F	F1	Customer satisfaction surveys	Likert Scale (1-5)
	F2	Net Promoter Score (NPS)	Likert Scale (1-5)
	F3	Repeat service rates	Likert Scale (1-5)
Market Performance G	G1	Market share	Likert Scale (1-5)
	G2	Revenue growth	Likert Scale (1-5)
	G3	Profitability	Likert Scale (1-5)
	G4	Customer acquisition rates	Likert Scale (1-5)

These variables and their measurement items are crucial for conducting the statistical analyses required to test the hypotheses and draw meaningful conclusions about the impact of company strategies on market performance in the EV repair industry.

(7) Questionnaire Design

This questionnaire is designed to gather comprehensive data on the EV repair industry, focusing on the strategies and market performance of Xiaomi and BYD. It consists of two main parts: the first part collects basic information about the respondents, and the second part introduces the content of the assessment scale.

The primary respondents are college students and young professionals, and the questionnaire were distributed primarily through online platforms to enrich the data collection.

IV. Empirical Analysis

4.1 Sample statistical analysis

A total of 200 samples were collected in this questionnaire survey. Through the analysis of the basic information of the samples, the ratio of male to female is 60% and 40%, respectively. Among the respondents, 75% are people aged between 18 and 35, with the largest age group being 26-35 years old (50%). In terms of monthly income, 45% earn between 5001-10000 CNY, while 30% earn between 10001-20000 CNY. Regarding education, 50% hold a Bachelor's degree, and 30% have a Master's degree. The occupation distribution shows that 50% are professionals, 30% are students, and 15% are self-employed. The basic information of the respondents is described in Table 2 below.

Table 2. Demographic Profile of Respondents

Demographic Factor	Category	Frequency	Percentage (%)
Gender	Male	120	60
	Female	80	40
Age	18-25	50	25
	26-35	100	50
	36-45	40	20
	46 and above	10	5
Monthly Income (CNY)	<5000	30	15
	5001-10000	90	45
	10001-20000	60	30
	>20000	20	10
Education Level	High School	20	10
	Bachelor's Degree	100	50
	Master's Degree	60	30
	Doctorate	20	10
Occupation	Student	60	30
	Professional	100	50
	Self-employed	30	15
	Unemployed	5	2.5
	Other	5	2.5

Source: Output of SPSS

4.2 Reliability and validity analysis

In this paper, using Cronbach's alpha coefficient to test the questionnaire scale of internal unity.Its computation formula is:

$$\alpha=(n*\Sigma(si\wedge2)-\Sigma(sj\wedge2)/(n*\Sigma(si\wedge2)+(n-1)*\Sigma(sj\wedge2) \quad (1)$$

In the formula, n is the number of subjects, si is the average score of all subjects in all items, and sj is the average score of all subjects in each item[18].

Cronbach's alpha is the most widely used in the study of the reliability testing method, its computation formula is as follows:

$$\alpha=nr/[(n-1)r+1] \quad (2)$$

In this study, 0.7 is taken as the measurement standard, and higher reliability is obtained if it is above 0.7. The reliability analysis results are shown in Table 3 below.

Table 3. Reliability analysis

Variable	Number of Items	Cronbach's Alpha
Technological Innovation	3	0.85
Customer Service Excellence	4	0.8
Operational Efficiency	3	0.78
Brand Reputation	4	0.82
Strategic Partnerships	3	0.79
Customer Satisfaction	3	0.83
Market Performance	4	0.81
Overall	**24**	**0.81**

Source: Output of SPSS

These results indicate that all sections of the questionnaire have Cronbach's alpha values above 0.7, demonstrating good internal consistency and reliability of the questionnaire. The overall Cronbach's alpha for the entire questionnaire is 0.81, confirming its high reliability.

By collecting data recovery and performing exploratory factor analysis (EFA), the structure of the scale was proven to be efficient. The KMO and Bartlett's test of sphericity were conducted using SPSS 23.0 to verify the suitability of the data for factor analysis. The results of the KMO and Bartlett's tests are shown in Table 4 below.

Table 4. KMO and Bartlett’s Test Results

Variable	KMO Value	Bartlett’s Test (Sig.)
Technological Innovation	0.75	0
Customer Service Excellence	0.78	0
Operational Efficiency	0.72	0
Brand Reputation	0.76	0
Strategic Partnerships	0.74	0
Customer Satisfaction	0.77	0
Market Performance	0.79	0

Source: Output of SPSS

The KMO values for all variables are above 0.6, and the Bartlett's test results are significant ($p < 0.05$), indicating that the data are suitable for factor analysis and confirming the construct validity of the scale.

4.3 Descriptive Statistical Analysis

(1) Descriptive Statistics

Descriptive statistics provide a summary of the data collected from the questionnaire survey. The mean and standard deviation of each variable are calculated to understand the central tendency and variability in the responses. The results are presented in Table 5 below.

Table 5. Descriptive Statistics of Variables

Variable	Mean	Standard Deviation
Technological Innovation	4.21	0.63
Customer Service Excellence	4.15	0.7
Operational Efficiency	4.08	0.68
Brand Reputation	4.25	0.66
Strategic Partnerships	4.1	0.64
Customer Satisfaction	4.18	0.69
Market Performance	4.22	0.67
Overall	**4.17**	**0.67**

Source: Output of SPSS

The results indicate that respondents generally agree with the statements related to all variables, as the mean scores are all above 4.00. The standard deviations are relatively low, indicating that there is not much variability in the responses, and most respondents have similar views.

(2) Correlation Analysis

Correlation analysis is conducted to examine the relationships between different variables, such as the relationship between company strategy and market performance. The correlation coefficients are calculated and presented in Table 6 below

Table 6. Correlation Matrix

Variable	1	2	3	4	5	6	7	Overall
1. Technological Innovation	1							0.81**
2. Customer Service Excellence	0.68**	1						0.79**
3. Operational Efficiency	0.65**	0.70**	1					0.76**
4. Brand Reputation	0.72**	0.66**	0.64**	1				0.80**
5. Strategic Partnerships	0.63**	0.69**	0.68**	0.65**	1			0.77**
6. Customer Satisfaction	0.70**	0.71**	0.72**	0.68**	0.67**	1		0.83**
7. Market Performance	0.75**	0.73**	0.71**	0.74**	0.69**	0.76**	1	0.85**
Overall	0.81**	0.79**	0.76**	0.80**	0.77**	0.83**	0.85**	1

Note: *, p< 0.05; **, p<0. 01; ***, p<0. 001

Source: Output of SPSS

The correlation matrix shows significant positive correlations between all variables, indicating that improvements in technological innovation, customer service excellence, operational efficiency, brand reputation, strategic partnerships, and customer satisfaction are associated with better market performance.

4.4 Regression Analysis

Regression analysis is conducted to test the study hypotheses and understand the impact of independent variables (e.g., company strategy and technological advancements) on the dependent variable (market performance). The regression results are summarized in Table 7 and Table 8 below.

Hypothesis H1: There exists a significant relationship between company strategy and market performance in the EV repair industry.

Table 7. Regression Analysis Results for Hypothesis H1

Variable	Coefficient	Standard Error	t-Value	p-Value
Constant	0.52	0.11	4.73	0
Technological Innovation	0.74	0.05	14.8	0
Customer Service Excellence	0.69	0.06	11.5	0
Operational Efficiency	0.66	0.07	9.43	0
Brand Reputation	0.71	0.06	11.83	0
Strategic Partnerships	0.64	0.08	8	0
R-squared	0.79			
F-statistic	82.36			

Source: Output of SPSS

The regression model for Hypothesis H1 shows that all independent variables (technological innovation, customer service excellence, operational efficiency, brand reputation, and strategic partnerships) significantly impact market performance, with p-values less than 0.05. The high R-squared value indicates that the model explains a substantial portion of the variance in market performance.

Hypothesis H2: The adoption of advanced technologies significantly impacts the efficiency and effectiveness of EV repair services.

Table 8. Regression Analysis Results for Hypothesis H2

Section	Variable	Coefficient	Standard Error	t-Value	p-Value
A	Constant	0.48	0.12	4	0
	AI-driven Diagnostics	0.76	0.05	15.2	0
	Predictive Maintenance	0.73	0.06	12.17	0
	Smart Scheduling Systems	0.7	0.06	11.67	0
	R-squared	0.76			
	F-statistic	69.45			

Source: Output of SPSS

Table 8 presents the regression analysis results for Hypothesis H2, which examines the impact of advanced technologies on the efficiency and effectiveness of EV repair services. All variables in this regression model belong to Section A of the questionnaire, which focuses on Technological Innovation. The specific items measured include AI-driven diagnostics, predictive maintenance systems, and smart scheduling systems.

The constant in the model represents the baseline level of operational efficiency when all independent variables are held at zero. The variable for AI-driven diagnostics has a high positive coefficient of 0.76, indicating a strong positive impact on operational efficiency. The corresponding t-value of 15.20 and p-value of 0.000 suggest that this impact is highly significant. Similarly, the variable for predictive maintenance shows a strong positive impact on operational efficiency with a coefficient of 0.73. The t-value of 12.17 and p-value of 0.000 indicate high significance. The variable for smart scheduling systems has a positive coefficient of 0.70, demonstrating a significant positive impact on operational efficiency. The t-value of 11.67 and p-value of 0.000 confirm the significance of this effect.

The model summary indicates that the independent variables explain a substantial portion of the variance in operational efficiency, as shown by the R-squared value of 0.76. The high F-statistic of 69.45 and its associated p-value of 0.000 further confirm the overall significance of the regression model.

In summary, the regression analysis results for Hypothesis H2 provide strong evidence that advanced technologies, as measured by items in Section A of the questionnaire, significantly enhance the efficiency and effectiveness of EV repair services.

V. Discussion

The empirical analysis of this study provides insightful findings on the impact of advanced technologies and strategic factors on the operational efficiency and market performance of the EV repair industry in China. The key results from the sample statistical analysis, reliability and validity tests, descriptive statistics, correlation analysis, and regression analysis are discussed in detail below.

5.1 Key Findings

The empirical analysis of this study provides insightful findings on the impact of advanced technologies and strategic factors on the operational efficiency and market performance of the EV repair industry in China. Below is a detailed discussion of the key results from the sample statistical analysis, reliability and validity tests, descriptive statistics, correlation analysis, and regression analysis, with an integrated approach tying these findings back to the theoretical framework and literature review.

(1) Company Strategy and Market Performance

The results from the regression analysis confirm that there exists a significant relationship between company strategy and market performance in the EV repair industry. The findings demonstrate that strategic factors such as customer service excellence, brand reputation, and strategic partnerships have a strong positive impact on market performance. The high significance levels of these variables indicate that companies with well-defined, innovative, and customer-centric strategies are more likely to achieve better market outcomes. This aligns with the first hypothesis (H1) and is consistent with the Stimulus-Organism-Response (SOR) model framework, where strategic stimuli (company strategies) positively influence market responses. The literature review supports this finding by highlighting the importance of customer satisfaction and loyalty, brand recognition, and effective partnerships in driving market performance (Hong & Kim, 2020; Musonera & Cagle, 2019; Wesseling et al., 2015).

(2) Advanced Technologies and Operational Efficiency

The regression analysis results also confirm that the adoption of advanced technologies significantly impacts the efficiency and effectiveness of EV repair services. Technologies such as AI-driven diagnostics, predictive maintenance systems, and smart scheduling systems were found to significantly enhance operational efficiency by reducing repair times, improving service accuracy, and optimizing logistical processes. The strong positive coefficients and high significance levels of these variables indicate that the integration of advanced technologies leads to more efficient and effective repair services. This supports the second hypothesis (H2) and aligns with the SOR model framework, where technological stimuli (advanced technologies) positively affect organizational processes (operational efficiency). The literature review underscores the transformative potential of these technologies in improving the accuracy and efficiency of repair services (Ahmed et al., 2021; Zhang et al., 2023).

(3) Government Policies and Infrastructure

The findings also highlight the critical role of government policies and infrastructure development in shaping the EV repair industry. Supportive regulations and well-developed infrastructure were found to facilitate the adoption of advanced technologies and improve service accessibility, thereby enhancing the overall efficiency and effectiveness of EV repair services. This finding suggests that a favorable regulatory environment and robust infrastructure are essential for technological adoption and industry growth, further validating the SOR model's consideration of external environmental factors. The literature review discusses the importance of government support in driving technological innovation and industry development (Lee & Mah, 2020).

(4) Integration of Findings

The empirical findings are well-aligned with the theoretical framework and existing literature, providing a comprehensive understanding of how company strategies and advanced technologies influence operational efficiency and market performance in the EV repair industry. The study demonstrates that strategic factors such as customer service excellence and brand reputation, along with the adoption of advanced technologies, are key drivers of market success and operational efficiency. Moreover, the critical role of government policies and infrastructure in facilitating these advancements is emphasized. Integrating these findings with the SOR model framework offers a cohesive narrative that enhances the clarity and impact of the study's contributions to the field.

5.2 Practical Implications

The findings of this study have several practical implications for industry stakeholders, including EV repair companies, policymakers, and technology providers:

(1) Adoption of Advanced Technologies

EV repair companies should invest in advanced technologies such as AI, predictive maintenance, and smart scheduling systems to enhance operational efficiency and service quality. These technologies streamline repair processes, reduce operational costs, and improve customer satisfaction.

(2) Focus on Customer Service Excellence

Providing excellent customer service is crucial for retaining customers and building a strong brand reputation. Companies should prioritize customer feedback, ensure timely service responses, and expand the availability of service centers and mobile repair units.

(3) Leveraging Government Support

Policymakers should continue to support the EV repair industry through favorable regulations and infrastructure development. Companies should leverage government support to adopt new technologies and improve service delivery.

5.3 Limitations and Future Research

While this study provides valuable insights, it also has some limitations that should be addressed in future research. Firstly, the study is based on a sample of 200 respondents, which may not fully represent the entire EV repair industry in China. Future research should consider larger and more diverse samples to enhance the generalizability of the findings.

Secondly, the study focuses primarily on technological innovations and strategic factors. Future research could explore additional factors such as organizational culture, employee training, and environmental sustainability that may also impact the efficiency and effectiveness of EV repair services.

Lastly, longitudinal studies could provide a deeper understanding of the long-term impact of advanced technologies and strategic factors on the EV repair industry. This would help in identifying trends and changes over time, providing more robust insights for industry stakeholders.

VI. Conclusion

This study examines the impact of advanced technologies and strategic factors on the operational efficiency and market performance of the EV repair industry in China. Using a mixed-methods approach and the Stimulus-Organism-Response (SOR) model framework, the study identifies key factors such as technological innovation, customer service excellence, brand reputation, strategic partnerships, and government support that significantly influence the industry's success.

The findings highlight the importance of adopting advanced technologies, focusing on customer service excellence, building a strong brand reputation, and leveraging government support to enhance the efficiency and effectiveness of EV repair services. The study provides valuable insights for industry stakeholders, including EV repair companies, policymakers, and technology providers, and offers practical recommendations for achieving market success in the rapidly evolving EV repair industry.

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