

MODEL OF DIGITAL TRANSFORMATION EFFECTING TO ENTERPRISES PERFORMANCE OF AUTOMOBILE MANUFACTURING ENTERPRISES IN SHANDONG PROVINCE, THE PEOPLE'S REPUBLIC OF CHINA

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Abstract: The purpose of this study is: 1) To study the factors affecting the performance of automobile manufacturing enterprises in Shandong Province, People's Republic of China. 2) To develop model of digital transformation to enterprises performance of automobile manufacturing enterprises in Shandong Province, People's Republic of China. This study adopts a mixed research method combining quantitative and qualitative research. The quantitative research selects 400 automobile manufacturing enterprises from 56900 automobile manufacturing enterprises in Shandong Province as samples to conduct questionnaire survey. The qualitative research method was in-depth interview. We mainly interviewed 15 employees, including 4 senior managers employed by the enterprise, 5 managers in the human resource management department, and 6 senior employees who have worked in the operation management department for more than 10 years.

The main find in GA are as follows :(1) As for the influencing factors of digital transformation and the performance of automobile manufacturing enterprises, the research finds that digital operation and management costs can be studied as intermediate variables. Enterprises can improve their performance by introducing advanced technologies, enhancing innovation capabilities, promoting differentiation of products and services, developing intelligent enterprises, establishing sound intelligent management and marketing mechanisms, strengthening the construction of talent teams, improving the comprehensive quality of employees, and increasing financial support. (2) In the original conceptual framework, we have a total of five assumptions. With the help of the SEM model, the final conclusion is that all hypotheses are valid, indicating that there is a positive correlation between different aspects of digital transformation (such as digital strategy, production, marketing, etc.) and key performance indicators, indicating that diversified digital methods contribute to positive results of enterprise performance. (3) Regarding the performance of automobile manufacturing enterprises, enterprises can improve their performance from three aspects: digital transformation, digital operation, and management cost. In addition, they can explore the use of cutting-edge technologies such as artificial intelligence, big data, cloud computing, and the Internet of Things as a means to upgrade products, services, processes, and business models. Government departments formulate policy support to promote the digital transformation of automobile manufacturing enterprises, create an environment conducive to innovation and informatization, and give full play to the leading role of the government! The research data are as follows: Chi-square=103.232 df.=72 CMIN/df.=2.81 n=214 CFI=0.990 NFI=0.931 GFI=0.932 IFI=0.988 RMSEA=0.049 SRMR=0.043

Keywords: Automobile manufacturing industry; Digital transformation; Digital operation; Administrative costs; Enterprise performance

1. Introduction

The digital economy is regarded as an effective means to deal with the new challenges of economic growth. According to the "China Digital Economy Development Report" released by the China Academy of Information and Communications Technology over the years, the scale of China's digital economy increased from 18.6 trillion yuan to 45.5 trillion yuan in 2015-2021, and the proportion of GDP increased from 27.5% to 39.8% (see Figure 1-1). The digital economy has become a key force in reorganizing global factor resources, reshaping the global economic structure, and changing the global competition pattern. In the wave of digitalization, "ABCD" underlying technologies such as Artificial Intelligence, Blockchain, Cloud Computing, and Big Data have emerged

and been iteratively upgraded. Data processing capacity from KB level to PB level, through mining the value of data elements to drive industrial digital transformation and upgrading, for the enterprise "intelligent manufacturing" to reduce costs, improve quality, and increase efficiency into the digital power (Blichfeldt and Faullant, 2021), the role of data in the production process is increasingly prominent. The Fourth Plenary Session of the 19th CPC Central Committee recognized data as the seventh factor of production after labor, capital, land, knowledge, technology and management. The underlying technology of "ABCD" is gradually integrated with traditional businesses (such as shared bicycles, etc.), which has a profound impact on production, life and even ecology, and the economic paradigm has gradually changed in essence (Stiglitz, 2002).

In 2012, the United States launched the National Strategic Plan for Advanced Manufacturing in the United States to encourage innovation and reshape the industrial landscape by developing advanced digital manufacturing technologies. At the Hannover MESse in 2013, Germany officially proposed the concept of Industry 4.0, and promulgated the "German High-tech Strategy 2025" in 2018 to take digital transformation as the core of the scientific and technological innovation development strategy, and the "German Industrial Strategy 2030" in 2019 is to provide important support for accelerating the digitization process of the manufacturing industry. In 2020, Japan proposed a "digital New Deal" to actively deploy digital construction and intelligent manufacturing to further enhance the competitiveness of the national digital economy. In addition, the "group" development model represented by the EU puts more emphasis on digital cooperation and technology sharing, from the "European Data Strategy" to the "New European Industrial Strategy" continues to refine strategic deployment, leading to accelerate the digital transformation of the manufacturing industry. Similarly, in the face of the new trend of in-depth adjustment, transformation and upgrading of enterprises, China has successively issued a series of documents such as the "14th Five-Year Plan" Development Plan for the Deep Integration of informatization and Industrialization, the "14th Five-Year Plan" Digital Economy Development Plan, and the "Guide to the Digital Transformation of Small and medium-sized Enterprises" to strengthen the in-depth implementation of the strategy of digital power. Take digital transformation as one of the main driving directions to improve the level of enterprises. According to the latest data from the Ministry of Industry and Information Technology, by the end of 2022, the CNC rate of key processes in key industrial enterprises is 58.6%, and the penetration rate of digital R & D design tools has reached 77%. China has made great progress in advanced manufacturing fields such as electronic information, high-end equipment, new energy, and biomedicine, accounting for a rising share of the manufacturing industry, and the transformation and upgrading of the manufacturing industry has achieved initial results. Digital transformation is a development mode that subverts the traditional production mode of enterprises and innovates the organizational structure of enterprises through digital technology, and is expected to become a possible breakthrough point for enterprises to achieve high-quality development.

The report of the 20th National Congress of the Communist Party of China pointed out that it is necessary to accelerate the development of the digital economy, promote the deep integration of the digital economy and the real economy, and build digital industrial clusters with international competitiveness. The 14th Five-Year Plan for National Economic and Social Development of the People's Republic of China and the Outline of the 2035 Vision Goals have a separate chapter on the digital economy, which clearly emphasizes the need to create new advantages of the digital economy, promote the deep integration of digital technologies with the real economy, and empower the transformation and upgrading of traditional industries. The Fifth session of the 13th National People's Congress clearly pointed out that promoting the development of the digital economy. We will strengthen the overall plan for building a digital China. We will build digital information infrastructure, gradually build a national integrated big data center system, promote the large-scale application of 5G, and promote the digital transformation of industries. In the context of the rapid growth of digital economy and continuous attempts to achieve deep integration with traditional business, the performance research of digital transformation has become a hot issue in the academic community (Ravichandran and Liu, 2011; Wang Yu et al., 2020). Some scholars pointed out that digital transformation can generate digital dividends to support enterprise performance growth (Lin Lin and Lv Wendong, 2019; Wang Kaikang et al., 2020; Xiao Jinghua et al., 2021), while some other scholars believe that digital transformation will exacerbate the digital divide and inhibit enterprise performance (Xie Kang et al., 2016; Zhou Xiang et al., 2018; Qi Yudong and CAI Chengwei, 2020). It can be seen that the academic community has not yet formed a unified consensus, which is in urgent need of further research. To sum up, in the context of the country's strong support and implementation of the deep integration of digital economy and physical business, the enterprise's own willingness to carry out digital transformation is high, but the quality and efficiency of digital transformation needs to be improved, digital transformation is already a "black box" with

many puzzles to be solved, which leads to a scientific problem worthy of in-depth exploration: Can and how does digital transformation affect enterprise performance?

Based on relevant theories and literature, this study proposes: Model of digital transformation effecting to enterprises performance of automobile manufacturing enterprises in Shandong province, the people's republic of China. This study takes the automobile manufacturing industry in Shandong Province of China as the research object, and constructs the research model and hypothesis of digital transformation effecting to enterprises performance of automobile manufacturing enterprises in Shandong province, the people's republic of China. from the three-dimensional perspective of digital transformation, Digital operation and administrative cost formed from four aspects: digital technology, heterogeneity of executive team, market environment and Government act. An online questionnaire survey was conducted by Likert scale, and AMOS-SEM method was used to conduct an empirical study on the obtained sample data. The impact of digital transformation on enterprise performance was analyzed, and the mediating effect of Digital operation and administrative cost was tested. This research has a certain theoretical value, and at the same time provides decision-making basis for government departments to promote the integration of digital economy and real economy. And provide better operational strategies for digital transformation enterprises.

Research objectives

1. To study the factors affecting the performance of automobile manufacturing enterprises in Shandong Province. People's Republic of China.
2. To develop model of digital transformation to enterprises performance of automobile manufacturing enterprises in Shandong Province. People's Republic of China

Research Hypothesis

- Hypothesis 1 (H1) Digital transformation has a influence on Digital operation
 Hypothesis 2 (H2) Digital transformation has a influence on administrative cost
 Hypothesis 3 (H3) Digital transformation has a influence on enterprise performance
 Hypothesis 4 (H4) Digital operation has a influence on enterprise performance
 Hypothesis 5 (H5) Administrative cost has a influence on enterprise performance

2. Literature Review

2.1 Concepts, theories, and related research

Theory of digital transformation

Digital transformation is a strategic concept, and different scholars have different interpretations on the concept of digital transformation. Liere Netheler (2018) defines digital transformation as a process of using new digital technologies such as social media, mobile, analytics or embedded devices to help enterprises achieve major business improvements. Significant business improvements include enhancing the customer experience, optimizing operations, or creating new business models." Kane GC (2017) et al. define digital transformation as the adoption of business processes and practices that help orGAnizations compete effectively in an increasingly digital world. Besson,Rowe (2012) and others believe that for enterprises undergoing digital transformation, digital transformation is an overall form of business transformation driven by information systems, accompanied by fundamental economic and technological changes at the or GAnizational and industry levels. Based on the above research, this study defines digital transformation as an or GAnizational behavior, which is an or GAnization's use of digital technology to transform enterprise management structure, promote the reform of information structure, management mode, operation mechanism and production process, and the final result is to achieve the improvement of enterprise performance. In summary, it is found through literature research that scholars have two key viewpoints on digital transformation in the existing research results. One is to emphasize the supporting role of digital technology and believe that digital transformation is the upgrading and transformation after the change of information technology, which means embedding digital technology into the internal business model of enterprises and intelligently collecting information in the market through digital technology. Providing decision

support to stakeholders ultimately essentially affects corporate performance (Valdez-De-Leon, 2016; Andriole, 2017). Another view is to emphasize the organizational changes brought about by digital transformation. Scholars believe that digital transformation is the introduction of digital technology by enterprises to fundamentally reshape the business model, organizational structure and management mode of enterprises, and build a new business model to improve production efficiency (Singh and Hess, 2017; Li Baizhou and Yin Shi, 2020).

Theory of enterprise performance

Either way, it can be concluded that corporate performance is closely related to strategic goals. The academic circles believe that with the in-depth study of management theory, the goals of enterprises are not limited to economic goals, and corporate performance includes not only economic results, but also some non-economic results. According to the study of Runyan et al. (2008), corporate performance can be evaluated by financial indicators and operational performance, such as revenue growth, net profit, net gross profit, cash flow and changes in the number of employees. However, the use of only financial indicators to evaluate corporate performance is limited, because it ignores other aspects, such as customer loyalty and other aspects that are beneficial to the company. Research has shown that success at one particular level of performance does not necessarily mean success at other levels of performance. Scholars and managers generally agree that performance should be measured from several levels, including direct factors, such as sales revenue, profit margin and market share, and other indirect factors, such as improving corporate image, improving old customer retention and attracting new customers' attention, etc. Ottenbacher (2007). To sum up, the implications of this paper for enterprise performance, especially for enterprise digital transformation, are as follows: In order to achieve enterprise strategic goals and promote enterprise development, business consequences in both financial and non-financial fields will be generated after enterprise digital transformation. Among them, the financial performance of the enterprise refers to the evaluation of the profit level and the value creation ability of the enterprise. Non-financial performance A variety of other non-financial performance including innovation performance. Product and service innovation; Ren Yizhong (2020), based on the research achievements of Hombu and Pflesser (2000), Wu Yong et al. (2013), Li Yu et al. (2014), Wu Xiaobo et al. (2015), Customer satisfaction, product and service innovation, market share, sales revenue, profit rate, theoretical scale and return on investment are used to measure enterprise performance. To sum up, build a new platform for data transformation manufacturing collaboration, promote product and service innovation in the automobile manufacturing industry, improve the mutual penetration between the manufacturing side and the digital side, drive the rapid iteration of the supply chain with large-scale enterprises, and drive the automobile manufacturing enterprises to carry out network collaborative manufacturing and the incubation of new business forms and models based on the new technology of digital transformation, so as to improve enterprise efficiency. Customer satisfaction. The scale designed by Homburg and Pflesser (2000) mainly includes seven contents: achieving customer satisfaction, providing value to customers, retaining existing customers, attracting new customers, obtaining expected growth, ensuring expectation, market share and average annual return on sales, and fully considers the impact of organizational culture on corporate performance. Jurgen Meffert (2018) believes that in order to better achieve digital transformation, enterprises should transform or upgrade current business models and processes, so as to improve customer experience and corporate efficiency. To sum up, under the digital transformation technology, customers will be surprised by the functions of products, the duration of products, the timeliness of delivery and the comprehensiveness of services. By using digital technology, enterprises can fully understand customer needs, implement targeted customer satisfaction strategies, and carry out two-way interaction and communication with customers, which can improve customer satisfaction with half the effort. The higher the customer satisfaction, the more can improve the efficiency of the enterprise. Market share; The scale developed by Venkatraman and Ramanujam (1986) covers not only financial indicators such as sales and profit rate, but also non-financial indicators such as marketing and market share. The higher the score of the scale fillers, the higher the enterprise performance. Wu Xiaobo et al. (2015) measured enterprise performance from five aspects: sales revenue, market share, pre-tax profit, after-tax profit and investment return. To sum up, digital transformation can promote innovation, seize new market opportunities, develop new business projects, increase market share and revenue, and improve business performance. In order to achieve high performance under digital transformation, automobile manufacturing enterprises need to have strong market competitiveness to obtain competitive advantages and occupy market shares, so as to achieve large profits. Enterprise management ability; Yuan Yong (2017) believes that BPR is an effective management tool provided for the realization of digital transformation, which can help enterprises

reduce costs, improve production efficiency and optimize decision-making process. He argues that red and blue exercises can help systematic evaluation and improvement in the process of financial transformation or change, so as to make the transformation or change process more perfect. Yang Yingzhe et al. (2018) found through their research that the digital transformation of manufacturing enterprises would promote the improvement of enterprise management from the two levels of production and or GAnization. Therefore, the path of digital transformation is divided into the production level and the or GAnizational level. The former mainly realizes the digital transformation of production and manufacturing technology and operation process, while the latter refers to making the internal or GAnizational structure and or GAnizational personnel composition adapt to the needs of digital transformation. Liang Xiao (2020) believes that enterprise management is actually the management of the process of value creation. By evaluating enterprise performance based on value creation and value creation ability, work efficiency can be improved more effectively and enterprise development can be promoted. To sum up, the improvement of enterprise management ability plays a vital role in the long-term development of enterprises and the improvement of their competitiveness. Senior managers of enterprises are the key factors in corporate decision-making. The higher the tolerance and attention of senior managers to the digital transformation derived from the wave of digital economy, the higher the innovation willingness to take the initiative to carry out the digital transformation of enterprises. This requires the executive team to have sufficient risk taking capacity and the speed of management improvement to match the speed of digital technology update. The stronger the management ability of senior managers, they can use their own social network and interpersonal resources to obtain resource support for the enterprise, and complement each other in major decisions and improve enterprise performance. Profitability level; According to the study of Runyan et al. (2008), corporate performance can be evaluated by financial indicators and operational performance, such as revenue growth, net profit, net gross profit, cash flow and changes in the number of employees. Hu Wangbin et al. (2014) mainly measured enterprise performance from three aspects: innovation level, growth potential and profit level. Specifically, four measures were technology innovation ability and level, market share, sales revenue growth rate and net profit level, all of which were measured by 7-point Likert scale with subjective evaluation. To sum up, financial performance is one of the important factors to measure enterprise performance, mainly including sales, net profit, profit level, return on investment and so on. In the digital context, enterprises taking intelligent manufacturing as the theme is more conducive to improving profitability and improving corporate performance. In summary, re GArless of the view, it can be concluded that business performance is closely related to digital transformation. The academic circles believe that with the in-depth study of management theory, the goals of enterprises are not limited to economic goals, and corporate performance includes not only economic results, but also some non-economic results.

Theory of digital operation

"Digital operation" is a way to use "digital" methods and tools to manage enterprise operations after the development of digital construction to a certain extent. On the one hand, "digital operation" is a way of working to promote business growth through data capabilities, and on a deeper level, "digital operation" is an important ability to better apply digital technology management and business decision-making after digital construction to a certain extent. Gregory Vial (2019) points out that this phase of digital transformation can be viewed as a cycle. In this process, the corresponding operation strategy or plan will be made based on the enhancement of enterprise value. In the process of digital upgrading, the important technologies include information and communication technology. Claudia Loebbeckea and Arnold Picotb (2015) proposed that the key ability to carry out digital transformation is to be able to seize opportunities, seize opportunities and have digital capabilities. The key to digital transformation is to apply digital capabilities well in daily work, that is, to continuously improve digital operations. In summary, digital operations refers to the application of digital technologies into traditional business processes to increase efficiency, reduce costs, and achieve better business results and customer experiences. It involves automating and improving all aspects of a business, including production, supply chain, sales, marketing and customer service, through the use of computers, the Internet and other technological tools. The implications of digital operations; With the rapid development of information technology and the popularization of the Internet, digital operation has become one of the key strategies for enterprise transformation. Digital operation is not only to transform the traditional business model into an online form, but also to redefine the operation mode and business model of enterprises through technological innovation and data-driven. P Chandel (2016) believes that the digital economy has become a new form of economic development, and in this context, the or GAnizational structure and business process of enterprises will undergo corresponding changes, and the traditional management mode is no longer suitable for the digital operation of enterprises.

In order to improve operational efficiency, enterprises will choose to apply digital technologies, transform traditional business processes, optimize governance structures, and achieve their own innovation and development. Duan Jiangyong (2021) believes that economic globalization has brought the increasingly fierce competition in the manufacturing industry and the rapid development of intelligent manufacturing in China. External competitive pressure has provided challenges and opportunities for enterprises to improve their own capabilities, and also put forward higher requirements for the operation management of manufacturing enterprises. The combination of digitalization and operation management has provided various solutions for production enterprises. Feng Weiyi (2021) believes that the direction of planning the digital transformation of manufacturing industry should be carried out from the aspects of strengthening top-level design, promoting intelligent manufacturing, establishing digital marketing platform, management collaboration, and building "digital ecological community". To sum up, digital operation refers to the process of transforming an enterprise's operational activities, business processes and decision-making processes into digital forms, and using information technology and data analysis to manage and optimize them. It covers the entire value chain of the enterprise, including marketing, supply chain management, customer relationship management, human resource management and other aspects. Through the application of digital technology, digital operation realizes the intelligent, efficient and personalized operation, which brings huge competitive advantages to enterprises.

Elements of digital operation theory; Digital strategy. Enterprise digitization strategy is a strategic way to accelerate the development of Chinese state-owned enterprises, which provides a new strategic paradigm for Chinese state-owned enterprises to serve national strategy and realize national mission. Chen Zhang, Kan Fengyun and Hu Guoliang (2017) proposed that digital strategy can greatly reduce the cost of connection among industries, enterprises and or GAnizations. Individuals can combine "arbitrarily", and all aspects can make full use of their respective strengths and complement each other, thus constituting an interconnected industry ecology; Promote the development of industrial clusters and guide the coordinated development of industries. Roberto et al. (2018) found through enterprise research that the rapid development of digital technology is promoting changes in strategic management and innovation, which also promotes the implementation of differentiation strategy of enterprises. The digital strategy of American enterprises aims to maintain competitiveness and realize new value vitality through the development of emerging technologies. The U.S. government has focused on the development of digital technologies such as big data and artificial intelligence, and issued the Artificial Intelligence Research and Development Strategy, including the Big Data Research and Development Strategy. At the national level, a policy system based on openness, innovation, and the promotion of traditional industries has been established, thus effectively promoting the development of digital transformation in the United States. Silicon Valley in the United States, with its strong scientific research strength and innovative spirit, makes the high-tech industry take the lead in realizing the digital strategy. To sum up, in order to successfully achieve digital transformation and adapt to the development of the digital era, traditional manufacturing enterprises can adopt new methods such as formulating digital strategies, absorbing digital talents, and investing digital technologies into various business links. Guided by restructuring strategic layout, they can timely optimize and adjust strategic objectives and strategic positioning, improve traditional driving forces and stimulate new driving forces for development. Combine enterprise strategy and digitalization to form a digital strategy that conforms to the characteristics of the industry and has its own characteristics.

Digital production; The purpose of digital production is to form a closed loop focusing on production planning, implementation, tracking and problems to promote the whole production process with "PLM (Product life cycle Management system), ERP (Enterprise resource Management system), APS (Advanced production scheduling system)" and other systems. Focus on product manufacturing process and supply chain process control, and finally realize the whole process of intelligent production. Graetz and Michaels (2017) analyzed the economic contribution of industrial robots in the process of digital transformation, believing that the use of robots can improve labor productivity and total factor productivity, and reduce output prices. Uwe Winkelhake (2019) pointed out in his article that digital transformation is fundamentally about digitization of products, digitization of operations and digitization of employees. By improving the intelligence of products, improving service efficiency and user experience, product digitalization ultimately promotes the transformation of enterprises to the product-as-a-service model, that is, the business model. Through various digital means to achieve the digitalization and transparency of the entire business process, to achieve the goal of improving quality, reducing cost and increasing efficiency, and ultimately promote enterprises to shift to data-driven. Employee digitalization will accompany the entire digitalization process, empowering employees through the digital data of products or operations to improve their work efficiency. Hou Tingting and Li Yunting (2020) believe that the main fields of digital transformation in manufacturing industry include digitalization of design, digitalization of manufacturing and digitalization of management. Design digital transformation refers to the product assembly process simulation experiment, digital preassembly, data analysis and so on in the virtual environment. Manufacturing digital transformation refers to the digitization of

manufacturing, process, control and inspection; Management digital transformation refers to the use of digital technology, quantitative assessment of enterprise management personnel and management behavior through data technology, and ultimately the manufacturing model and business model of enterprises will be fundamentally changed. To sum up, digital production can use big data to empower, open up the whole link from design and production to sales and service, form an intelligent production management system, implement visual management of problems existing in the production process, and provide data support for high-quality production of enterprises. At the same time, the product customization ability of car companies continues to improve. Under the change of user consumption trend, in order to meet customer needs, car companies have established a user-oriented personalized customization platform, which can allow users to participate in the design and production process of cars, create personalized exclusive cars, and build digital smart factories. Digital marketing; With the rapid development of science and technology, enterprise management methods are constantly changing and sublimating, and digital marketing comes into being. At present, digital marketing is still a new marketing method, and scholars at home and abroad have the following explanations for its definition: Digital marketing is the core means of enterprise marketing in the era of digital economy, and digital marketing is also one of the current marketing methods. It is defined as a means to achieve the established marketing objectives under the combination of communication technology, Internet and digital interaction technology. This definition attaches more importance to the future development trend of digital marketing. The pursuit of digital marketing is to maximize the use of computer technology, combined with STP theory to subdivide the market, find the target market to determine the market positioning, to achieve efficient market development and tap the needs of consumers. With the help of digital media such as Weibo, short video, Taobao, wechat and mail, precise marketing can be achieved for target users in the database. Yang Long et al. (2014) put forward that the emergence of digital marketing has turned marketing into a science with strong interaction, high degree of personalization and controllability, overcoming the traditional marketing based on experience, intuition and enthusiasm, promoting enterprise innovation and service, obtaining unexpected market opportunities, and significantly improving enterprise competitiveness. Zhou Yong (2019) proposed that for enterprises, marketing at each stage should be adjusted according to the market environment and consumer behavior. Digitalization requires "putting people first", making shopping easier and more convenient, increasing the value of goods and services, and reducing the cost of buying for customers. Yang Jia-cheng (2021) Digital sales is a strategy, but digital marketing is a concept, a new mode of thinking, a cognitive revolution in the era of digital economy. To sum up, the Internet has accelerated the big data of automobile sales, and digital marketing has become the general trend. Compared with the traditional marketing model, digital marketing carries out data collection and face recognition through the intelligent marketing data management platform, which effectively solves the problem of information asymmetry caused by the disconnection between the seller and the customer. Digital research and development Digital R & D system refers to the use of digital technologies and tools to build a complete set of R & D processes and systems to improve R & D efficiency and quality. The establishment of digital research and development system can help enterprises realize digital transformation, improve product innovation ability and market competitiveness. The establishment of a digital research and development system can bring multiple benefits. First of all, it can improve the efficiency and quality of research and development, shorten the product development cycle and reduce development costs. Secondly, it can improve product innovation ability and market competitiveness to meet user needs and market changes. Finally, digital transformation can be achieved to improve the digital capability and management level of enterprises. Qi Yudong and CAI Chengwei (2019) proposed that through the use of digital R&D platforms (such as low-code platforms) to achieve basic R&D sharing services, reduce fixed investment in R&D, reduce R&D costs, and improve enterprises' R&D innovation capabilities and R&D design services. Such as Ali Cloud, Tencent Cloud, WPS Cloud, Baidu Cloud and other services through the rental of storage space and computing power to eliminate the technical and fixed investment threshold of independent server, reducing the cost of digitalization of small and medium-sized enterprises. Lu Dongheng (2020) pointed out that digital transformation refers to the changes of traditional enterprises from the inside out, from local to overall, from continuous to subversive development in four main aspects: technology foundation, customer experience, operation process and business model. To sum up, under the background of digital transformation, the R&D and innovation capability of the automobile manufacturing industry is essential. Increasing digital research and development efforts are mainly reflected in adjusting the or GAnizational structure, increasing the proportion of digital talents in enterprises, and engiving research and development processes, research and development tools, etc., to reduce research and development costs and improve research and development efficiency. Digital service; Digital service is an innovation of service mode. Digital service is the use of computers or other intelligent devices as production tools, the use of digital

means to collect and analyze data and information, to integrate the resources of the enterprise, improve the service efficiency of the enterprise, improve the relationship between the enterprise and the customer, optimize the service mode of the enterprise, and finally provide customers with personalized services. Chen GAng (2021) believes that digital service is a personalized matching mode of large-scale production, dissemination and consumption based on big data and artificial intelligence technology. The driving force of digital servitization is the change of technology, society and people. The process includes the improvement of digital capability, the change of or GAnizational structure and the adjustment of business model. The realization path is the micro-service innovation and iterative innovation at the front and back end, and the impact results include the change of enterprise performance and the reconstruction of industrial chain. Chen Xuepin (2021) proposed in Reading Digital Transformation in One Book that the main areas of digital transformation include the transformation of products and services, or GAnizations and talents, marketing and channels, management and corporate culture. To sum up, with the improvement of national quality, after-sales service experience has become as important as driving experience. Therefore, the complete digital transformation structure is inseparable from the digital precision service implemented by the digital platform for the whole process of consumer car purchase, in order to fit the digital upgrade strategy of car networking and smart stores. In summary, since the 21st century, the digital economy has developed vigorously, and the world has entered the digital era. In May 2016, the Guiding Opinions of The State Council on Deepening the Integrated Development of Manufacturing Industry and the Internet were issued, emphasizing the need to stimulate and promote the transformation and upgrading of manufacturing enterprises to the direction of digitalization, networking and intelligence, so far, the digital transformation of manufacturing enterprises has been officially defined and entered the public vision. As an important pillar industry of the national economy and an important part of the traditional manufacturing industry, the automobile manufacturing industry has ushered in a comprehensive digital transformation stage in a real sense.

Theory of administrative cost

Administrative cost refers to the various costs incurred by enterprises in the course of operation. These costs include not only explicit costs, such as manpower, material resources, financial resources, etc., but also some implicit costs, such as time costs, risk costs, information costs, etc. The technological innovations brought about by digital transformation will change the production methods and processes of the manufacturing industry, thus affecting the generation and allocation of costs. Artificial intelligence and Internet of Thin GA technology can realize the intelligence and automation of machines, reduce labor costs and improve production efficiency. Data analysis and forecasting technology can help companies achieve more accurate demand forecasting and production planning, thereby reducing inventory costs and avoiding resource waste. In other words, digital transformation can reduce the cost of manufacturing by optimizing production processes and resource utilization. The constituent elements of administrative cost theory Operating cost; Digital transformation is not only the update and application of technology, but also an optimization of enterprise operating costs. Operating costs, also known as operating costs, are formed by production and operating costs, mainly including: direct materials, direct labor, manufacturing expenses, and other direct conversion costs. Teece (2007) found in his research that digital transformation can realize intelligent operation and reduce costs and expenses. Through digital transformation, enterprises can take advantage of the huge use value hidden in data assets to help enterprises achieve intelligent operations, improve labor efficiency, and reduce unnecessary human resources. Wu Xi et al. (2017) proposes the opposite view. Through the research on the application of digital technology in retail listed companies and diversified enterprises in the past two years, it is found that digital transformation has not significantly reduced the transaction cost of enterprises, has not led to the improvement of asset turnover rate, and has little impact on the overall performance of enterprises. Based on the perspectives of consumption decision making and production decision making, Qi Yudong and CAI Chengwei (2019) found through their research that digital transformation enables enterprises to efficiently utilize a large amount of fragmented user data in the past, analyze consumers' wishes more targeted, and thus reduce transaction costs. In this way, customer satisfaction is improved and production efficiency of enterprises is effectively improved. Business performance has improved. To sum up, it is obvious that digital transformation can optimize the operating costs of enterprises. By improving work efficiency, accelerating the flow of information, enabling intelligent management, expanding market opportunities and improving risk prevention capabilities, companies can reduce operating costs and improve profitability. Digital transformation is not only the trend of current enterprise development, but also the core of future enterprise competitiveness. Therefore, enterprises should actively respond to digital transformation, use the power of technology to promote business development, and achieve the optimization of operating costs. Conversion cost;

The term "Conversion Cost" was first coined by Michael Porter in 1980 and refers to the one-time costs incurred when a consumer switches from one provider of a product or service to another. The costs are financial as well as time, effort and emotion. Such as the cost of adding new equipment, redesigning products, adjusting testing tools, retraining users, etc. Qi Yudong and CAI Chengwei (2019) made a further study on the motivation of digital transformation, believing that digital transformation can reduce the conversion cost of enterprises themselves and reduce the cost of enterprises in the operation process. Qi Yudong and Xiao Xu (2020) believe that from the perspective of the supply side, the traditional sales mode of enterprises is offline sales, which is easily affected by market factors and local characteristics, resulting in serious inventory accumulation. However, under the new model of enterprise digital marketing, enterprises can open up new sales channels online, establish direct contact with consumers, reduce a series of links needed in the middle, and then improve distribution efficiency, promote commodity circulation, and effectively alleviate the unsaleable pressure of suppliers. To sum up, under the digital transformation, enterprises can not only lock their own consumers, but also attract their rivals' consumers, reduce the conversion costs faced by consumers, in order to compete for market share and improve corporate performance. In summary, the application of new generation digital technologies such as big data, blockchain and cloud computing will help solve the phenomenon of "information island" and create favorable conditions for reducing operating costs and improving enterprise performance. The openness, sharing, interconnection and collaboration of enterprises after digital transformation will be improved, and Zhejiang will greatly reduce the inefficiency of traditional enterprises, improve operational efficiency, reduce operating costs, and promote business expansion.

2.2 The Conceptual Framework

The conceptual framework of this study integrates the relationship between digital transformation, Digital operation, administrative cost, and enterprise performance. Based on the literature and the original measurement scale, the constitutive dimensions of digital transformation are determined. Through questionnaire survey, the independent variables of digital transformation were identified. Through the mediating variables of Digital operation and administrative cost, the dependent variables affect enterprise performance. Details are as follows.

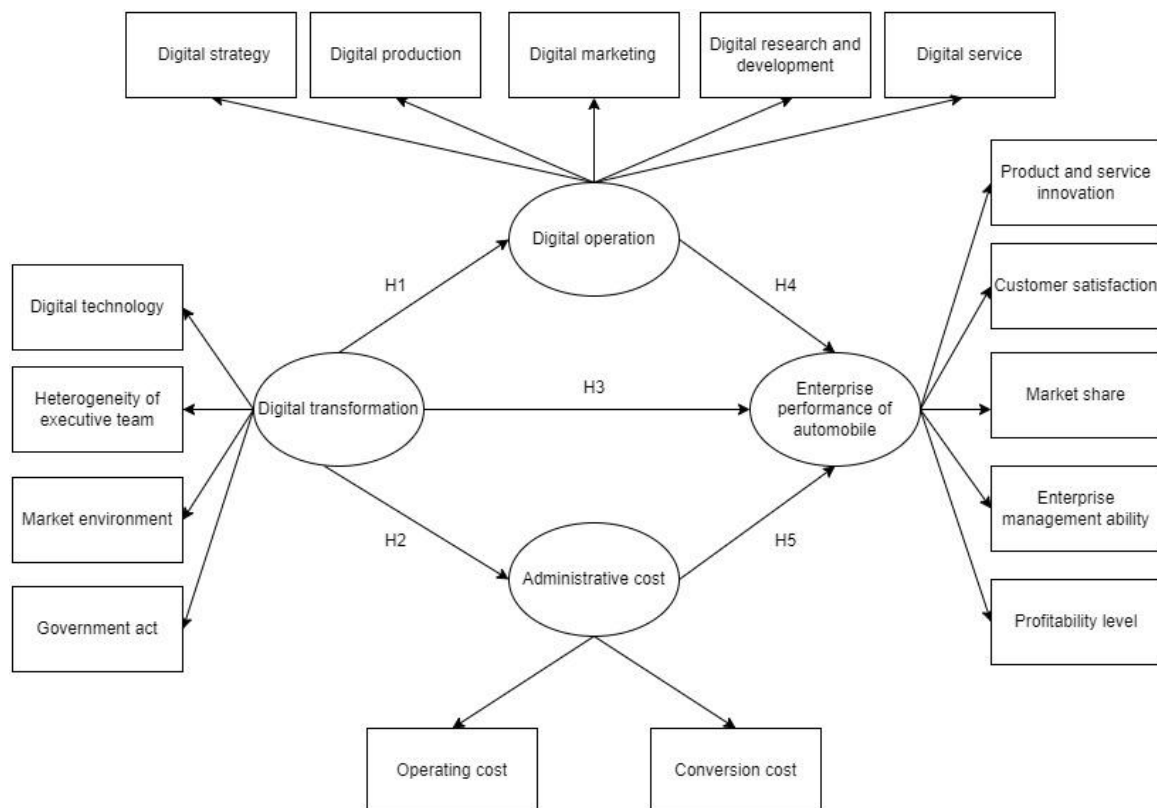


Figure 1: Research concept framework**3. Methods**

The researcher adopts the mixed research method, combines the qualitative research and the quantitative research, carries on the analysis, obtains the objective result.

Quantitative Research

The sample of quantitative research is the employee representatives of the automobile manufacturing enterprises in 16 cities, including Jinan, Qingdao, Yantai, Weifang and Jining. Automobile production enterprises in Shandong Province are mainly distributed in Jinan, Qingdao, Yantai, Weifang, Jining. So, choose Jinan, Qingdao, Yantai, Weifang, Jining as the main investment area. The samples drawn are as follows: There are 56,900 automobile manufacturing enterprises in Shandong Province (Shandong Bureau of Statistics :2023). The researchers used structural equation models to randomly select the appropriate sample size from the identified and recommended appropriate population through stratified random sampling. The researcher uses structural equation modeling and AMOS data analysis, and uses empirical rules to determine the sample method in the selection of sample size. (Schumacker and Lomax, 1996, Hair et al., 1998 cited in Nongluck Wiratchai, 1999). There are 16 variables in the model. A suitable and sufficient sample size is 10×16 to $20 \times 16 = 320$. In order to better use structural equation modeling statistical tool for data analysis, therefore, the total number of samples used in this study is 400 employees. The quantitative research tool is a questionnaire. The questionnaire was issued in proportion to the number of automobile manufacturing enterprises in Shandong Province. The researchers compiled the questionnaire on the basis of consulting relevant literature, digital transformation of automobile manufacturing enterprises, and development status of automobile manufacturing enterprises. The researchers examined concepts, theory, and relevant literature in questionnaires to determine operational definitions and structures of study variables. The researchers then set up questions based on measurement tools and research goals, which were continually refined to fit the study. Experts examined the questionnaire through the content of the questions. After testing the validity and reliability of the questionnaire, the researchers performed the quality test of the research tool. The data analysis used descriptive statistical analysis and Structural Equation Modeling. In the data analysis, using frequency, mean, standard deviation, hypothesis testing, using Structural equation modeling to analyze the influencing factors of Jiangxi tourism competitiveness, establish a conceptual framework, and analyze the relationship between theories. For variables, the researcher tests the relevance of the model to empirical data (model fit evaluation). Data analysis was performed using Statistical Product and Service Solutions tools, and Likert scales were used to measure the degree of consistency.

Qualitative Research

The interview sample group was set up according to the targeted interview method, set interview questions, and interviewed 15 key informants in charge of automobile manufacturing enterprises in Jinan City, Qingdao City, Yantai City, Weifang City and Jining City. The main targets of the survey included four senior managers hired by the company, five managers of the human resource management department of the company, and six senior employees who had worked in the operation management department of the company for more than 10 years. Because the data collection method adopts the form of in-depth interviews, the tools used in this qualitative research are conducted in the form of questions. Researchers designed open-ended questions. These types of questions allow researchers the opportunity to ask questions freely about certain issues, and respondents may provide additional information. The statistics used in data analysis to analyze the content and purpose of the interview; the researchers extracted the information provided by the 8 key informants. The analysis and processing of relevant personnel of the organization are as follows: 1) Group the information obtained in the interview records. 2) Collect and complete the respondents' answers. 3) After collecting the main points of all respondents' answers, analyze and summarize according to the conceptual framework.

4. Results

Table 1 Summary of research hypothesis testing results

Research Hypothesis	Test Result
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Hypothesis 1 (H1) Digital transformation has a influence on Digital operation	Accept
Hypothesis 2 (H2) Digital transformation has a influence on administrative cost	Accept
Hypothesis 3 (H3) Digital transformation has a influence on enterprise performance	Accept
Hypothesis 4 (H4) Digital operation has a influence on enterprise performance	Accept
Hypothesis 5 (H5) Administrative cost has a influence on enterprise performance	Accept

Through the research, all the hypotheses are verified, and the influence of digital transformation on enterprise performance is positively correlated. It shows that improving Digital transformation is one of the key factors to promote the improvement of enterprise performance. It provides additional theoretical and practical basis for improving the performance of automobile manufacturing enterprises. (refer to Table 1)

This paper addresses the topic of focusing on the impact of digital transformation on the performance of automobile manufacturing enterprises in Shandong Province, People's Republic of China., asking two key questions: (1) What factors affect the operation of automobile manufacturing enterprises in Shandong Province, the People's Republic of China? (2) What factors affect the operation of automobile manufacturing enterprises in Shandong Province, the People's Republic of China? Based on extensive literature research, data compilation, data collection and empirical analysis, we clarify the factors affecting digital transformation and enterprise performance and propose the path of digital transformation.

The results answer the research objective No. 1: This study adopts the view of Amit and Zott (2007, 2008,2010), which classifies digital transformation into four dimensions: Digital technology, Heterogeneity of executive team, Market environment and Government support, using the maturity scale developed by Zott and Amit (2007), and conducts the study with empirical analysis to discuss the relationship between four dimensions of digital transformation and firm performance including product and service innovation, customer satisfaction, market share, enterprise management ability and profitability level. In this paper, an in-depth questionnaire survey was conducted with a sample of 400 Automobile manufacturing enterprises in Shandong Province, and validated by reliability, validity, Z-test and t-test, and validated factor analysis, correlation coefficient analysis, and structural equation modeling, which concluded that digital transformation has a positive contribution to firm performance through the role of intermediate variables digital operation and administrative cost. Digital transformation has a positive contribution to digital operation with a path coefficient of 0.56, including a path coefficient of 0.53 for the creation and development of digital strategy, 0.51 for digital production, 0.62 for the digital marketing, 0.47 for digital research and development and 0.64 for digital service. Digital transformation has a positive effect on administrative cost with a path coefficient of 0.58, where the path coefficients are 0.51 for operating cost, 0.49 for Conversion cost. Survey results underscore the unanimous acknowledgment among respondents regarding the pivotal role of digital transformation in enhancing enterprise performance within Shandong Province's automobile manufacturing sector. In-depth interviews corroborated this perspective, emphasizing the transformative effects of digital initiatives in augmenting operational efficiency, stimulating innovation, and bolstering overall competitiveness. Correlation analyses unveiled a positive relationship between diverse digital approaches—ranging from digital strategy to production and marketing and key performance indicators. This correlation signifies that a multifaceted digital transformation positively influences various aspects of enterprise performance.

The results answer the research objective No.2: To develop model of digital transformance to enterprises performance of automobile manufacturing enterprises. According to the results of the qualitative analysis, the digital transformance selection should consider Digital operation, in addition to the administrative cost, but also consider Digital technology, Heterogeneity of executive team, Market environment, Government support. There is a compelling need to fortify innovation capabilities and foster product and service differentiation. This entails creating an environment conducive to continuous innovation, embracing new technologies, and diversifying offerings to align with evolving market demands. Additionally, the infusion of advanced technology emerges as a critical strategy to elevate overall infrastructure and information technology within these enterprises. The development of intelligent enterprises emerges as a key strategic focus, necessitating the establishment of a robust intelligent management and marketing mechanism. This strategic direction aligns with broader industry trends in digitization and smart technologies, ensuring enterprises are well-equipped to navigate the complexities of the contemporary business landscape. Concurrent with technological advancements, a paramount emphasis is placed on human capital development. Strengthening the talent pool is recommended to enhance the overall quality of the workforce. This involves investment in training programs, strategic talent acquisition, and the cultivation of an organizational culture that values continuous learning and development. In conclusion, these tailored suggestions and measures collectively contribute to the enhancement of enterprise performance through digital

transformation in the automobile manufacturing sector of Shandong Province. The integration of innovation, technology, talent development, financial support, and cultural alignment forms a holistic approach to address the challenges and opportunities posed by the rapidly evolving business landscape.

5. Discussion

The discussion is centered around the evaluation of the research hypotheses and aims to provide a coherent interpretation of both quantitative and qualitative research results within the context of the stated objectives. The study focused on understanding the impact of digital transformation on digital operation, administrative cost, and enterprise performance in Shandong's automobile manufacturing sector. Research Hypotheses Evaluation:

H1: Digital transformation has an influence on Digital operation

The quantitative results confirm the positive impact of digital transformation on digital operation, supporting H1. the path coefficient between DT ($B=0.561$) and DO is positive and statistically significant ($p<0.001$), Hypothesis 1 is verified. Qualitative insights from senior managers and operational employees further reinforce the notion that embracing digital transformation enhances operational processes. Digital transformation (DT) has a total effect and direct influence on digital operation (DO) with a degree of 0.422, indicating that digital transformation has a significant positive effect on digital operation. This result is consistent with H1 hypothesis, that is, digital transformation has an influence on digital operation. From a qualitative perspective, senior managers and operational employees also confirmed that digital transformation improved their operational processes and efficiency.

H2: Digital transformation has an influence on administrative cost

Both quantitative and qualitative findings uphold H2, emphasizing the considerable influence of digital transformation on administrative costs. The path coefficient between DT ($B=0.557$) and AC was positive and statistically significant ($p<0.01$), Hypothesis 2 was verified. Senior managers, HR professionals, and operational employees concur that automation and digitalization contribute to substantial cost savings. Digital transformation (DT) has a total and direct impact on administrative cost (AC) with a degree of 0.526, suggesting that digital transformation leads to considerable cost savings. This result supports H2 hypothesis, that is, digital transformation has an influence on administrative cost. The qualitative insights from senior managers, HR professionals, and operational employees further corroborated that automation and digitalization reduced their administrative expenses and enhanced their cost management.

H3: Digital transformation has an influence on enterprise performance

Quantitative and qualitative analyses support H3, affirming that digital transformation positively influences enterprise performance. The path coefficient between DT ($B=0.438$) and EP is positive and statistically significant ($p<0.001$), Hypothesis 3 is verified. Senior managers, HR professionals, and operational employees unanimously acknowledge the positive effects on production efficiency, supply chain management, and overall enterprise metrics. Digital transformation (DT) has a total and direct impact on enterprise performance (EP), the direct impact is 0.414, the total impact is 0.647, it also has an indirect impact through digital operation (DO), administrative cost (AC) the indirect impact is 0.233. This result verifies H3 hypothesis, that is, digital transformation has an influence on enterprise performance. The qualitative feedback from senior managers, HR professionals, and operational employees unanimously acknowledged the positive effects of digital transformation on production efficiency, supply chain management, and overall enterprise metrics.

H4: Digital operation has an influence on enterprise performance

Both sets of results substantiate H4, highlighting the influence of digital operation on enterprise performance. The path coefficient between DO ($B=0.339$) and EP is positive and statistically significant ($p<0.001$), Hypothesis 4 is verified. The qualitative insights from senior managers and operational employees further emphasize the pivotal role of digital operations in driving competitiveness, efficiency, and success. Digital operation (DO) has a total and direct impact on enterprise performance (EP) with a degree of 0.341, implying that digital operation plays a pivotal role in driving competitiveness, efficiency, and success. This result confirms H4 hypothesis, that is, digital operation has an influence on enterprise performance. The qualitative insights from senior managers and operational employees further emphasized the importance of digital operations in achieving their strategic goals and objectives.

H5: Administrative cost has an influence on enterprise performance

The quantitative and qualitative outcomes validate H5, emphasizing the influence of administrative costs on enterprise performance. The path coefficient between AC ($B=0.293$) and EP is positive and statistically significant ($p<0.05$). Hypothesis 5 is verified. The consensus among stakeholders is that efficient management of costs, facilitated by digital transformation, positively contributes to overall enterprise performance. Administrative cost (AC) has a total and direct impact on enterprise performance (EP) with a degree of 0.234, indicating that efficient management of costs, facilitated by digital transformation, positively contributes to overall enterprise performance. This result validates H5 hypothesis, that is, administrative cost has an influence on enterprise performance. The consensus among stakeholders is that lower administrative costs lead to higher profitability and performance.

New knowledge

This research, centered around the "Model of Digital Transformation Effecting to Enterprises Performance of Automobile Manufacturing Enterprises in Shandong Province, the People's Republic of China," contributes significant new knowledge to the understanding of digital transformation dynamics in the context of automobile manufacturing enterprises. The following key insights have been Gained:

- (1) The study highlights the critical importance of digital transformation in shaping the performance of automobile manufacturing enterprises. It emphasizes that the integration of digital technologies is not merely a technological upgrade but a comprehensive transformation that significantly influences overall business performance. By exploring the multifaceted impact of digital transformation on enterprises in Shandong Province, the research enriches our understanding of the intricate relationship between technological advancements and or GAnizational outcomes.
- (2) A novel aspect introduced by this research is the emphasis on the unique characteristics of digital transformation within the specific context of Shandong Province's automobile manufacturing sector. By focusing on a regional perspective, the study recognizes that the effectiveness of digital transformation strategies is influenced by local industry nuances, economic factors, and regulatory environments. This regionalized approach provides a nuanced understanding of the challenges and opportunities specific to the automobile manufacturing landscape in Shandong Province.
- (3) The paper introduces a comprehensive model that elucidates the mechanisms through which digital transformation affects the performance of automobile manufacturing enterprises. It goes beyond a mere correlation analysis and delves into the intricacies of how digital transformation initiatives impact various dimensions of enterprise performance. The model considers not only financial metrics but also factors in customer performance, internal processes, and learning and growth performance. This holistic view of effectiveness aligns with contemporary business paradigms and enriches the conceptualization of enterprise performance in the digital era.

In conclusion, this research augments the body of knowledge related to digital transformation in the specific context of automobile manufacturing enterprises in Shandong Province. By offering insights into the transformative impact and regional nuances of digital initiatives, the study contributes valuable perspectives that can inform both academic discourse and practical decision-making in the dynamic landscape of digital business transformation.

Suggestions

- (1) Geographic Extension and Comparative Analysis:

While the current research focuses on Shandong Province, the next phase of exploration could involve extending the study to other key regions in China, such as Beijing, Shanghai, Shenzhen, among others. Conducting a comparative analysis of the enterprise performance levels, specifically in terms of innovation capability, information technology, and intelligent enterprise status, across different regions would provide valuable insights. This comparative approach can help identify regional nuances and disparities, leading to the formulation of targeted strategies to enhance the enterprise performance of automobile manufacturing enterprises in each specific region.

(2) Expansion Research on New Technology Applications:

To further delve into the transformative potential of digital technologies, future research could focus on an expanded exploration of the application of emerging technologies. Delving into the potential and challenges presented by technologies such as artificial intelligence, big data, cloud computing, and the internet of things for high-tech SMEs would offer a comprehensive understanding. Analyzing the impact of these technologies on product innovation, process innovation, or organizational innovation, and marketing innovation within automobile manufacturing enterprises would contribute to a nuanced understanding of the broader implications of technological adoption in the industry.

These suggestions aim to guide future research endeavors, expanding the scope of inquiry and delving deeper into the intricacies of digital transformation within the context of automobile manufacturing enterprises in various regions of China. By addressing these research avenues, scholars and practitioners can contribute to the ongoing discourse on digital transformation, digital operation, and administrative cost within the dynamic landscape of the automotive industry.

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