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A Research on the Influencing Factors of Digital Transformation in China's Automotive Aftermarket

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Abstract

The Chinese automotive aftermarket has a huge market size due to a combination of political support, economic development, and changing social and technological trends. There exists an increasing demand for the digitization of products and services with core competencies in this industry. Digital transformation will change the future of the industry. In particular, the widespread use of new technologies and the emphasis on sustainable development. This paper focuses on the repair and maintenance and used car markets of the Chinese automotive aftermarket as the main research area. The digital transformation of China's automotive aftermarket is a complex process that is influenced by a combination of factors. Fifteen hierarchical indicator factors are designed based on the Technology-Organization-Environment (TOE) framework. The Analytic Hierarchy Process is used to determine the index weights, and the factors influencing the digital transformation of the automotive aftermarket are ranked according to their comprehensive weights, reflecting the relevance of the factors influencing digital transformation to the target. The results of the study revealed that the top four factors influencing were Financial support or investment, use of digital professionals, industry competition, and enterprise digital technology innovation capability. Accordingly, countermeasures for China's automotive aftermarket digital transformation are proposed.

Keywords: *digital transformation, Analytic Hierarchy Process(AHP), Automotive aftermarket, influencing factors, China*

1. Introduction

The spread of blockchain, industrial Internet, cloud computing, 5G, and other emerging technologies in recent years has made the global and national digital development process a pressing concern for all businesses. China had 372 million motor vehicles in 2020, of which 281 million were automobiles (Yang Y, 2021). The vast automobile industry provides a new consumer market, making the automotive aftermarket an integral part of the industry chain. Car use in repair, maintenance, or replacement owners needs solid after-sales service support. But the aftermarket in China was slow to develop, and many businesses are looking for outside technical assistance. The equivalent of China's automotive aftermarket is currently going through a crucial phase of enterprise development, industry resource integration, and transformation. The automotive aftermarket connects more than 300 million car consumers and has a market worth billions of dollars. All industrial aftermarket players have sophisticated needs.

According to Figure 1, around 80% of Chinese automotive aftermarket companies have recognized the importance of digital transformation and are actively seeking to transform. However, the level of implementation varies somewhat among automotive aftermarket companies. Larger companies tend to be more aware and proactive but are relatively cautious about making transformation decisions due to the size of their investments, the difficulty of integrating technology, and the complexity of their organizational structures. Small and medium-sized companies, on the other hand, can respond faster to market changes due to their smaller size and efficient decision-making. Therefore their digital transformation is more focused on rapid validation and trial and error. In general, Chinese automotive aftermarket companies are becoming more aware of digital transformation and the potential advantages that digitalization.

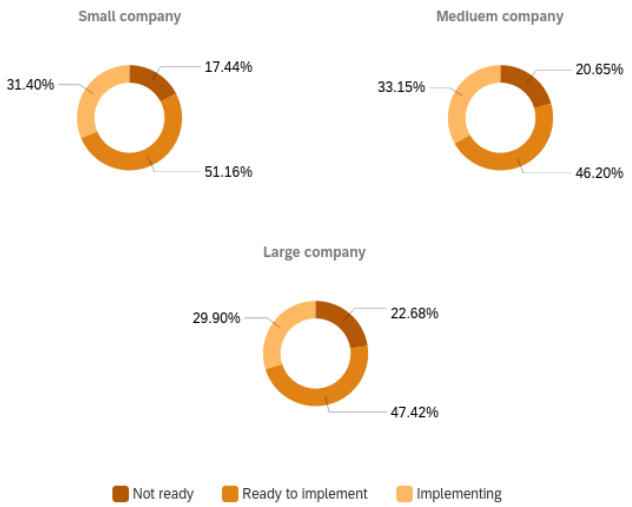

Figure 1 Distribution of Aftermarket Companies in China for Digital Transformation Implementation

On this basis, Chinese automotive aftermarket companies have entered this transform stage, but the current challenges and opportunities are manifold. This is because the situation of China's aftermarket due is to a combination of political support, economic development, and changing social and technological trends.

In terms of policy, the government has introduced policies that encourage the development of the automotive aftermarket, including measures for regulating the market order and breaking the monopoly in the field of auto repair. The Chinese government has implemented several policies to boost the development of the automotive aftermarket. In 2017, it issued the "Guiding Opinions on Promoting the Healthy Development of the Automotive Service Industry" (State Council of the People's Republic of China, 2017), which aimed to improve service quality, increase competition, and promote innovation in the sector. In 2019, it launched the "Three-Year Action Plan for Promoting the Development of the Automotive Aftermarket (2019-2021)" (Ministry of Commerce of the People's Republic of China, 2019), which set goals for the expansion of the aftermarket, improvement of services, and strengthening of industry standards. Additionally, the government has provided support for the development of new energy vehicles and encouraged the recycling of used parts (Xinhua, 2020), which has helped to drive growth in the automotive aftermarket in China.

In terms of the economy, the Chinese market has abundant labor resources and relatively low labor costs, but implementing digital transformation in the automotive aftermarket requires significant capital. However, COVID-19 has harmed the Chinese automotive aftermarket economy, with many companies struggling to transform due to a lack of capital. People discovered that the epidemic had a significant impact on the automotive market, resulting in a decline in sales and revenue, as well as leaving automakers and dealers with tight capital flows, further impeding the advancement of digital transformation (Liu et al.,2020).

In terms of society, consumers in China's automotive aftermarket are increasingly demanding more convenient, quick, and efficient services. Digital transformation can help businesses meet the needs of their customers, improve their customer experience, and increase customer loyalty. Furthermore, Chinese society is becoming more accepting of technology and digitalization, laying the social groundwork for digital transformation.

In terms of technology, the flourishing development of artificial intelligence technology in the digital transformation era promotes the vehicle industry in smart roads. Big data, artificial intelligence, and cloud computing are expanding the automotive aftermarket's opportunities. Artificial intelligence technology, for example, can be used to automate part identification and optimize inventory management. In contrast, big data technology can analyze and predict customer demand, allowing the automotive aftermarket to provide more

accurate services. The trend of digital transformation in China's automotive aftermarket will become more visible as a result of digital technology. However, the Chinese automotive aftermarket industry is highly competitive and requires technological innovation and market repositioning.

Therefore, the automotive aftermarket will be the center of the Chinese automotive industry's development in the coming decades. The main subject of the aftermarket will be digital transformation. In particular, the adoption of new technologies and the emphasis on sustainability are likely to shape the future of the industry. After hierarchical analysis, the study analyzed the factors of transformations to reflect the correlation degree of manufacturing transformation and upgrading influence factors on the target level. At the same time, it serves as a guide for aftermarket companies to implement digital transformation.

2. Objective

The three main objectives of this study are as follows.

1) To study the existing digital transformation situation in China's automotive aftermarket.

2) To identify the critical factors that influence the digital transformation of the Chinese automotive aftermarket.

3) To provide suggestions for companies to improve their business strategies and decision-making processes in the digital transformation period of China's automotive aftermarket.

3. Scope of the study

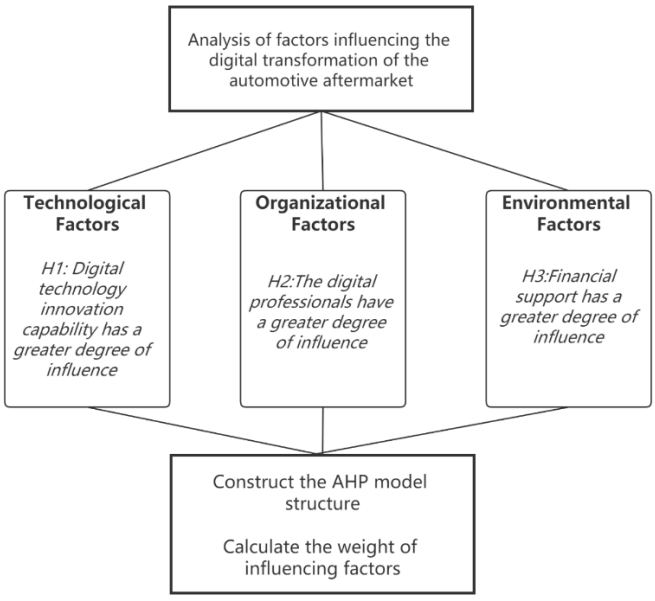

Figure 2 The conceptual framework

This study takes the Chinese automotive aftermarket as the main object of study, where the automotive aftermarket is defined as the repair and maintenance services and used car transactions after the sale of a car. The TOE framework divides the influence factors of digitalization into three categories, mainly referring to technical conditions, organizational conditions, and environmental conditions(Baker, 2012). The TOE framework is for understanding the factors that influence the adoption and implementation of new technologies (Kumar and Krishnamoorthy, 2020).

3.1 Criteria for selection of influencing factors

Technological factors mainly include its core technology capability, innovation capability, and technology facility base, focusing on the analysis of the impact caused by a series of behaviors of technology in the application process (Lin, H. F., 2007). Five factors are included:

1) Effective use of digital software and hardware resources

Making full use of digital equipment resources can improve the efficiency of enterprise operations and promote digital operations and development.

2) Enterprise digital technology innovation capability

It can help enterprises understand and apply digital technology, accelerate the integration of digital innovation and business models, foster the emergence of new digital products and services, and form a complete technological innovation chain.

3) Data acquisition capability improvement

Data has become a key element in the development of the digital economy, how to filter useful data in the process of providing products or services, will affect the efficiency of digital operations.

4) Amount of digital equipment inputs

Enterprises can improve their intelligent management, sales, production, and other aspects by investing in digital equipment. Not only includes the application of digital equipment but also requires the input of equipment. For example, automotive repair involves instrumentation services, and a small amount of digital equipment cannot meet the needs of digitization.

5) Technical Cooperation resources

The advantages gained by the digital transformation of a single enterprise are small. Establishing technology sharing with cooperative partners can enhance the ability of digital technology innovation and application of enterprises.

Organizational factors mainly include its to explore the factors affecting technological innovation among them based on organizational and management perspectives, including technology support (resource allocation) organizations and technology application organizations (Holsapple and Joshi, 2000). Five factors are included:

1) Use of Digital Professionals

Digital talents refer to professionals with rich knowledge related to digital transformation and practical operation talents for digital technology development and application. A professional digital team is equipped according to the business characteristics of the automotive aftermarket to enhance the ability of enterprises to adapt to the digital environment.

2) Enterprise importance of digital transformation

Enterprises that focus on digital transformation can leverage the latest technology to streamline operations, improve customer experience, and reach new markets. These companies are also able to use data-driven insights to inform decisions and tailor their products and services. The result is a greater competitive advantage and increased profitability.

3) Digital-friendly organizational management restructuring

By adjusting the structure, organizations can create an environment that is more conducive to the adoption of digital technologies. In addition, an organization's culture can be improved by adjustment, which can help to ensure that employees are motivated and engaged with the transformation.

4) Scale of company

Large enterprises are more likely to have the resources and expertise needed to take on more complex and comprehensive digital transformation initiatives. They also have the advantage of economies of scale and can leverage the expertise of multiple departments. Smaller organizations, on the other hand, may have limited resources and may struggle to find the right talent to implement digital initiatives. However, they may also be

more agile and adaptive and can take advantage of new technologies quickly.

5) Organizational development digital strategy

Digital strategies can help to improve the competitiveness of aftermarket companies by enabling them to quickly access information and better understand customer needs. Furthermore, digital strategies can help organizations implement automated processes, reduce paperwork, and streamline operations.

Environmental factors include several aspects such as external demand and pressure. Among them, macro policies and input funds will have an impact on technology application, but with the increasingly competitive market and the complex form of industrial integration, industry-related developments and the rise of e-commerce platforms also have an impact (Bin and Hui, 2021). Five factors are included:

1) Government policy guidance

Digital transformation requires an orderly market environment. The government provides a good policy environment for automotive aftermarket enterprises and increases support to help ease the transition pressure on enterprises.

2) Industry Competition

Digital technologies are actively used by businesses to gain a competitive advantage in highly competitive industries. To maintain their market position, companies must constantly increase their technological innovation capabilities. On the other hand, the successful digital transformations of peer companies may also serve as a model and source of inspiration for other businesses.

3) Financial support or investment

The process of digital transformation involves the replacement of digital hardware and equipment, and the market development of digital services requires a lot of financial support. Financial support comes from the government and private businesses. Such as tax reduction and financial subsidies, which can help solve the problem of insufficient funds.The rise of the Internet and e-commerce platforms.

4) The rise of the Internet and e-commerce platforms

With the development of the Internet and e-commerce platforms, the automotive aftermarket has moved from the conventional offline model to an online model, improving the quality and effectiveness of services like online after-sales service, maintenance, and parts supply.

5) Supply Chain Digital Development

By enabling the digital management of all aspects of information flow, logistics, and capital flow, the development of supply chain intelligence can support the digital transformation of the entire supply chain, enhancing business efficiency and service quality.

4. Materials and Methods

The Analytic Hierarchy Process (AHP) is a method for analyzing complex decisions. Based on the data collected by a questionnaire, influencing factors are discerned, and a hierarchy is created. It transforms relevant decision factors that are difficult to quantify into multi-level individual problems, where each sub-problem can be calculated individually. Then, the weighting relationships between the indicator factors are calculated (Saaty and Peniwati, 2013).

1) Research sample

This questionnaire was distributed to automotive aftermarket companies in the form of an electronic questionnaire and other operable ways. To improve the reliability and accuracy of this questionnaire, and to minimize possible errors in the process of filling out the questionnaire, employees engaged in the automotive aftermarket were asked to fill out the questionnaire, and the requirements and precautions for filling out the questionnaire were explained and clarified to the fillers.

The questionnaires were distributed and collected between mid-December 2022 and early January 2023. A total of 500 questionnaires were distributed and 470 questionnaires were collected, with a return rate of 94%;

excluding invalid questionnaires that did not match the subject of the study, such as questionnaires from other areas of the automotive aftermarket, a total of 11 questionnaires were collected, resulting in a total of 459 valid questionnaires, with an efficiency rate of 91%.

2) Analyze the data

The questionnaire survey included three scales that passed the validity and reliability tests. The Cronbach's Alpha was greater than 0.7. The KOM and Bartlett's test results were both greater than 0.6. Therefore, these fifteen-factor indicators can be used to analyze the factors influencing the digital transformation of China's automotive aftermarket.

3) Establish a hierarchical model

Table 1 Hierarchical Model of influencing factors

Goal level	Determinant level	Criteria level
A Influencing factors of digital transformation in China's automotive aftermarket	**A1** Technological factors	**A11** Effective use of digital software and hardware resources
		A12 Enterprise digital technology innovation capability
		A13 Data acquisition capability improvement
		A14 Amount of digital equipment inputs
		A15 Technical Cooperation resources
	A2 Organizational factors	**A21** Use of Digital Professionals
		A22 Enterprise importance of digital transformation
		A23 Digital-friendly organizational management restructuring
		A24 Scale of company
		A25 Organizational development digital strategy
	A3 Environmental factors	**A31** Government policy guidance
		A32 Industry competition
		A33 Financial support or investment
		A34 The rise of the Internet and e-commerce platforms
		A35 Supply chain digital development

4) Establish the Judgment Matrix

The numbers of a level are compared in pairs with specific numbers of neighboring levels. This comparison is a relative value or a quotient of two quantities, measured on a scale of 1-9.

Table 2 The 1-9 Ration scale used in AHP

Intensity	Definition	Intensity	Definition
1	Equal importance	2	Between equal and moderate important
3	Moderate Importance	4	Between moderate and strong importance
5	Strong Importance	6	Between strong and very strong importance
7	Very Strong Importance	8	Between very strong and extreme importance
9	Extreme Importance	Countdown	Aij is the comparison between i and j.

Source: Saaty, 1980

5) Calculate weights and check the consistency ratio

The weight vectors need to be calculated for the obtained judgment matrix, and the root method is used to calculate the weight vectors, etc. After calculating the weight vectors, to prevent inconsistency in scoring assignments, a consistency test is performed, and then a discriminant matrix is constructed with weight being the eigenvectors of matrix A and n being the order. (Singh, M. et al., 2018)

Table 3 Determinant level matrix

Determinant level	A1	A2	A3	Weight
A1	1	1/3	1/3	0.1396
A2	3	1	1/2	0.3325
A3	3	2	1	0.5278

Table 4 Level A1 matrix

LEVEL A1	A11	A12	A13	A14	A15	Weight
A11	1	1/4	2	2	3	0.1632
A12	4	1	7	9	9	0.6142
A13	1/2	1/7	1	1/2	3	0.0838
A14	1/2	1/9	2	1	1	0.0844
A15	1/3	1/9	1/3	1	1	0.0544

Table 5 Level A2 matrix

LEVEL A2	A21	A22	A23	A24	A25	Weight
A21	1	3	3	3	3	0.4199
A22	1/3	1	2	2	2	0.2122
A23	1/3	1/2	1	1	2	0.1400
A24	1/3	1/2	1	1	1/2	0.1061
A25	1/3	1/2	1/2	2	1	0.1219

Table 6 Level A3 matrix

LEVEL 3	A31	A32	A33	A34	A35	Weight
A31	1	1/2	1/3	2	1/2	0.1121
A32	2	1	1/3	4	2	0.2242
A33	3	3	1	6	3	0.4438
A34	1/2	1/4	1/6	1	1/3	0.0594
A35	2	1/2	1/3	3	1	0.1604

5. Results and discussion

The three determinants and 15 criteria that affected the digital transformation yielded the following results after making related influential calculations:

Table 7 Determinants level priority ranking

Determinant	Weight	Priority
A1 Technological Factors	0.139648	3
A2 Organizational Factors	0.332516	2
A3 Environmental Factors	0.527836	1

The proportion of the weight of the three guideline level influence factors obtained was 13% weight for technological factors, 33% weight for organizational factors, and 54% weight for environmental factors, indicating that the employees of automotive aftermarket companies agreed that the influence of environmental factors was more significant in the process of digital transformation. The acceleration of the digital transformation of enterprise transformation should have focused on environmental factors.

Table 8 The overall priority ranking

Determinant	Criteria level	Relative weights	Absolute weight	Priority
A1 Technological Factors	A11	0.163169	0.022786	12
	A12	0.614245	0.085778	4
	A13	0.083793	0.011701	14
	A14	0.084404	0.011787	13
	A15	0.05439	0.007595	15
A2 Organizational Factors	A21	0.419925	0.139632	2
	A22	0.212163	0.070547	6
	A23	0.139975	0.046544	8
	A24	0.106081	0.035274	10
	A25	0.121855	0.040519	9
A3 Environmental Factors	A31	0.112119	0.05918	7
	A32	0.224238	0.118361	3
	A33	0.443825	0.234267	1
	A34	0.059379	0.031343	11
	A35	0.160439	0.084685	5

The meaning of 1 is the highest degree means it is the best. Combining the calculation results of the indicators related to the consistency test of each hierarchical single ranking in Section 4.5, the CR of the hierarchical total ranking is less than 0.1 by applying Equation, which passes the consistency test. Therefore, the hierarchical total ranking is valid.

Through the hierarchical analysis used to determine the weighting ratio of each influencing factor in the digital transformation process of Chinese automotive aftermarket enterprises, the following key conclusions can be made:

Among the three dominant level indicators, technology-based factors account for 13% weight, organizational factors account for 33%, and environmental factors account for 54% weight, indicating that employees of automotive aftermarket companies agree that the influence of environmental factors has more significant in the process of digital transformation, and relatively minor were technology and organizational factors. Accelerate the enterprise transformation digital transformation to focus on environmental factors.

Secondly, looking at the weights of the factors influencing the fifteen indicator tiers, it was found that they varied widely. The weights are ranked according to 1-15, with the number 1 indicating that the factor has the greatest weight and the strongest influence among the 15 factors. The number 15 means that the weight proportion is small and the degree of influence is the weakest. The degree of influence is judged by the ranking of the weights. Among the weights of all influencing factors, the top four factors are Financial support or investment, Use of digital professionals, Industry Competition, and Enterprise digital technology innovation capacity. This means that these four factors can have a greater degree of influence during the current stage of digital transformation in China's automotive aftermarket.

From this, it can be seen that financial assistance has the greatest impact. This is because digital transformation necessitates a significant amount of human, material, financial, and other resources, all of which are dependent on financial support and investment. Because the technological factors for digital transformation in China's automotive aftermarket are relatively mature, the technology category is less influential. Automotive aftermarket solutions based on big data analytics, for example, are already widely used in practice. Alibaba's intelligent automotive service platform is built on "Alicloud" computing and storage capabilities (Zhang et al., 2019). Big data analytics can also be used to provide services such as customer profiling and satisfaction assessment (Geng & Wang, 2019). Some companies have also developed digital transformation solutions based on technologies such as artificial intelligence, cloud computing, and blockchain, and these mature solutions and technological solutions provide practical support for technological factors' relative maturity. Therefore, technology does not prevent digital transformation. Even with the most advanced technology, digital transformation or technological innovation will be impossible to achieve without adequate financial support and investment.

The automotive aftermarket's digital transformation must rely on advanced technologies and instruments, which must be driven and applied by people with the necessary knowledge and skills. As a result, the use of digital talent is second only to financial support in importance. They can not only provide technical assistance, but they can also play an important role in the digital transformation process, such as using digital machinery and assisting in the development of digital transformation programs. Furthermore, digital talents can drive companies to change their existing management and operation models to better adapt to the new digital economy environment (Zhang et al., 2021).

Furthermore, industry competition has a positive effect. When a company is up against fierce peer competition, it has more incentives and pressures to improve its technological innovation capabilities to maintain its competitive advantage. For example, in the automotive manufacturing industry, competitive pressure can encourage firms to increase their research and development investment and technological innovation capabilities, thereby increasing their market share and profitability (Chen et al., 2021). Industry competition can also boost the company's technological innovation capabilities through technology transfer and learning, such as resource sharing and cloud platform service. While technological innovation capability is also important, it has a smaller impact in the top four rankings because technological innovation capability refers to improving a company's

ability to innovate, while digital transformation focuses on how a business can apply existing digital technologies and resources to improve operational efficiency and competitiveness.

6. Conclusion

Any one factor cannot be a high condition for or a facilitator of digital transformation. The digital transformation will most likely be hampered if these factors are ignored. The study suggests countermeasures related to promoting digital transformation from three angles, taking into account the factors affecting the digital transformation of China's automotive aftermarket.

1) Government encouragement and financial support

The government can promote digital transformation and ensure it receives financial and technological support. To encourage and facilitate the development of businesses that have undergone digital transformation, the government can create policies that support it, such as lowering business taxes and streamlining administrative approvals. or raise financial investments and subsidies. The government can provide a start-up fund to support businesses that meet the criteria and have promising transformation prospects by covering the costs associated with digital transformation. China's policy practices today reflect this. For example, the "Guiding Opinions of the State Council on Deepening the Integration of Informatization and Industrialization and Accelerating the Development of Informatization and Industrialization" proposes to increase policy tilt and introduce more fiscal and financial policies suitable for digital transformation enterprises (National Development and Reform Commission, 2016).

The government can encourage businesses to invest in digital technology innovation while also improving product quality and service. The government, for example, could establish a digital transformation innovation center or a digital transformation consultancy to provide technical support for digital transformation enterprises, such as technical consultation, technical training, and technical exchange, to help enterprises improve their digital transformation capabilities.

Furthermore, by conducting technology exchange and promotion activities, the government can promote technology sharing and cooperation among digital transformation enterprises. Establish a demonstration base for digital transformation of the automotive aftermarket, for example, to provide support for digital transformation enterprises in terms of venues, equipment, and talents, while also serving as a digital transformation model for other businesses.

2) Increasing the use of digital professionals

The digital transformation of China's automotive aftermarket necessitates more than just technology; it necessitates a focus on developing industry professionals' digital skills and strengthening the country's digital innovation capabilities.

Companies create programs for developing digital talent. Through internships, project collaboration, and school-business partnerships, businesses and universities can work together to hire digital talent with practical experience and professional skills. To improve their employees' digital skills and knowledge, after-market businesses must also invest in training and education initiatives that support internal training and employee rotation. For instance, create programs in product development, automotive IoT, digital technology, and other related fields. Additionally, it is possible to fully benefit from regional policies on talent introduction subsidies.

In addition, establish a digital workplace. To increase the motivation and innovation of digital talents, create a good working environment for them, complete with effective tools, cutting-edge technological hardware, and software facilities. In the meantime, increase leadership support and digital awareness. To attract and retain outstanding digital talents, the leadership provides opportunities for career development and promotion.

Encourage experimentation and practice. Companies should encourage digital talent innovation and practice by providing adequate support and resources, as well as creating incentive mechanisms to encourage digital talent to participate in innovative practices in projects, product development, and commercialization.

3) Enhancing the digital technology innovation capability

Aftermarket companies need to invest more in digital technology research and development. Companies must continuously innovate in technology and introduce new technologies and services to gain a competitive

advantage in the digital era. For example, precision marketing by targeting consumer needs and developing digital products and services such as online reservations, payments, and after-sales services.

Analytics and big data can also be used to improve digital innovation capabilities. This could entail examining customer feedback, sales patterns, and market trends. An open platform for aftermarket players to share technology, digital platforms, technology standards, and industry information should also be developed, resulting in improved collaboration and strategic development. Investing in digital infrastructure, such as cloud computing, the Internet of Things, and other emerging technologies, can help to ensure that digital solutions are integrated seamlessly. Furthermore, the adoption of new technologies such as augmented reality, virtual reality, artificial intelligence, and blockchain can help to improve aftermarket operations.

In conclusion, the study used hierarchical analysis to determine the factors that affected the digital transformation of Chinese automotive aftermarket enterprises described in this paper. The relative importance of each influencing factor in the process of digital transformation, that is, the weighting ratio of each influencing factor, is examined using questionnaires, and it is argued that encouraging enterprises to undergo digital transformation requires attention to financial support and digital transformation capability development in the location.

Digital transformation is a complicated process, though, and it still requires more development and in-depth study. These issues need to be researched and explored further to facilitate the digital transformation of Chinese automotive aftermarket enterprises. Firstly, research methodologies on the transformation impact factors must be improved, and better, scientific models must be chosen for the study. Second, more variables must be taken into account, and comprehensive influencing variables must be added for in-depth research. Third, the findings of this research must be followed up on and further examined because they are time-sensitive. Measures to support digital transformation may need to be adjusted following the growth of the digital economy and the adoption of related policies.

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