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Enterprise Digital Management Efficiency under Cloud Computing and Big Data

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Abstract: In recent years, with the rapid development and popularization of information technology, digital management has become an indispensable part of enterprises. Digital management can improve enterprise efficiency, reduce cost, and optimize service, which is an important means for enterprises to realize transformation and upgrading and improve economic benefits. However, there are still many challenges and bottlenecks in the process of digital transformation. The emergence of cloud computing and big data technology also provides new ideas and methods for digital management. For this reason, this paper used cloud computing and big data to optimize the digital management efficiency of enterprises. It used a data envelopment analysis (DEA) model for analysis. The research results show that under the same other conditions, 140 people agreed and 160 people disagreed with the efficiency of enterprise digital management before optimization. There was no difference between the two. A total of 270 people agreed with the optimized digital management efficiency of the enterprise, while only 30 people disagreed. The significant increase in the number of people who agreed indicated that employees had a very high level of recognition for the efficiency of optimized digital management of the enterprise. These technologies have improved the efficiency of enterprise digital management and provided more practical, operable, and sustainable digital transformation solutions for enterprises.

Keywords: enterprise digitalization; cloud computing; big data; management efficiency

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1. Introduction

In the context of cloud computing and big data technology, enterprise digital management is facing a series of problems [1]. For example, how can cloud computing resources be effectively utilized to improve enterprise computing and storage efficiency? How can big data technology be used to mine valuable information in enterprise data? How can cloud computing and big data technology be combined with the digital management of enterprises to achieve the optimization of business processes and support for decision-making? These issues are all challenges faced by enterprise digital management in the era of cloud computing and big data.

This article is suitable for enterprise managers, information technology professionals, researchers, and readers interested in cloud computing and big data technology. For enterprise managers, this article can provide practical guidance on how to use cloud computing and big data technology to improve the efficiency of digital management in enterprises. For information technology professionals, this article can provide a reference for them to understand and apply the role of cloud computing and big data technology in enterprise digital management. For researchers, this article can fill the research gap in the efficiency of enterprise digital management under cloud computing and big data, providing them with new research directions and ideas.

Through literature analysis, it can be found that there are some research gaps in the efficiency of enterprise digital management under cloud computing and big data. Previous

research has focused on the application of cloud computing and big data technology in enterprise digital management, but few studies have explored how to effectively combine cloud computing and big data technology to improve the efficiency of enterprise digital management. Therefore, this article aims to fill this research gap and deeply explore methods and strategies for improving the efficiency of enterprise digital management under cloud computing and big data.

The purpose of this article is to explore how cloud computing and big data technology can improve the efficiency of digital management in enterprises and propose corresponding methods and strategies. Through experimental research, we hope to provide guidance for the digital management of enterprises in the era of cloud computing and big data and help them better utilize cloud computing and big data technology to optimize business processes and support decision-making.

This article mainly explores the efficiency of enterprise digital management under cloud computing and big data and uses the DEA model for research. In the methodology section, the meaning of cloud computing and an introduction to big data were introduced, and DEA models based on cloud computing and big data were analyzed. The experimental part first explains the case and then understands the efficiency characteristics of digital management in Chinese enterprises. Then, it introduces the history and current situation of digital management in X company and provides suggestions for optimizing the efficiency of digital management in X company for cloud computing and big data. Finally, by comparing the impact of cloud computing and big data optimization on the efficiency of digital management in X company before and after, the relationship between them is verified.

2. Literature Review

2.1. Enterprise Digital Management under Cloud Computing and Big Data

Cloud computing is an Internet-based computing model that provides computing resources, storage resources, and applications to users to achieve on-demand use, elastic scalability, and rapid deployment. Cloud computing can provide flexible computing and storage capabilities to help enterprises better respond to changing business requirements and improve resource utilization and efficiency. Big data refers to the combination of massive, high-speed, and diversified data and various data analysis technologies to discover new data patterns and gain new business insights to support decision-making and innovation. Big data technology can help enterprises mine the value information in data, optimize business processes and decisions, and improve the efficiency and competitiveness of enterprises. Digital management is used to transform the traditional enterprise management process and business process into digital form and to realize the automation, intelligence, and optimization of management activities with the help of information technology. Digital management can improve efficiency, reduce human error and costs, and provide real-time data and analytics support to help businesses make more accurate decisions.

2.2. Domestic and Foreign Research

With the rapid development of the digital economy, the combination of enterprise digital management and digital business will become the trend of enterprise management in the future. For enterprise management, a large number of research results have been studied. As shown in Table 1:

Table 1. Specific situation of existing research.

Author	Particular Year	Research Contents
Eshov M. A. N. S. U. R [2]	2020	Influence assessment of enterprise management value based on coefficients methods under the risk conditions.
Nurlankyzy Nagym Ainel [3]	2019	Business Process as the Basis of the Process Approach in Enterprise Management.
Faizova Svitlana [4]	2018	Prospects for improving the methodology of strategic enterprise management.
Ionescu Constantin Aurelian [5]	2021	The new era of business digitization through the implementation of 5G technology in Romania.
Fulop Melinda Timea [6]	2022	Opportunities And Challenges In The Accounting Profession Based On The Digitalization Process.
Fülöp Melinda Timea [7]	2023	Challenges and perceptions of e-learning for educational sustainability in the "new normality era".
Hnatenko Iryna [8]	2020	An approach to innovation potential evaluation as a means of enterprise management improving.
Shen Lei [9]	2022	Digital technology adoption, digital dynamic capability, and digital transformation performance of textile industry: Moderating role of digital innovation orientation.
Burova Ekaterina [10]	2021	The Cost Management of Innovative Products in an Industrial Enterprise Given the Risks in the Digital Economy.
Ferreira João J. [11]	2023	Industry 4.0 implementation: Environmental and social sustainability in manufacturing multinational enterprises.
Wen Huwei [12]	2021	Digitalization and environment: how does ICT affect enterprise environmental performance?
Rana Saurabh [13]	2021	Provably secure authenticated content key distribution framework for IoT-enabled enterprise digital rights management systems.
Gao Jun [14]	2022	Analysis of enterprise financial accounting information management from the perspective of big data.
Shang Hongyu [15]	2021	Early warning of enterprise finance risk of big data mining in internet of things based on fuzzy association rules.
Qi Wenhao [16]	2022	Facilitating big-data management in modern business and organizations using cloud computing: a comprehensive study.
Javaid Mohd [17]	2021	Significant applications of big data in Industry 4.0.

Among them, the study of Eshov M. A. N. S. U.R discussed the basic value of enterprise management through the discounted cash flow method [2]. Nurlankyzy Nagym Ainel's research found that the use of the process balance system method can improve the quality of enterprise management [3]. Faizova Svitlana's research aims to outline the prospect and direction of improving strategic enterprise management methods in the case of the evolution of strategic enterprise management to balanced enterprise management [4]. The purpose of Ionescu Constantin Aurelian is to identify the advantages and benefits of the use and implementation of 5G technology for the development and evolution of Romania's business environment. He verified the research hypothesis by analyzing the results of the questionnaire through the identified association table and contingency table. The results show the availability and interest in implementing 5G technology (more than 69% agreed to implement 5G over a period of up to five years), given the cost, high level of network security, and competitive advantages that 5G can generate [5]. Due to the COVID-19 pandemic and related restrictions, digital work has increasingly become a focus for Chinese enterprises. Therefore, the aim of Fulop Melinda Timea is to provide

an overview of the various digital processes in the field of accounting to help businesses choose the one that works best for them. The research results show that there are a series of digital variants in the market, and it is an important process to make the optimal choice according to the needs of each enterprise [6]. The findings of the FLU, p Melinda Timea link e-learning satisfaction with academic performance and the use of e-learning by Romanian students during the pandemic. The results show that external factors do not affect perceived usefulness; therefore, students believe that perceived ease of use does not affect their willingness to use new technologies [7]. As a research topic, the complexity and multifaceted nature of the innovation potential of enterprises leads to a variety of methods to evaluate it. Therefore, an urgent area of research is to develop a comprehensive approach to quickly and adequately diagnose the state of a company's existing innovation potential. Hnatenko Iryna proposes a method for evaluating innovation potential based on resources and production methods. Based on the research results, the index representing the largest amount of information on constituent elements of innovation potential is determined, and on this basis, the calculation method of existing enterprise innovation potential utilization efficiency and related final indicators is proposed [8]. Shen Lei used the data from 367 questionnaires from Chinese textile enterprises to analyze the impact of multiple regression technology on enterprises' digital transformation. Based on the resource capability–performance framework, a conceptual model of the impact of digital technology adoption, digital dynamic capability, and digital innovation orientation on digital transformation performance is constructed. The results show that the positive correlation between digital technology adoption and digital transformation performance is not significant. This path is completely regulated by digital dynamic capabilities. In addition, compared with textile enterprises with a lower level of digital technology adoption, textile enterprises with a higher level of digital technology adoption show a significant positive correlation between digital transformation performance. These findings confirm the validity of the model, contribute to the existing literature on enterprise technology efforts, and provide guidance to help managers make informed decisions about digital transformation [9]. Burrova Ekaterina's research aims to explore the inherent risk mechanism of innovative product cost management in industrial enterprises. This mechanism is based on the combination of the cost-driven concept and risk control concept. In the highly volatile digital economy, risk assessment in cost management and the development of mechanisms to maintain the flexibility and adaptability of continuous changes are the focus of further development of cost management systems of industrial enterprises, which also helps to increase the dynamic and flexibility of cost management processes of innovative products and maintain the competitiveness of innovative products [10]. Digital technology has made a positive contribution to achieving the environmental and social sustainability of these companies. However, the contribution of implementing each digital technology to environmental and social sustainability is unequal, allowing multinational corporations to prioritize investment based on strategically defined returns. Ferreira Jo ã o J.'s research contributes to the evolution of the resource-based view of digital technology as a strategic resource. This report focuses on evaluating the contribution of five digital technologies to achieving environmental and social sustainability and demonstrates the importance of digital transformation towards green manufacturing production from an environmental and social perspective. The report also proposes practices that managers and policymakers can implement to accelerate digitization and achieve the United Nations' sustainable development goals [11].

2.3. The Combination of Cloud Computing and Big Data for Enterprise Digital Management

Despite the increasing use of digital technologies in industrial production, how industrial digitization affects the environmental performance of production activities remains unclear. Shen Lei supplemented the research literature on the relationship between industrial digitalization and corporate environmental performance by taking Chinese manufacturing enterprises as samples. The research results show that in the process of industrial digital

transformation, the environmental performance of manufacturing enterprises has been significantly improved [12]. The purpose of an enterprise digital rights management system is to manage access to electronic records, and it needs to establish a standard set of access requirements, bind these access requirements to electronic records, and calculate licensing criteria. In this chain of control, effective authenticated access to electronic documents is a critical task. To solve these problems, Wenhu devised a protocol. The security of the scheme is proved in a random oracle model. Use "Internet Security Protocol and Application Automatic verification" for security verification, indicating that the protocol is secure; comparative studies show that this method has good efficiency attributes [13]. However, the above studies are all about enterprise management and lack of experimental research on optimization methods. Therefore, a scientific method is needed to analyze its optimization.

In view of the above problems, the use of big data to optimize enterprise digital management has become the focus of more and more people. At present, there are many studies on the combination of big data and enterprise management. Among them, Gao Jun analyzed and discussed the financial accounting information management of enterprises under the background of big data and proposed effective strategies for the management of financial accounting information of enterprises [14]. Shang Hongyu's research shows that financial crisis warning based on big data mining of the Internet of Things plays an increasingly important role in enterprise management [15]. Despite some big data efforts implemented in enterprises, the fundamental issues of big data still exist (especially big data management (BDM)). Therefore, Qi Wenhao introduced the modern system of organizational BDM and analyzed the latest research results on using cloud computing to manage data generated by organizations. The survey results reveal several benefits of integrating big data and cloud computing, with the most significant being increased company efficiency and improved international trade. The study also highlights some of the hazards in complex computing environments [16]. Big data, artificial intelligence (AI), robotics, Internet of Things (IoT), cloud computing, and 3D printing are the main technologies that have successfully adopted Industry 4.0. Big data is the key to identifying fundamental issues such as deviations, quality differences, and energy efficiency waste in the production process. Javaid Mohd discusses the important application of big data in Industry 4.0. For a suitable monitoring system, the industry needs to have a high degree of technology or personalized methods to make big data a valuable source of market insight statistics or information-based predictive analysis and operational management. In the future, big data will further drive the development of Industry 4.0 and play an effective role in its successful adoption [17]. These studies illustrate the applicability of big data in the field of enterprise management and lay a solid foundation for its application in optimizing the efficiency of enterprise digital management.

The reason why this special approach is proposed in this paper is that cloud computing and big data technology have become an important trend in today's digital era and play an important role in the digital management of enterprises. By making full use of cloud computing and big data technology, enterprises can realize efficient utilization of resources, accurate analysis of data, and scientific support for decision-making, thus improving management efficiency and competitiveness. Therefore, studying how to optimize the efficiency of enterprise digital management from the perspective of cloud computing and big data is of great significance to the development of enterprises.

Contributions to this paper:

(1) This paper provides a scheme to optimize the efficiency of enterprise digital management from the perspective of cloud computing and big data to help readers understand how to apply cloud computing and big data technology to optimize enterprise digital management.
(2) The article provides clear, simple, and easy to understand expressions, enabling readers to have a deeper understanding of the specific applications and advantages of cloud computing and big data in digital management, and providing inspiration for the digital transformation of enterprises.

3. Cloud Computing and Big Data Construction

3.1. Meaning of Cloud Computing

Cloud computing provides computing, storage, networking, and other resources on the Internet. It is a technology to flexibly use, deploy, and provide corresponding services for these resources according to needs. Cloud computing is one of the core technologies of the Internet. Cloud services can reduce enterprise operating costs and improve operational efficiency. Its application scope is shown in Figure 1:

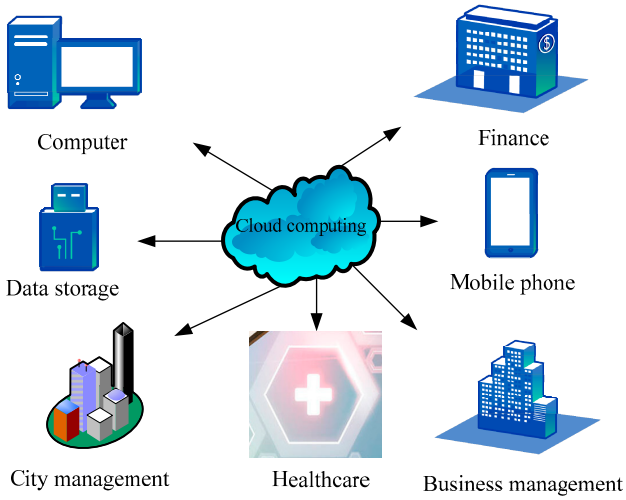

Figure 1. Application scope of cloud computing.

3.2. Introduction to Big Data

"Big data" can be understood as "valuable data". With the rapid development of the Internet, a large amount of information has been digitized, generating big data, and everyone is surrounded by massive data [18,19]. The most prominent feature of big data is its massive data.

After years of development and progress, big data has formed the concept of using "five V" to represent big data in the industry, as shown in Figure 2. It can be known from this that big data is not a simple big data set, but a complex and large data system. In the traditional digital management process, a great number of electronic data has not been used, and big data is being widely used in the field of enterprise management. From its main components, Internet big data is gradually transforming into enterprise digital management and has gradually become one of the most important parts of traditional enterprise digital management [20,21].

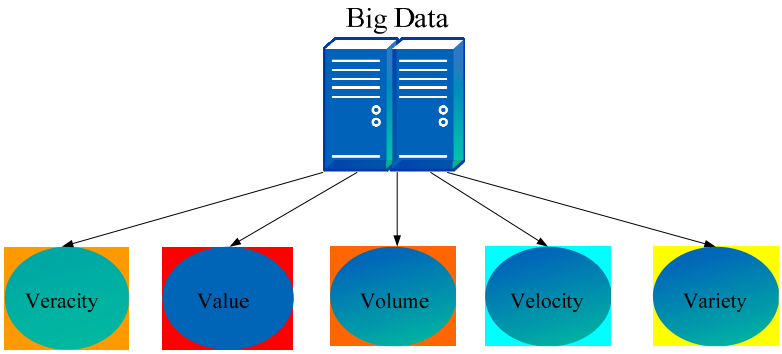

Figure 2. Concept of big data.

3.3. DEA Model Based on Cloud Computing and Big Data

The DEA model is a common efficiency evaluation method aimed at measuring the efficiency of different decision-making units in resource utilization. It can help decision-

makers identify areas with lower resource utilization efficiency and propose improvement measures. The improvement of digital management efficiency in enterprises requires comprehensive consideration of multiple factors, including information technology investment, digital process capabilities, digital organizational structure, etc. The DEA model can quantitatively measure and evaluate multiple input and output indicators when considering them comprehensively. Specifically, the efficiency of digital management in enterprises can be calculated through the DEA model for technical efficiency and scale efficiency. Among them, technical efficiency reflects the ability of enterprises to achieve maximum output under given resource conditions and is one of the important indicators to measure the effect of enterprises' digital transformation; scale efficiency reflects whether a company correctly allocates resources to achieve optimal profits and benefits. In practical applications, the DEA model can help enterprises evaluate the overall level of digital management and provide improvement suggestions and management optimization plans for enterprises. By using the DEA model, enterprises can compare the efficiency differences between different departments, teams, or production lines, adjust management strategies and resource allocation, improve digital management efficiency, and achieve better performance [22].

The biggest advantage of the DEA model is that it can evaluate complex inputs and outputs under multiple inputs and outputs. Therefore, there is no need to subjectively weigh each indicator before evaluation, thus avoiding subjective marketing and leading to scientific and objective method selection. It is very consistent to apply it in analyzing the efficiency of enterprise digital management. Therefore, this paper extracted the annual index data of X Company and used DEA-Malmquist, Tobit, and other models for analysis and calculation [23,24]. The DEA model is very sensitive to outliers and requires high-quality data input, which may cause deviation if the data quality is poor. In addition, the DEA model is unable to take into account the impact of environmental factors, nor can it explain the reasons behind the efficiency score.

(1) Application of DEA model

The DEA model is based on the input and output of enterprises and is applied to digital management, financial management, and other aspects of enterprises [25]. Due to the fact that X Company's digital operations are still in their early stages and have not yet reached a certain level of maturity, this article adopts a variable scale model of enterprise–enterprise–customer. The expressions are:

$$\min\left\lfloor \vartheta - \varphi\left(\sum_{o=1}^{n} d_o^- + \sum_{t=1}^{n} d_t^+\right)\right\rfloor \tag{1}$$

$$\begin{cases} \sum_{k=1}^{m} a_{ok}\mu_k + d_o^- = \vartheta a_{ok_0}, o \in (1,\ldots,n) \\ \sum_{k=1}^{m} a_{tk}\mu_k - d_o^- = b_{tk_0}, t \in (1,\ldots,d) \\ \sum_{k=1}^{m} \mu_k = 1 \end{cases} \tag{2}$$

$$0 \le \vartheta \le 1, d_o^- \ge 0, d_t^+ \ge 0 \tag{3}$$

Among them, n is the input indicator, and d is the output indicator; a_{ok_0} is the o input of the k_0-th unit, and b_{tk_0} is the t output of the k_0-th unit; d_o^- and d_t^+ are relaxation and residual variables, and φ is a non-Archimedean infinitesimal quantity; ϑ is the efficiency value of the k-th decision-making unit (DMU).

Generally, DEA is used to solve the parameters of the model and analyze the input-output data of the selected X company to obtain the corresponding average value of digital management efficiency.

(2) Malmquist index model

As the DEA model is a static analysis method, it can only analyze the benefits of a certain period. Therefore, this paper used the Malmquist index evaluation method to analyze the digital management efficiency of enterprises. It can be obtained:

$$N_0(a_{u+1}, b_{u+1}, a_u, b_u) = \sqrt{\frac{f_0^u(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)} \times \frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^{u+1}(a_u, b_u)}} \quad (4)$$

Among them, a_u, a_{u+1}, b_u, b_{u+1}, and f_0^u, f_0^{u+1} are input, output variables and distance functions at u and $u+1$, respectively. When the calculated value of Formula (4) is greater than 1, it indicates that the total output of the enterprise is increasing.

The total productivity of an enterprise can be divided into digital management efficiency and technological innovation. The digital management efficiency of an enterprise indicates whether the digital operation level of the enterprise has been optimized, and technological innovation determines whether the technological innovation is optimal [26,27]. The decomposition formula can be expressed as:

$$N_0(a_{u+1}, b_{u+1}, a_u, b_u) = \sqrt{\frac{f_0^u(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)} \times \frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^{u+1}(a_u, b_u)}} \times \frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)} \quad (5)$$

Digital management efficiency and technological innovation are $\frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)}$ and $\sqrt{\frac{f_0^u(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)} \times \frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^{u+1}(a_u, b_u)}}$, respectively.

The efficiency of digital management can be divided into two indicators: the change in digital management technology and the change in scale and capacity. The decomposition formula is as follows:

$$\frac{f_0^{u+1}(a_{u+1}, b_{u+1})}{f_0^u(a_u, b_u)} = \frac{f_0^{u+1}(a_{u+1}, b_{u+1}|C)}{f_0^u(a_u, b_u|C)} \times \frac{DR_0^{u+1}(a_{u+1}, b_{u+1})}{DR_0^u(a_u, b_u)} \quad (6)$$

Among them, digital management technology change and scale capacity change are $\frac{f_0^{u+1}(a_{u+1}, b_{u+1}|C)}{f_0^u(a_u, b_u|C)}$ and $\frac{DR_0^{u+1}(a_{u+1}, b_{u+1})}{DR_0^u(a_u, b_u)}$, respectively.

(3) Application of Tobit regression model

The Tobit model is derived from the Probit probabilistic model and is mainly applied to the terminal model at both ends [28]. The numerical value of the model is limited due to the existence of endpoints. The efficiency value of the digital model in this paper is 0-1, which meets the use conditions.

The panel model is as follows:

$$B_{ou} = \chi_0 + \chi_{1A_{ou}} + i_{ou} \quad (7)$$

Among them, B, χ_0, A, χ, i, o and u are, respectively, represented as, the explained, variable constant term explanatory, variable parameter, to be calculated, random, error term samples, and years.

In the economic development mode, the enterprise realizes the automation and intelligence of the production process by means of informatization, which makes the production efficiency and the utilization rate of enterprise resources become higher and higher, ultimately promoting the continuous improvement of enterprise market competitiveness. At the same time, it is also an important means to promote national modernization and achieve sustainable economic and social development. Therefore, digital transformation is an indispensable and important factor in the future development direction.

4. Management Efficiency Experiment of Enterprise Digitalization Based on Cloud Computing and Big Data

4.1. Case Introduction

In the United States, many businesses are leveraging cloud computing and big data to optimize digital management. Here is a specific case: Amazon is a prime example of leveraging cloud computing and big data to optimize digital management. As a global e-commerce and cloud computing giant, Amazon uses its own cloud computing platform

AmazonWebServices(AWS), and big data analytics capabilities to achieve efficient digital management and operations. Cloud computing: Amazon migrates an enterprise's digital management systems to the cloud through a powerful cloud computing infrastructure provided by AWS. This can significantly reduce IT infrastructure costs and provide highly scalable, flexible, and secure resources. Enterprises can flexibly adjust compute and storage capabilities based on actual needs to meet the growing demand for digital management. Data collection and storage: Amazon has accumulated vast data resources using its e-commerce business and cloud services platform. This data includes consumers' purchase history, behavioral data, and more. Amazon collects, collates, and stores this data to build a huge data lake and data warehouse. Companies can use this data to support digital management and make decisions. Data analytics and intelligent applications: Amazon uses big data technology and artificial intelligence algorithms to analyze massive amounts of data to extract valuable information and insights. For example, by analyzing consumers' purchase history and behavior data, Amazon can implement personalized recommendations, precision marketing, and supply chain optimization. These intelligent applications can improve the operational efficiency, customer satisfaction, and competitiveness of enterprises. Data security and privacy protection: Amazon focuses on data security and privacy protection in the digital management process. They take a number of measures to protect the security of data, including encryption, access control, and monitoring. At the same time, Amazon also complies with relevant privacy regulations to protect users' personal data and privacy. Through the application of cloud computing and big data, Amazon has realized the efficient operation and innovation of digital management, which provides a success story for other businesses.

4.2. Efficiency Characteristics of Digital Management of Chinese Enterprises

The operation efficiency of an enterprise refers to the reasonable allocation of various resources of the enterprise by the enterprise managers in a certain period of time to achieve the best operation efficiency. This can improve the enthusiasm and cohesion of employees, improve the production efficiency, operating efficiency, overall planning, and long-term development of the enterprise. Enterprise digital management is a kind of planned organization of various economic activities for enterprises to achieve their goals through reasonable organization of human, material, financial, and other resources.

This paper selected Chinese enterprises as the research object and compared them with German enterprises. Four main dimensions and 16 questions were used to measure the digital management efficiency of Chinese enterprises and a field questionnaire survey was conducted on Chinese enterprises, which was classified as a comprehensive survey of Chinese enterprises. The management effectiveness score of this questionnaire is 0–1. The closer to 1, the higher the enterprise's digital management efficiency is. The results are shown in Figure 3 (A: score of digital management efficiency, and B: proportion of inefficient enterprises; C: proportion of efficient enterprises):

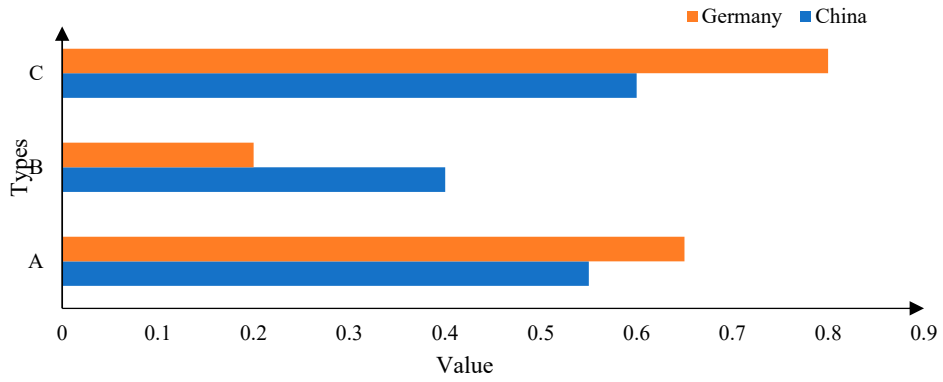

Figure 3. Digital management efficiency score and enterprise proportion of Chinese and German enterprises.

It can be seen from Figure 3 that the digital management efficiency score of Chinese enterprises was 0.55, while that of German enterprises was 0.65. High- and low-efficiency enterprises in China accounted for 60% and 40%, respectively, while high- and low-efficiency enterprises in Germany accounted for 80% and 20%, respectively. It showed that there is still some gap between the comprehensive score of digital management efficiency of Chinese enterprises and that of German enterprises, and the proportion of enterprises with high management efficiency is low, which should be noted.

From the perspective of enterprise attributes, different types of companies have differences in digital management efficiency. The detailed information is shown in Figure 4:

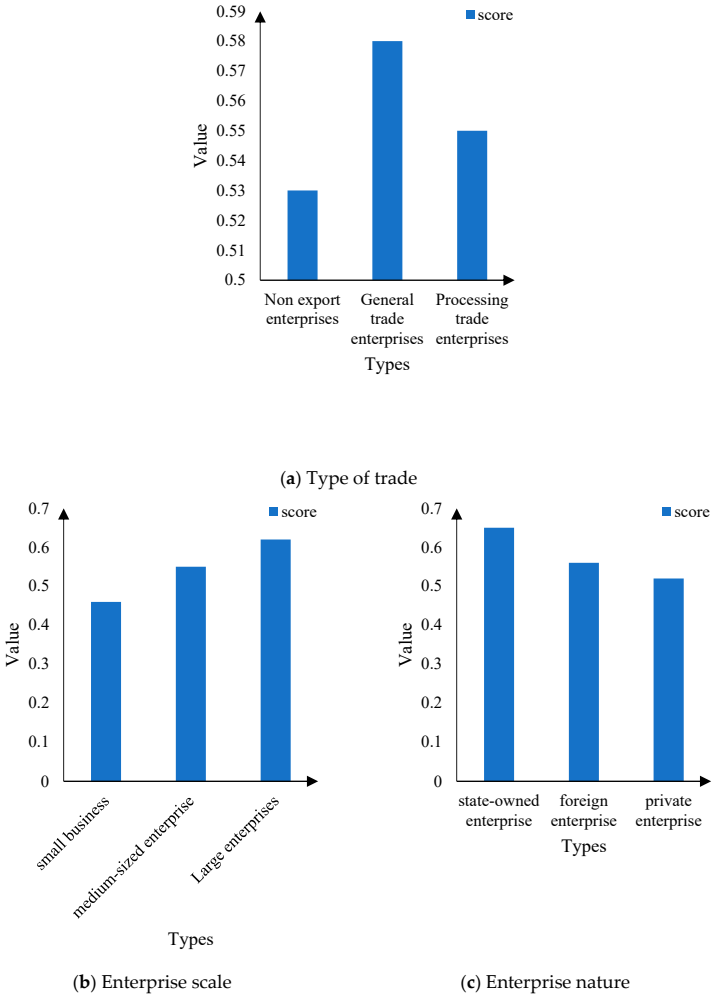

Figure 4. Scores of management efficiency of different types of enterprises in China.

From Figure 4a, it can be seen that general trade enterprises have the best performance, with a digital management efficiency score of 0.58. The second is processing trade enterprises with a score of 0.55, and the worst is non-export enterprises with a score of 0.53. From Figure 4b, it can be seen that in large enterprises, the efficiency of digital management is 0.62. In medium-sized enterprises, the efficiency of digital management is 0.55. In small enterprises, the efficiency of digital management is 0.46. From Figure 4c, it can be seen that the digital management efficiency of state-owned enterprises is significantly higher than that of private enterprises and foreign enterprises, ranking first with a score of 0.65. The digital management efficiency of foreign-funded enterprises ranks second with a score of 0.56. The efficiency of digital management in private enterprises ranked last with a score of 0.52. From Figure 4, it can be seen that from the perspective of trade types, there are also certain differences in the efficiency scores of digital management among enterprises of different trade types, but overall, it is not significant. From the perspective of enterprise

nature and scale, the digital management efficiency of state-owned and large enterprises is significantly higher than that of other enterprises, but only scored 6.5 points, indicating that the digital management efficiency of Chinese enterprises is relatively low.

In summary, Chinese state-owned enterprises have the highest score for digital management efficiency, but their score is only 0.65, which is still relatively low. Therefore, there is an urgent need for scientific methods to optimize the efficiency of digital management in enterprises.

4.3. History and Current Situation of Digital Management of X Company

(1) Profile of X Company

X Company is a large state-owned construction company that integrates transportation, equipment, production, consulting, engineering design, construction, management, and services. Company X is one of the Fortune 500. At present, X Company has more than 100 wholly owned or holding subsidiaries, operating for more than 150 years in more than 200 countries. Company X has formulated a corresponding plan, which is carried out in three phases, and the first phase is to reach the international first-class level by 2022. The second stage is to surpass all Chinese-related companies in 2027. The third stage is to become a world-class construction company in 2037. X Company began to implement digital management in early 2011 and optimized digital management based on cloud computing and big data in 2018, which has been used since then.

(2) Problems in Digital Management of X Company Before Optimization

As a large state-owned construction company, the business model of X Company tends to be the traditional business mode. The system reform and management innovation cannot be synchronized, which is not a suitable entrepreneurial environment and does not meet the requirements of digital construction and development. The digital architecture of an enterprise is a technological innovation, management innovation, and system innovation based on the company's strategy. The original management mode of X Company has become the main obstacle restricting its digital transformation. For the digital transformation of X Company and other construction units, it is necessary to establish a set of efficient and versatile systems, methods, procedures, and rules and regulations to collect and process relevant data, carry out digital transformation and improvement, and play the largest role.

Company X has achieved digitalization. However, like most domestic construction companies, it has not yet formed a complete modern enterprise system and lacks the necessary innovation impetus to promote enterprise digitalization. In addition, the digital construction of enterprises also inevitably requires business structure adjustment. The digital construction of enterprises is based on standardization, systematization, and scientization. Business restructuring and management regulation inevitably involve the readjustment of employees' rights and interests, while business restructuring is more difficult.

4.4. Suggestions on Optimization of Digital Management Efficiency of X Company for Cloud Computing and Big Data

After cloud computing and big data technology are widely used in enterprise digital management, enterprises can also make good use of these new technologies to innovate and manage their own businesses. Therefore, in-depth analysis and research on big data application capabilities and levels have become important content in the construction of enterprise digital management systems. In order to improve the application degree and level of big data technology in enterprises, enterprises should strengthen their own construction and technology research and development efforts. During big data development, cloud computing must be fully concerned and utilized to achieve reasonable resource allocation and effective utilization.

(1) Cloud computing improves enterprise operation and management efficiency

As a new technology, cloud computing is widely used in enterprise management, and can achieve reasonable resource allocation, efficient resource utilization, and cost

reduction. First of all, cloud computing can make good use of existing infrastructure and equipment resources to achieve cloud platform building and cloud resource monitoring and transmission mechanisms. For some large enterprises, this function can achieve three effects: improving business management requirements and business operation efficiency and reducing business costs. Secondly, the cloud platform can effectively manage the generation and circulation of information content in the process of enterprise operation and management. For example, through the information platform and some big data application service platforms in the cloud platform, the traditional offline entity services can be transformed into online services in the form and process to improve management efficiency and service level.

(2) Big data optimizes enterprise operation efficiency

The utilization of big data mainly includes data processing and analysis, which can further advance the efficiency of the operation and management of traditional enterprises. In the process of traditional enterprise management, there are many shortcomings, such as the internal decision-making process of enterprises has not been fully concerned. The utilization of big data technology can clearly increase the work productivity of all links. Meanwhile, the utilization of these data can also improve the attention of all posts to data processing. In the case of practical applications, the technology of big data can not only effectively control various costs and waste of resources, but also process and analyze large amounts of data. With the gradual growth of the enterprise's digital management system, enterprise operation becomes more standardized and scientific, thus bringing more opportunities for enterprises.

4.5. Impact of Cloud Computing and Big Data Optimization on X Company's Digital Management Efficiency

(1) Digital management efficiency from the perspective of management cost rate

Based on the management expense rate of 14.25% in 2013, this paper compared the digital management expense rate and growth rate of the four years before and after the optimization, and the results are shown in Figure 5 (data source: annual summary report of X Company):

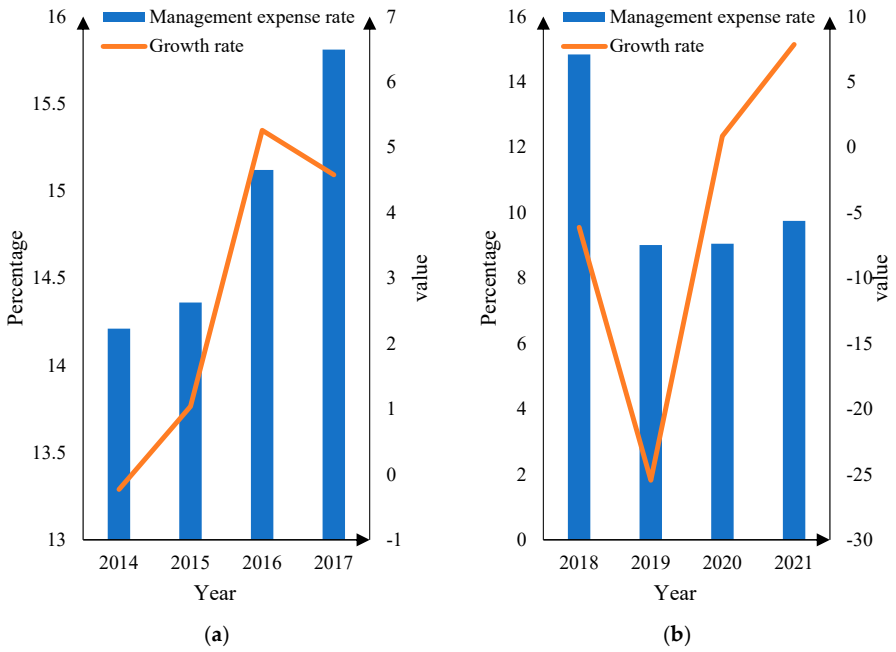

Figure 5. Digital management expense rate of X Company from 2014 to 2021. (**a**) Management expense rate before optimization; (**b**) Management expense rate after optimization.

It can be seen from Figure 5a that from 2014 to 2017, the company's digital management expense rate increased from 14.21% to 15.81%. From the perspective of growth rate, the growth rate from 2014 to 2017 was about 3% on average, indicating that X Company's management efficiency was quite low before optimization. With the passage of time and the expansion of production and operation scale, it became increasingly difficult for Company X to control the entire enterprise, and its management costs were higher and higher, accounting for a larger proportion of revenue. It can be seen from Figure 5b that the management expense rate in 2018 decreased by 6.12% compared with the same period last year; since 2018, the management expense rate of X Company decreased significantly, especially reaching 9.01% in 2019, a year-on-year decrease of 39.29%, which is very significant; in 2020 and 2021, the digital management expense rate was 9.05% and 9.75%, respectively. Although they increased, they were lower than 10%. It can be seen from Figure 5 that the optimization method of X Company based on cloud computing and big data has achieved remarkable results in improving the digital management efficiency of enterprises. It preliminarily showed that cloud computing and big data can optimize the efficiency of enterprises in digital management.

(2) Digital management efficiency from the perspective of employee education

The higher the education level of employees, the higher the relevant technology and quality they have mastered. Through digital training for employees, their work efficiency can be better improved, which is conducive to more convenient digital management of employees in enterprises, so that the information transmission and feedback mechanism of enterprises can be more effective, and the overall efficiency of digital management of enterprises can be optimized. Therefore, this paper analyzed the optimized employee education from 2018 to 2021, and the results are shown in Figure 6:

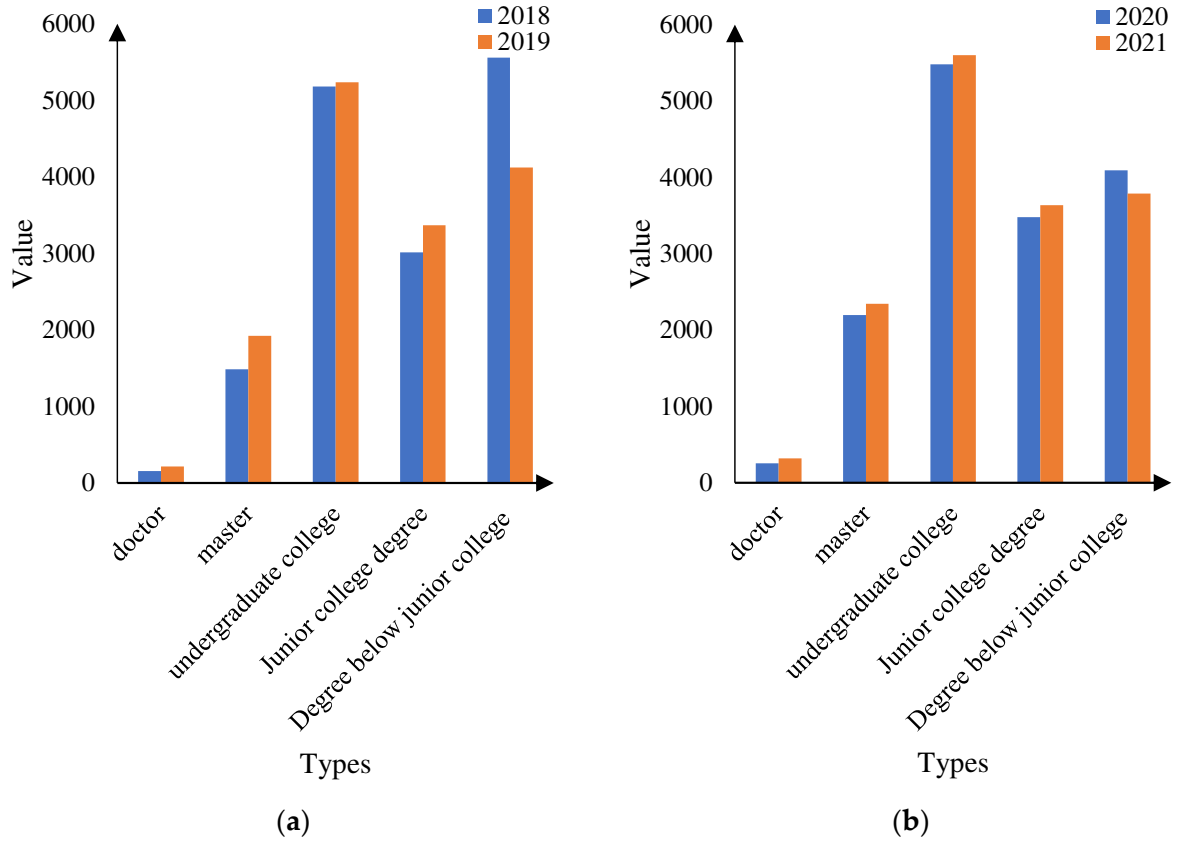

Figure 6. Changes in employees' educational level from 2018 to 2021. (**a**) Education background of employees from 2018 to 2019. (**b**) Education background of employees from 2020 to 2021.

It can be seen from Figure 6a that in 2018 and 2019, the number of employees with doctor's degrees, master's degrees, undergraduate degrees, junior college degrees, and degrees below junior college was 155, 1485, 5178, 3011, 5555 and 215, 1921, 5234, 3367, 4123, respectively. It can be seen from Figure 6b that in 2020 and 2021, the number of employees with doctor's degrees, master's degrees, undergraduate degrees, junior college degrees, and degrees below junior college was 255, 2198, 5478, 3478, 4091 and 321, 2345, 5601, 3636, 3789, respectively. It can be seen from Figure 6 that only the number of employees below the college level decreased, while the number of employees with other degrees increased, which further indicates that cloud computing and big data are conducive to optimizing the digital management efficiency of enterprises.

4.6. Employee Satisfaction with X Company's Digital Management Efficiency

A total of 300 questionnaires were prepared in this paper, including 100 for managers and 200 for basic personnel. All questionnaires were collected, and no unqualified questionnaires were found. The questionnaire focused on the statistics of employees' satisfaction with the digital management efficiency of X Company. The results are shown in Figure 7:

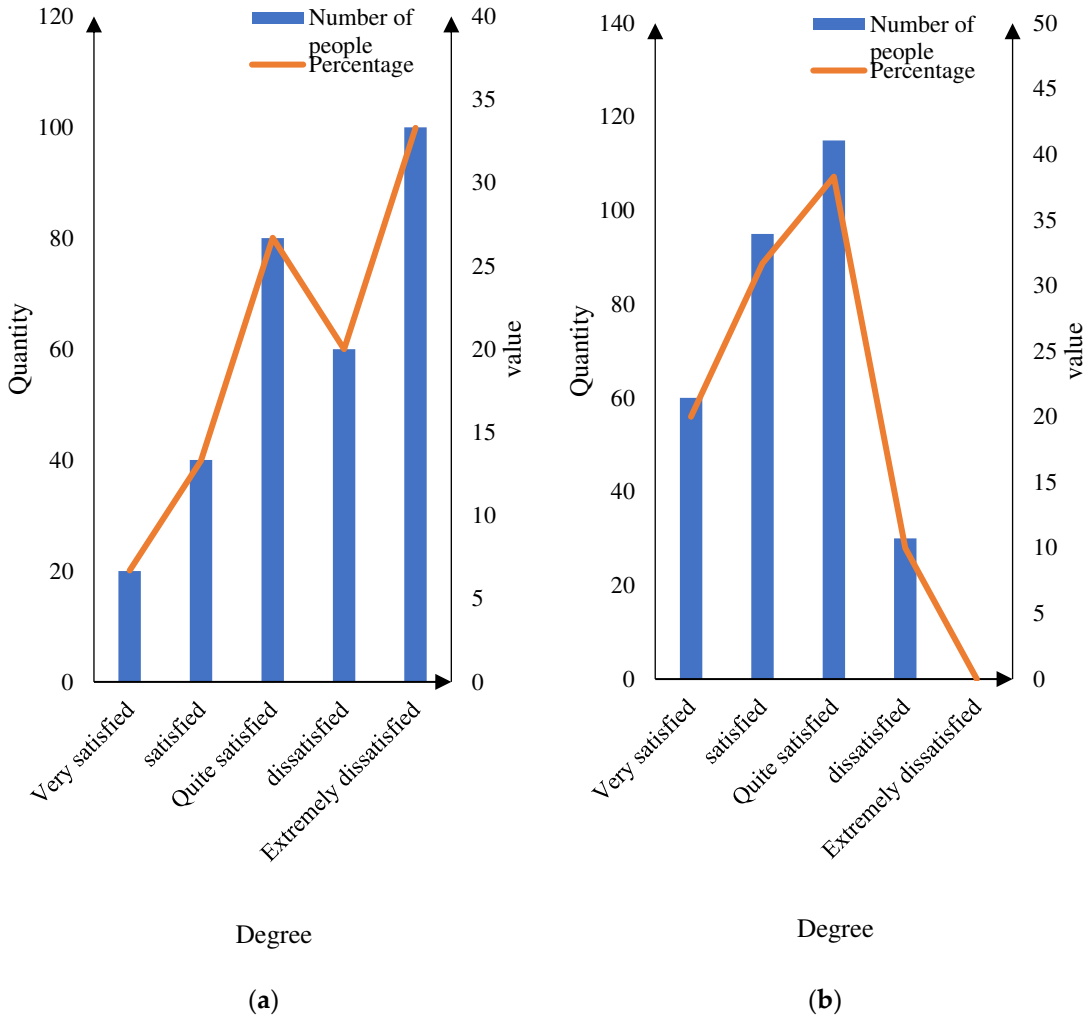

Figure 7. Employee satisfaction with enterprise digital management efficiency before and after optimization. (**a**) Satisfaction before optimization; (**b**) Satisfaction after optimization.

It can be seen from Figure 7a that for the enterprise's digital management efficiency before optimization, the number of highly satisfied employees was 20, accounting for 6.7%; the number of satisfied employees was 40, accounting for 13.3%; the number of relatively satisfied employees was 80, accounting for 26.7%; the number of dissatisfied employees

was 60, accounting for 20%, and the number of highly dissatisfied employees was 100, accounting for 33.3%. It can be seen from Figure 7b that for the optimized enterprise digital management efficiency, the number of highly satisfied employees was 60, accounting for 20%; the number of satisfied employees was 95, accounting for 31.7%; the number of relatively satisfied employees was 115, accounting for 38.3%; the number of dissatisfied employees was 30, accounting for 10%, and there were no very dissatisfied employees. It can be seen from Figure 7 that 140 people agreed with the enterprise digital management efficiency before optimization, accounting for 46.7%; 160 people disagreed, accounting for 53.3%; 270 people agreed with the optimized enterprise digital management efficiency, accounting for 90%; 30 people disagreed, accounting for 10%. It showed that employees have a high degree of approval for the optimized digital management efficiency, proving that cloud computing and big data are effective in optimizing the enterprise's digital management efficiency.

5. Conclusions

5.1. Main Results

The application of cloud computing technology can help enterprises realize the elastic allocation and efficient utilization of resources. With the powerful computing and storage capabilities provided by cloud service providers, enterprises can rapidly expand or reduce computing resources according to requirements, thereby achieving reasonable cost control and improving response speed. Big data technologies can help organizations collect, store, and analyze large amounts of structured and unstructured data. Through technologies such as data mining and machine learning, companies can discover valuable information hidden in massive data and turn it into insight and decision support, thus enabling the refinement and personalization of strategy formulation. Digital management can automate and optimize business processes and promote information sharing and collaborative work. With digital tools and systems, there can be seamless collaboration between departments and employees within an enterprise, increasing work efficiency and productivity.

5.2. Theoretical Significance

The theoretical significance of this paper is that it theoretically verifies the positive impact of cloud computing and big data on the efficiency of enterprise digital management. The influence mechanism of cloud computing and big data technology on enterprise management mode, organizational change, and strategy formulation is discussed. Some concepts and frameworks, such as resource elastic allocation, data-driven decision-making, and digital collaboration, are established, which provide new perspectives and methods for research in related fields.

5.3. Actual Impact

The findings have important practical implications for the following entities: Enterprises: By applying cloud computing and big data technologies, enterprises can improve the efficiency of digital management, optimize business processes, and innovate business models. At the same time, IT reduces the cost and complexity of IT infrastructure and improves the competitiveness and sustainable development ability of enterprises. University: The research results can provide guidance for teaching and research in related majors, cultivate professionals with a background in cloud computing and big data, and meet society's demand for digital management capabilities. Government/Policy: Governments can leverage research findings to promote the widespread use of cloud computing and big data in business management. At the same time, relevant policies and regulations should be formulated to guide and support the digital transformation and innovative development of enterprises and promote high-quality economic growth. Social: The application of cloud computing and big data technology enables enterprises to better meet the needs of society and provide more efficient and convenient products and services. In addition, it

has promoted the development of the digital economy and promoted the information and intelligent processes of society.

5.4. Limitations and Future Investigation Directions

This paper has the following limitations and needs further exploration: Since this paper does not cover all industries and enterprise scales, the sample scope can be further expanded in the future to further study the efficiency of digital management in different industries and enterprise backgrounds. Further research on the application of cloud computing and big data in enterprise risk management, innovation management, and organizational change processes to fully reveal their impact mechanism on enterprise management is needed. Interdisciplinary cooperation is an important direction of future research, and the integration of cloud computing, big data, artificial intelligence, the Internet of Things, and other technologies and disciplines will further improve the efficiency of enterprise digital management. We recognize the importance of cloud computing and big data in the efficiency of enterprise digital management and point out its significance and potential impact in practice. These findings provide important theoretical and empirical support for academic research and practical work in related fields, further promote the development of science and technology, and have a positive impact on businesses, universities, governments, and society.

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