THE APPLICATION OF BIG DATA TECHNOLOGY IN THE PREDICTIVE ANALYSIS OF ENTERPRISE CAPITAL OPERATION RISK

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ABSTRACT

The background of the big data era makes enterprise tax management face many opportunities and challenges, in order to improve the management of enterprise capital operation risks and promote the enterprise to take the road of sustainable development. This paper firstly indexes risk names with the help of web crawler technology, establishes data sources, and then circulates the crawler to obtain the required information. Secondly, a hashing algorithm is applied to compress the massive data into a unique and extremely compact section of hash values by means of constant mapping. Then association rules are used to determine the set of frequent risk items, and the values of the two are continuously changed to derive the final predictive analysis. Finally, a capital operation risk prediction and analysis platform is built by combining the above processes. In this paper, the effectiveness of the proposed platform is verified, and the practical results show that the accuracy of the proposed platform for risk prediction discovery is as high as 97%, and the time spent for risk discovery is controlled within 30 minutes. The relevant data results verify that big data technology improves the accuracy of enterprise capital operation risk prediction and analysis while accelerating the speed of risk discovery.

KEYWORDS

Web crawler; hashing algorithm; hash value; association rule; frequent risk item set.

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1. INTRODUCTION

Under the premise of continuous development of the economic market, enterprises must continuously expand their own business scope as well as business scale and management mode in order to gain a foothold in the market competition [1]. Therefore, enterprises often use capital operation to promote the efficient operation of capital and lay the foundation for the improvement of enterprise efficiency. The opportunities and risks faced by enterprises in capital operation are increased due to the influence of internal and external environment [2-4]. Therefore, it is necessary to study how to prevent the risk of enterprise capital operation and countermeasures.

Corporate capital operations have long been a hot topic of research in the industry [5-6]. The literature [7] states that firms with high social capital exhibit higher levels of risk-seeking behavior. Moreover, the relevant actions of firms lead to greater volatility in stock returns and earnings. Thus, it is clear that firms should conduct capital operations to generate returns while preventing risks from causing greater losses. The literature [8] constructs a minimum risk versus capital and risk diversification strategy for investment portfolios, taking into account the most frequent capital risks in various industries today. Risky capital is placed separately from risk-free capital, so that the benefit obtained is a weighted average of risk-free assets, while the risk is not a weighted average of risky assets, spreading the capital risk. The literature [9] used Bayesian network models in big data technology to calculate the risk of water pollution and assess the impact of contaminants in water, which identified the critical causes and thus the risk of adverse accidents. A new model for risk assessment was proposed in the literature [10]. Preliminary estimates are made with the help of reference scenario prediction methods and optimistic bias enhancement is performed. Uncertainties are introduced in the cost-benefit analysis. Thereafter, a quantitative risk analysis is provided using Monte Carlo simulation. Although the above-mentioned literature proposes a series of new methods for risk prediction, the proposed methods do not fully take into account the large size of the risk data, the data storage system is more settled, and the analysis of the data is not thorough enough, and the conclusions obtained are not representative.

Therefore, this paper builds an enterprise capital operation risk prediction and analysis platform based on big data technology. Firstly, with the help of the web crawler technology in big data collection technology, the capital operation risk is indexed and relevant data is obtained through continuous cyclic crawling. Secondly, the hash algorithm in big data storage technology is used to compress the massive data into unique and extremely compact hash values, and then realize the storage of massive data. Finally, the set of frequently occurring risk items is determined by using the confidence and support degrees in the association rules, and the values of both are continuously adjusted to derive the final capital operation risk prediction analysis data. In order to verify the effectiveness of the enterprise capital operation risk prediction and analysis platform built based on big data technology, this paper analyzes the accuracy and time required for enterprise capital operation risk prediction and analysis in the simulation experiment and verifies that the enterprise

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capital operation risk prediction and analysis can be achieved quickly and accurately based on big data technology.

2. CORPORATE CAPITAL OPERATION

2.1. CAPITAL OPERATION

Capital operation as a business concept has a long history and has been developed and perfected with the formation of a commodity economy and market economy. Capital operation is becoming an important way for enterprises to enhance economic efficiency and realize self-value appreciation. By capital operation, it means that the enterprise operator takes all the tangible or intangible assets and production factors owned by the enterprise, through flow, fission, combination, optimal allocation and effective operation in various ways, to gather a large amount of capital in a short period of time, and make the capital increase rapidly through capital expansion, in order to achieve the maximum capital appreciation [11-12]. The process of capital operation is also the concrete implementation process of capital management strategy and capital movement.

The various aspects of capital operation are interlocked to form a closed loop. Capital operation requires an all-around control of financing, investment and assets, etc. The object of capital operation is property rights in the form of stock assets, or physical capital that can be operated according to securitization and valuation, and is a capital-oriented enterprise operation mechanism. The capital operation usually leads to a transfer of ownership or a significant change in the original shareholder structure. The core issue of capital operation is how to optimize the structure of production factors to improve the efficiency of capital operation, which includes the optimization of resource allocation structure, the optimization of industrial capital, financial capital and property rights capital structure, the optimization of speculative capital and incremental capital and the optimization of capital operation process.

However, capital operation is a risky economic activity, which can bring great risks to the enterprise while bringing rapid development opportunities to the enterprise.

2.2. CAPITAL OPERATION RISK

Capital operation risk refers to the possibility of failure of capital operation or failure of capital operation activities to achieve the expected goals and losses due to the complexity and variability of the external environment and the limited cognitive ability of the capital operation subject in the process of capital operation. In simple terms, capital operation risk refers to the possible loss of the enterprise due to the occurrence of unfavorable events in the process of capital operation, which is mainly caused by the uncertainty of the environment.

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According to the definition of capital operation risk, it can be seen that the direct bearer of capital operation risk is the capital operation subject, i.e., the capital operation enterprise rather than the owner of the capital, although it also brings losses to the owner of the capital. Capital operation risk mainly comes from the complexity and variability of the environment, i.e. the uncertainty of the environment. The relatively limited cognitive ability of the capital operation subject to the environment is also an important factor leading to the capital operation risk. There are two consequences of capital operation risk: failure of capital operation and failure of capital operation activities to achieve expected goals. Failure of capital operation refers to the suspension of capital operation activities, while failure of capital operation activities to achieve the expected goal means that the capital operation activities are successful but do not achieve the desired efficiency. For example, the merging firm is forced to terminate the merger due to the anti-merger resistance of the merged firm.

In general, enterprise capital operation risk mainly contains the following aspects, namely, operational risk, information risk, management risk, legal and regulatory risk, etc.

Business risk refers to the occurrence of business risk due to the lack of comprehensive understanding of market information in the actual management process and the lack of countermeasures for problems in internal management, which creates problems in the operation process and thus affects the normal operation of the enterprise [13-14]. Financial risk, on the other hand, refers to the fact that enterprises do not have scientific planning for financial management work, the use of funds is more arbitrary, and operational risks are increasing, which leads to financial risk [15]. In the context of the information age, the processing of market information by enterprises is not scientific and reasonable enough, which leads to the phenomenon of information asymmetry and adversely affects the business decisions of enterprises. As enterprises are subject to state regulation of capital operation, the phenomenon of inefficient operation and unreasonable setting of capital structure still exists in the actual operation of enterprises. In addition for the internal management of enterprises, the deviation of management concept and the mistake of operation within the enterprises can cause management risks. In addition, capital operations in other countries can also spill over into the development of developing economies [16]. The development of the market economy must be based on the relevant national laws and regulations, and the macroeconomic regulation of the state will be adjusted, which will have a certain impact on the M&A behavior of enterprises, thus making the operating costs of enterprises higher.

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2.3. CHARACTERISTICS OF CAPITAL OPERATION RISK

2.3.1. OBJECTIVITY OF CAPITAL OPERATION RISK

Objectivity is the essential characteristic of capital risk, as can be seen from the definition of capital risk. Like all other risks, capital risks do not exist at the will of the operator. It exists objectively regardless of whether the operator acknowledges it or not, or whether he is aware of it or not. Capital operation risk exists not only in the preparation stage and the operation stage of capital operation but also in the commodity operation stage after capital operation.

2.3.2. VARIABILITY OF CAPITAL OPERATING RISKS

Capital operation risk can change under certain conditions. The probability of occurrence, the degree of impact, and even the scope of impact of capital operation risks are different in each period and each link of capital operation and under various conditions. This requires the capital operating entity to make full use of various methods and means to identify and prevent risks in the process of capital operation risk prevention.

2.3.3. PREDICTABILITY OF CAPITAL OPERATION RISK

Although capital operating risks are variable highly contingent and uncertain, capital operating risks can also be identified and predicted. While the occurrence of a single risk may be contingent and uncertain, the occurrence of a large number of risks is inevitable. In fact, the occurrence of risks before, during, and after the operation of capital operation will have certain characteristics. As long as the capital operation subject of the enterprise can capture such information, it is possible to detect the risks in time and prevent and avoid them early through prediction and analysis. However, in order to accurately anticipate risks and take effective preventive measures, it is necessary for capital operators to have risk awareness and accumulate experience in identifying and preventing risks.

Thus, it is very necessary to study and explore the risk of capital operation. In the new development period, enterprises should establish capital operation risk early warning mechanisms based on national and industry norms, based on laws and regulations, based on their own capital operation needs, etc., and use the early warning mechanism to timely discover, identify prevent, and control all kinds of risks in the process of capital operation, so as to fundamentally improve the security of capital operation. However, the current era is the information age, and big data technology has become the core weapon of each enterprise, which will play an important role in the transformation and development of enterprises and risk prevention and control. Therefore, enterprises wanting to conduct risk prediction and analysis of capital operations need to rely on big data technology.

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3. RISK PREDICTION UNDER BIG DATA TECHNOLOGY

Big data technology refers to a new type of information processing technology in which people and objects upload data between them through a third-party medium, the computer, and the computer categorizes, fuses, and processes the data uploaded into the network. The strategic significance of Big Data technology does not lie in the mastery of huge data information but in the specialized processing of these data containing meaning [17-19]. In other words, if big data is compared to industry, the key to the profitability of this industry lies in improving the processing capability of the data and realizing the value-added and prediction of the data through processing.

3.1. DATA ACQUISITION

Data acquisition is data mining, i.e., extracting high-value data information from inside massive data resources, and is an important method used to obtain association rule attributes to filter data. Data acquisition belongs to a decision support process, mainly based on artificial intelligence, machine learning, and pattern recognition, and can also interact with users or knowledge bases. The mining object is also not limited to a certain type of data source but can be a relational database, data warehouse, text, multimedia data, and other data sources containing semi-structured data or even heterogeneous data [20]. More common is the web crawler technique.

Web crawler technology is a technology based on the Internet that automatically crawls a specific web page. Its implementation mechanism is similar to the human click operation on web pages, and it can complete the interaction between the client and the server without human intervention to achieve automatic, accurate, and large-scale extraction of web data. According to the different crawling tasks, web crawlers can be classified into various types such as general-purpose, focused, priority, incremental, deep, etc. Meanwhile, users can also build custom web crawlers according to their actual needs.

Web crawler technology is used to collect information related to enterprise capital operation risk, the specific steps are as follows:

Firstly, collect data requirements according to predefined. Establish the data source website with the name of enterprise capital operation risk as the index. Use web crawler technology to crawl enterprise basic data and related information, such as national enterprise credit system, judicial system, Tian-eye search, enterprise search, Qixinbao, etc., focusing on asset data, trademark data, public litigation data, public opinion data and deep mining and crawling of enterprise relationship.

Next, the seed initialization crawler is constructed. Using the name data of existing corporate capital operation risks, we construct the initialization crawler based on the characteristics of each website. Then, we obtain the source documents of the web pages. The source document of the web page is parsed and the required text content is stored in the database, or the required data is extracted and put into the queue to

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be crawled and then entered into the cycle of crawling. Finally, the data obtained by the crawler is stored in the database.

3.2. DATA STORAGE

At this stage, the most commonly used system for data storage is a distributed electromechanical system. Distributed electromechanical systems can store massive amounts of data on multiple spatial and temporal scales. However, as the service time of the equipment becomes longer, the amount of data for remote monitoring of distributed electromechanical systems grows exponentially. At this time, the use of distributed storage systems for data storage may suffer from load-balancing imbalance. The use of a hashing algorithm can achieve distributed data storage with minimal and stable system changes, as shown in Figure 1.

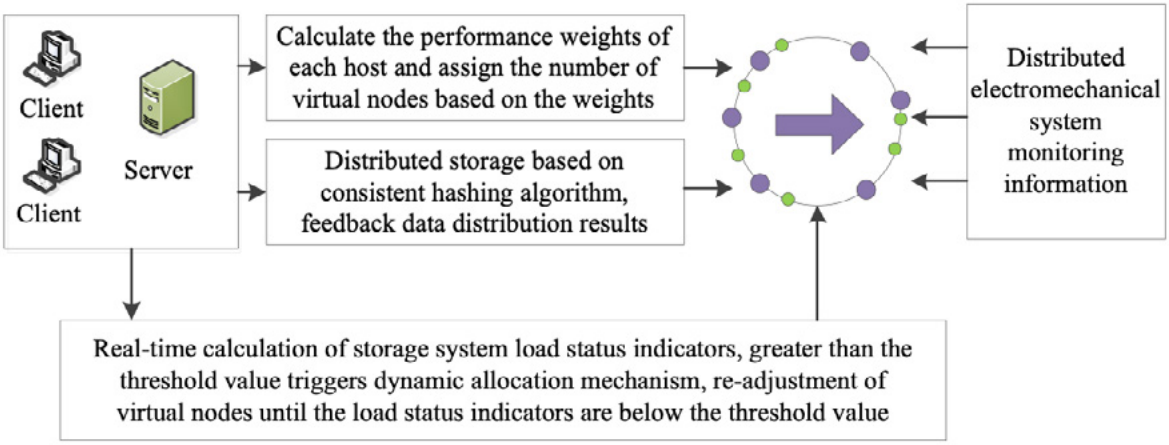

Figure 1. Distributed storage under hash algorithm

As can be seen in Figure 1, using hashing algorithms to store enterprise capital operation risk data, the entire risk data storage space can be abstracted as a ring of fixed length, and then storage nodes are assigned to this ring. In this way, the nodes on the ring all have a fixed hash value, and this ring is called a hash ring. The same hashing algorithm is used to find out the hash value of the keys of the stored data and they are mapped on the same hash ring as well. Finally, the storage node is found clockwise from the position of the data mapping, and the data is stored on the first found storage node. In this way, the enterprise capital operation data information becomes a unique and extremely compact hash value of the data, which facilitates the storage of information.

3.3. ASSOCIATION RULE PREDICTION ANALYSIS

In order to efficiently predict the risk of capital operations, we need to process and analyze the large amount of data generated during capital operations. Eighty percent of the data generated during capital operations is unstructured and grows exponentially by 60% every year. This corresponds to the data processed by big data

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technology. There are three main categories of data processed by Big Data technology, namely structured data, semi-structured data, and unstructured data, and unstructured data is becoming a major part of data.

In big data processing and analysis, correlation analysis is one of the simplest and most practical analysis techniques, which can be used to better handle unstructured data and generate frequent patterns and correlation models at the same time. The so-called association reflects that an event is dependent or related to other events to some extent and can be predicted according to the relevant rules. Association rules are a widely used pattern recognition method, which can be applied to enterprise capital operation risk prediction to effectively identify the risk factors involved.

Let the possible risks in the capital operation of an enterprise be set, and each risk in it can be regarded as a subset. Each risk subset and the whole risk set are logically implicitly related. If the probability of two risk subsets appearing simultaneously in the whole association rule is small, it is proved that the relationship between the two risks themselves is not significant. If the probability of the simultaneous occurrence of two risk subsets is very frequent, it indicates that the two risk subsets are related to each other, and this probability of simultaneous occurrence can also be called support. The probability of two risk subsets occurring simultaneously is the confidence level, and when the confidence level is 100%, then the two risk subsets are proved to be relational and intimate. When one of the risk subsets appears, the other risk subset also appears in a bundle.

The risk dataset stored by the hashing algorithm is used as input data, and the frequent item set is obtained by setting the minimum support, and then the next process proceeds. According to the confidence threshold, the strong association rules that meet the requirements are inferred from the results generated in the previous step and are aggregated and verified, and the whole mining process is finished. In the process, we can set different parameters to guide the mining process according to the actual needs, and the final results of risk prediction analysis factors are derived by continuously changing the values of both.

3.4. PREDICTIVE ANALYTICS BUILDING PLATFORM

Using the web crawler technology, hash algorithm, and association rule analysis in big data technology, we can achieve optimization in the accuracy and analysis speed of risk prediction, and better improve the process and results of capital operation risk prediction analysis. Accordingly, this paper builds an enterprise capital operation risk prediction and analysis platform based on the above algorithms, as shown in Figure 2.

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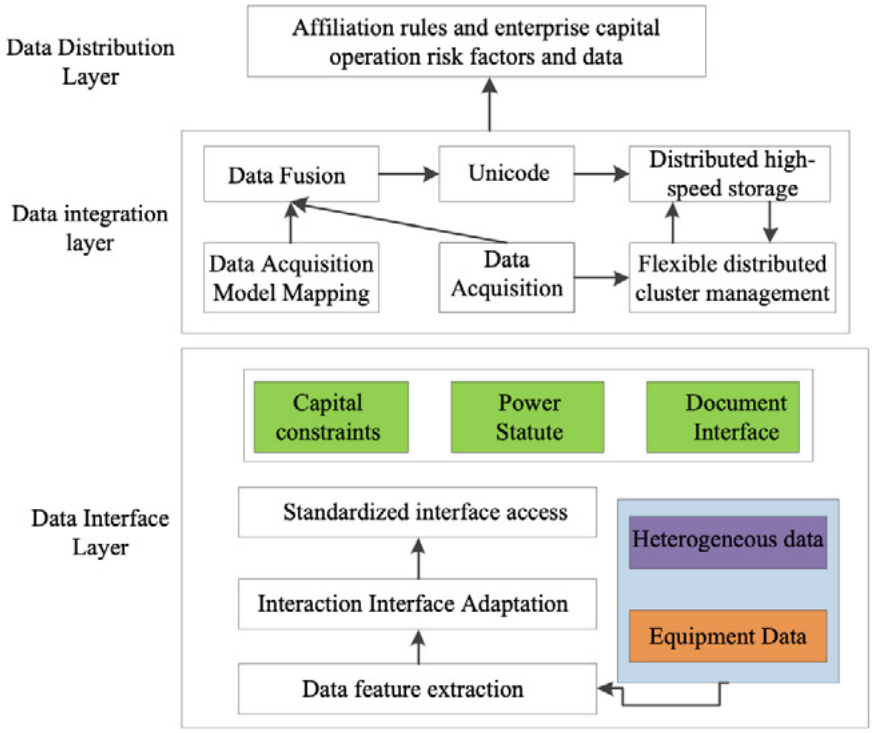

Figure 2. Enterprise capital operation risk prediction and analysis platform

As can be seen from Figure 2, the built enterprise capital operation risk prediction and analysis platform includes three modules: data interface layer, data integration layer, and data distribution layer. The data collected in the major platforms by relying on web crawler technology are input to the data interface layer and feature extraction of the data to extract high-risk data. Through the interface with the data integration layer, the high-risk data is connected to the data integration layer. In the data integration layer, the hash value of the keys of the stored data is derived by the hashing algorithm and mapped on the same hash ring. Finally, the storage node is looked up clockwise from the location of the data mapping, and the data is stored on the first found storage node. The data and hash ring are uniformly encoded to achieve distributed high-speed storage and flexible management of data. Finally, the stored data are analyzed by correlation rules to derive the most likely operational risks of the final enterprise when conducting capital operations. The platform has powerful data storage and processing capabilities in all aspects, which can effectively alleviate the problem of information asymmetry.

4. APPLICATION OF ENTERPRISE CAPITAL OPERATION RISK PREDICTION ANALYSIS

4.1. INCREASED ACCURACY OF PREDICTIVE ANALYSIS

The most fundamental purpose of applying big data technology to enterprise capital operation risk prediction and analysis is to improve the accuracy of enterprise capital operation risk prediction and analysis. Accordingly, in this paper, the platform was put

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into use in 10 companies in a city, denoted by letters A, B, C, D, E, F, G, H, I and J, to compare the predictive analysis accuracy of the 10 companies before and after using the platform. The results obtained under the same conditions are shown in Figure 3.

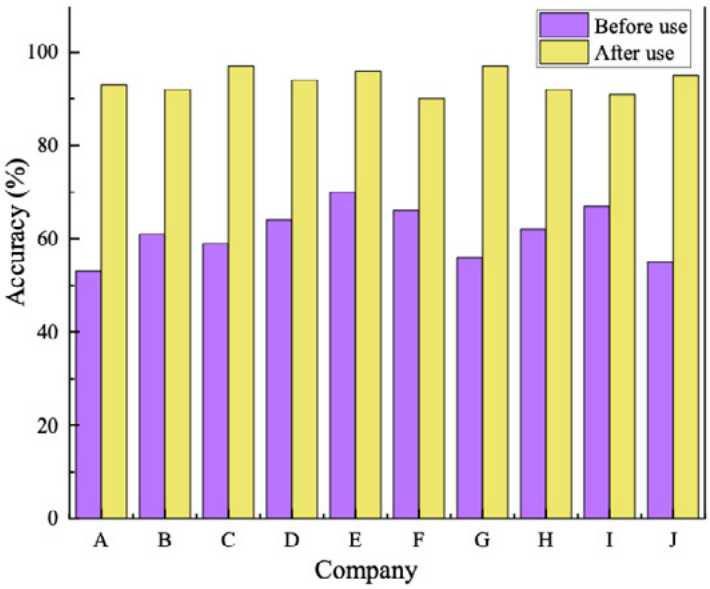

Figure 3. Comparison of accuracy rates of sample companies

As can be seen in Figure 3, before the use of big data technology, the accuracy of capital operation risk prediction analysis of Company A was only 53%, and after the use of Company A, the accuracy of capital operation risk prediction of Company A has increased by 40% to 93%. Company B's capital operation risk prediction accuracy increased from 61% to 91%, an increase of 31%. Both Company C's risk forecast accuracy and Company G's risk forecast accuracy peaked at 97%, an increase of 38% and 41%, respectively, from the previous levels. Before using the built platform in this paper, the risk prediction analysis accuracy of Company D was only 64%, while after using the built platform, the accuracy rate was 94%. Before applying the built platform to the whole process of capital operation, Company E had the highest accuracy rate of 70% in the risk prediction analysis of enterprise capital operation. Company F's risk prediction accuracy rate also improved significantly, lower than other companies, but also increased by 24% compared with that before. Company H and Company I improved their risk forecasting accuracy by 30% and 24%, respectively, compared to their pre-platform performance. Company J had the lowest risk prediction accuracy of 55%, but after applying the built platform, it improved to 95%, ranking third.

It can be seen that the introduction of big data technology in enterprise capital operation risk prediction and analysis has achieved a significant increase in the accuracy of enterprise capital operation risk prediction and analysis, which can help enterprises reduce unnecessary waste of resources and recover a lot of unnecessary losses.

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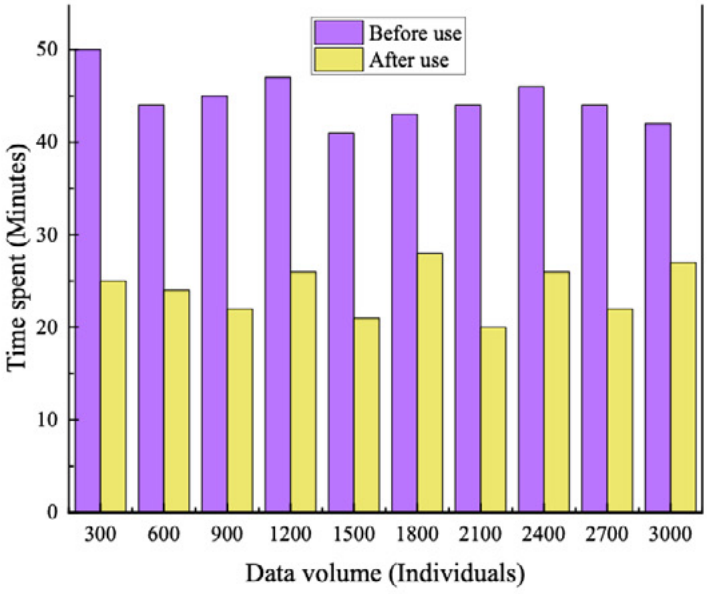
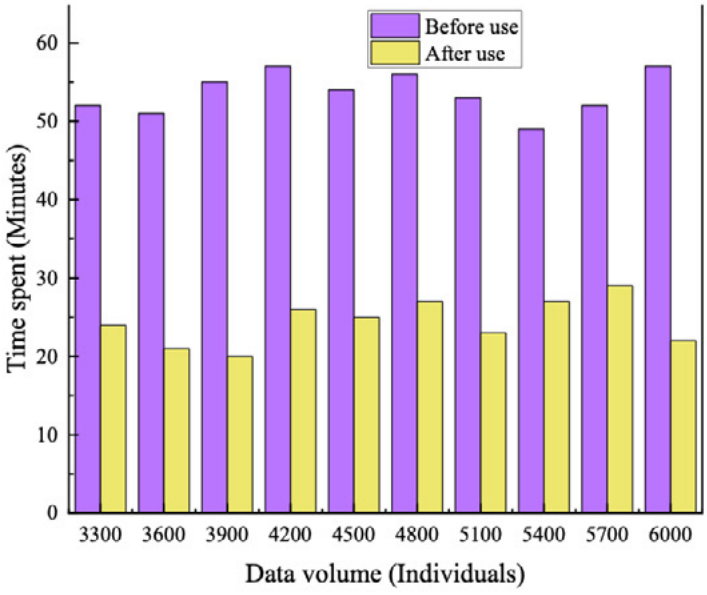
4.2. INCREASED SPEED OF PREDICTIVE ANALYSIS

Enterprise capital operation risks often occur in a split second, while the losses caused by the risks are infinite. The improvement of the speed of risk prediction and analysis is also based on big data technology in building prediction and analysis platforms needs to be considered. The speed of analysis should not decrease with the increase in the amount of information such as data. To verify the analysis speed of the platform built in this paper, 3,000 data, and 6,000 data were input into the platform to derive the platform risk prediction time and compare it with the time required before the enterprise uses the built platform, and the results are shown in Figure 4.



(a) Time required to analyze 3000 data



(b) Time required to analyze 6000 data

Figure 4. Time required to analyze the predicted risk of corporate capital operations

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As you can see in Figure 4(a), before using the platform, it took 50 minutes for companies to identify capital operation risks when analyzing data of up to 300. However, after using the platform, it only takes 25 minutes to identify potential capital operation risks, which is one-half of the time saved. When the data reached 600, the built platform took only 24 minutes to identify risks, a reduction of 20 minutes from the previous 44 minutes. When analyzing 900 pieces of data, it took 45 minutes to identify risks before the enterprise used the platform, while after the application, risk discovery took less than half the time. When the data was 1200, the time for risk discovery was reduced by 21 minutes compared to the original. When the number of data is 1500, the risk discovery time is reduced by 20 minutes. When the data reached 1,800, the built platform took only 28 minutes to discover the risk, a reduction of 15 minutes from the previous 43 minutes. As the data increased, the platform still took less time to discover risks than it did before use. When the data was 3000, the time for risk discovery was reduced by 15 minutes from the previous 42 minutes to only 27 minutes.

As can be seen in Figure 4(b), the risk analysis speed of the platform built in this paper remains at a high level as the data volume increases. When the data volume reaches 3300, the time taken by the built platform drops by 28 minutes. When the data volume was 3600, the time for the platform to discover risks was 21 minutes, which was 30 minutes less than before using the platform. Before using the platform, it took 55 minutes to discover capital operation risks when analyzing 3900 data. However, using the platform, companies can identify potential risks to capital operations in just 20 minutes, saving nearly one-third of the time previously. When analyzing 4,200 pieces of data, it took 57 minutes to identify the risk, but with the platform, it took only half the time to identify the risk with 5 minutes remaining. When the data reaches 4,500 to 5,700, the platform takes up to 27 minutes to identify potential risks, compared to a minimum of 49 minutes before use, a reduction of 22 minutes. When the data volume is as high as 6,000, the platform takes only 22 hours to discover risks, nearly a quarter of the time it took for the original enterprise.

By comparing the time spent on the same amount of data, it can be found that the time required for the capital operation risk prediction and analysis platform based on big data technology is controlled within 30 minutes, with a minimum of 20 minutes. With the increase of data and other information, the prediction and analysis accuracy rate can still be maintained at a high level. Thus, the application of big data technology to the prediction and analysis of enterprise capital operation risk is helpful to help enterprises quickly identify the existence of risks, and then take timely measures before the occurrence of risks, so that losses can be controlled within affordable limits.

5. CONCLUSION

In order to promote the benign development of enterprise capital operation, this paper uses web crawling technology to index the enterprise capital operation risk and

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then obtain the required data through cyclic crawling. Using a hashing algorithm, the relevant numbers of the massive enterprise capital operation risks are compressed through constant mapping, so that the massive data can be stored effectively. The frequent risk items are identified through association rules to derive the final capital operation risk prediction analysis data. Finally, an enterprise capital operation risk prediction and analysis platform is built based on the above big data technology. The accuracy of the built predictive analytics platform is 97%, and the risk prediction time is as low as 20 minutes and does not decrease as the amount of information increases. From the accuracy and speed of risk prediction analysis, it can be seen that the enterprise capital operation risk prediction analysis can be well achieved by relying on big data technology.

REFERENCES

(1) Прешкин, Г., Мехренцев, А., et al. (2019). Formation of forest management in conditions of digital market economy development. Forestry Engineering Journal, 9(1), 211-223.

(2) Abramov, R. A. (2016). To the problem of evaluation of the role of state in the process of market economy development. (páginas 59-63).

(3) Zheng, W., Ma, K., & Wang, X. (2015). TE-Shave: Reducing Data Center Capital and Operating Expenses with Thermal Energy Storage. IEEE Transactions on Computers, 64(11), 3278-3292.

(4) Xiao, J. H., Lee, S. J., Liu, B. L., et al. (2018). Capital Operations in China's Logistics Industry. En Contemporary Logistics in China (Capítulo 8, páginas 161-180). doi: 10.1007/978-981-13-0071-4

(5) Passador, M. L. (2015). Crowdfunding: among Suitability and Appropriateness Rules and its Applicability to Capital Increase Operations. Banca Impresa Società, (2), 287-332.

(6) Woodroof, E. A., Turner, W. C., Heffington, W., et al. (2021). Energy Conservation Also Yields: Capital, Operations, Recognition and Environmental Benefits (páginas 169-187).

(7) Ferris, S. P., Javakhadze, D., & Rajkovic, T. (2017). CEO social capital, risk-taking and corporate policies. Journal of Corporate Finance. doi: 10.1016/j.jcorpfin.2017.09.004

(8) Cesarone, F., Colucci, et al. (2018). Minimum risk versus capital and risk diversification strategies for portfolio construction. Journal of the Operational Research Society, 1-18.

(9) Tang, C., Yi, Y., Yang, Z., et al. (2016). Risk forecasting of pollution accidents based on an integrated Bayesian Network and water quality model for the South to North Water Transfer Project. Ecological Engineering, 96, 109-116.

(10) Salling, K. B., & Leleur, S. (2015). Transport Project Evaluation: Feasibility Risk Assessment and Scenario Forecasting. Transport, 32(2), 180-191.

(11) Dotan, A. (2018). Empathy And Co-Creation In Capital Markets Operations – Insights From The Field. Journal of Financial Transformation, 48, 1-12.

https://doi.org/10.17993/3ctic.2023.122.227-242

(12) Iwamura, K., & Liu, B. (2017). Dependent-chance integer programming applied to capital budgeting. Journal of the Operations Research Society of Japan, 42(2), 117-127.

(13) Zhan, J. (2021). A financing model with rebate contract in a capital-constrained supply chain. RAIRO - Operations Research, 55(1), S811-S836.

(14) Shenoy, R., & Haley, K. (2020). Improving Operations Within Capital Project Execution with Case Examples. In Abu Dhabi International Petroleum Exhibition & Conference, 202034.

(15) Zhuang, X., Tian, Y., & Zheng, Y. (2017). Dual-channel supply chain operations with working capital constraint: constant vs increasing marginal costs. In International Conference on Economic & Business Management, 215-225.

(16) Ikechukwu, N. C., & Anyanwokoro, M. (2019). Investigating the Impact of the Capital Market Operations on a Developing Economy: The Nigerian Experience (1983 – 2016). South Asian Journal of Social Studies and Economics, 1-13.

(17) Weil-Dubuc, P.-L. (2018). Big Data Individualisation des risques Individualisation of risks Médecine predictive Predictive medicine Solidarity Solidarité. Revue d'epidemiologie et de sante publique, PP S19-S23.

(18) Rogers, M. A., Elena, et al. (2018). Cardiovascular calcification: artificial intelligence and big data accelerate mechanistic discovery. Nature reviews. Cardiology, 261-274.

(19) Li, F., & Abo Keir Mohammed Yousuf. (2021). Mathematical model of back propagation for stock price forecasting. Applied Mathematics and Nonlinear Sciences. doi:10.2478/AMNS.2021.1.00089.

(20) Rumsfeld, J. S., Joynt, K. E., & Maddox, T. M. (2016). Big data analytics to improve cardiovascular care: promise and challenges. Nature Reviews Cardiology, 13(6), 350-359.

https://doi.org/10.17993/3ctic.2023.122.227-242