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Research Article

Early Warning and Monitoring Analysis of Financial Accounting Indicators of Listed Companies Based on Big Data

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With the continuous development of the economy and the continuous improvement of information network technology, the information age brings not only the innovation of social lifestyle but also the innovation of enterprise development management mode and management concept. It is more likely to cause financial information leakage and human risk out of control in the big data environment. Faced with these risks, it is necessary to actively explore ways of risk control and create a good early warning and monitoring mechanism. It aims to study the principle and data processing mechanism of the company's financial early warning monitoring, and the establishment and analysis of the early-warning monitoring model in the big data environment. Help managers find and put forward early warning signals when the company has just had a financial crisis, and remind the company to take countermeasures.

1. Introduction

With the rapid development of the economy and technology, we are now in an era of big data composed of computers and the internet. Big data brings countless convenience and opportunities to the development of enterprises [1, 2]. At the same time, it also brings many risks and challenges to enterprises. Making the competition between enterprises more intense, investors and enterprises pay more attention to the important role of financial crisis early warning in enterprise management. However, enterprise financial crisis early warning has always been a difficult problem in enterprise management. Therefore, when enterprises are preventing and responding to financial risks, in order to better adapt to the current environment, it has become an important task for enterprises to establish and improve the early-warning and monitoring system of financial accounting indicators adapted to the era of big data [3].

Scholars at home and abroad have conducted relevant research on financial early-warning indicators, the construction of early-warning model, big data information acquisition, and processing technology [4]. Aziz et al. found that the financial early-warning model using cash flow indicators has the best early-warning effect, which can better reflect the actual situation of listed companies [5]. Su and Wang proposed a financial early-warning computer big data model for listed real estate companies based on extension theory, and by combining them with each company, the specific actual data are verified to quickly and dynamically provide suggestions for the development of listed real estate companies [6]. Liang et al. used big data analysis to explore new economic risk early-warning methods, built a risk monitoring and early-warning platform, and realized rapid and scientific economic decision-making [7].

The application of big data in the financial field has long taken shape. At present, it is mainly active in the analysis of the stock market. Antweiler and Frank's research pointed out that the information between the volatility of the target company's market and the volume of stock transactions can be predicted [8]. Shin et al. found that the prediction effect of the BP neural network model is not as good as that of the support-vector machine (SVM) model in the aspect of enterprise financial early warning [9]. Min and Lee found that the SVM model had the best effect by comparing the multiple discriminant analysis (MDA), logit, and BP models [10].

Big data and financial early-warning monitoring are the common focus of researchers, but there is relatively little research on the application of big data to early-warning monitoring and analysis of corporate financial accounting indicators. This study mainly discusses the company's financial early-warning and monitoring principle and data processing mechanism, and the establishment and analysis of the early-warning and monitoring model under the background of big data. It aims to help managers take effective measures to avoid the recurrence of financial crisis when receiving the company's financial early warning.

2. Related Theoretical Analysis

2.1. Company Financial Crisis and Early Warning. According to the definition of financial crisis given by domestic and foreign research institutes, it mainly covers the following situations: first, enterprises that are insolvent; second, enterprises that cannot repay the principal and interest of the loan; third, enterprises in legal bankruptcy proceedings; and fourth, enterprises that have gone bankrupt. Judging from past foreign research studies, "bankruptcy" in the legal sense is basically the criterion for a company's financial crisis, but this criterion has much inappropriateness [3, 11, 12]. This study holds that financial crisis should be a broad concept, that is, the so-called financial crisis includes not only economic failure, technical insolvency, insolvency, and bankruptcy but also various situations between these states. The financial crisis is not only a state result but also a process. Economic failure is the beginning of the financial crisis. Insolvency and insolvency indicate that the company has been in a serious state of crisis. Bankruptcy is an extreme form of the financial crisis and the result of the financial crisis.

Financial early warning is the prevention of a financial crisis. The financial warning of an enterprise refers to analyzing the financial data generated by the enterprise in the past and predicting whether there will be a financial crisis in the future. Financial early-warning research can use relevant theories such as finance, statistics, and enterprise management [13]. According to the financial statements or other financial data provided by the enterprise, the financial situation of the enterprise is analyzed and predicted by using the analysis methods such as ratio analysis and mathematical modeling [14]. The financial crisis early-warning model can distinguish between financial crisis companies and normal companies, and judge the possibility of the financial crisis through the statistical analysis of early-warning indicators. Financial early warning can remind the enterprise of financial abnormalities that will occur and assist the enterprise management personnel to find the existing problems of the enterprise as soon as possible.

2.2. Big Data. Enterprise big data covers a very wide range, including the entire dataset in the field related to the financial status of the enterprise, and also includes the dataset that can be captured, stored, processed, and analyzed by software that takes longer than tolerable time. Corporate financial big data not only has the characteristics of big data 5 V (scale, diversity, high speed, growth, and value) but also has the relevance and real time in the financial field [15, 16]. (1) According to the main body of the data, it is the data generated by the emotional expression of the stakeholders of the enterprise, such as investors, consumers, related government agencies, enterprises, and institutions involved. (2) According to the data source, the financial big data of the enterprise comes from the network platform that can obtain the emotional expression of the abovementioned stakeholders or organizations. (3) According to the origin of data, corporate financial big data originates from corporate network public opinion.

The big data indicator is a new concept proposed by combining big data and the concept of network public opinion. The current research's commonly used method is to quantify sentiment classification and combine various types of information and data to study together. Most of the big data indicators are researched by using the network public opinion data obtained from the internet, mainly through the big data indicators quantified by sentiment analysis of the network public opinion. Big data indicators have strong data acquisition feasibility and strong data quantification feasibility.

The theory of signal transmission is actually caused by information asymmetry. The transmission of information in the crowd can be natural without human intervention. It plays a very important role in regulating the phenomenon of information asymmetry in the economic market. Based on the information purification function of the network comment platform, it can provide effective big data information for the financial early-warning research of enterprises. The prediction deviation caused by using only financial indicators is corrected, and the research of financial early warning is assisted to break through the bottleneck period limited to financial indicators.

In general, enterprise big data can be more specifically understood as the existence of multiple data sources, structures, and forms of enterprise-related datasets, which will eventually form an available dataset after certain sorting. The dataset includes structured data, unstructured data, and semistructured data, including basic data, historical data, and real-time data.

3. Early-Warning Monitoring Principle and Data Processing Mechanism

3.1. Principles of Company Financial Early-Warning Monitoring. Big data embodies the characteristics of group wisdom, and the density of valuable information is very low, which makes some artificial modification intentions. Under the balance of group behavior, the value of information is often not greatly affected, which can avoid being blinded by relying only on information providers [17]. With the development of big data technology, the acquisition of this information is more objective and comprehensive than the information obtained through company announcements, surveys, conversations, and other means in the past, and this information can include the embedded influence of the company in the social network.

In the social environment, the existence of the company is based on the recognition of stakeholders, including customers, investors, supply chain partners, governments, and so on. Taking into account the company's business behavior, it will affect the relevant information on the Internet [18]. Therefore, this study regards all netizens as "sensors" of the company distributed on the network. According to the stakeholder theory, some of these "sensors" reflect the internal operation state of the company, some reflect the overall market environment of the company, and some reflect the operation state of the relevant parties of the company. Thus, a model of corporate financial early warning based on big data is constructed, as shown in Figure 1.

3.2. Data Processing Mechanism. The financial early-warning system of big data companies does not exclude the traditional indicators available in financial reports. On the contrary, the traditional financial indicators should be part of the content of big data. Various behaviors are related to the company of internet users, such as the number of times the internet users clicked on news, comments, news messages published by reporters, etc. These contents include the reactions of offline people to the company due to their contact with the company. These reactions cover various possible situations such as customer satisfaction with products, investor attitude, policy orientation, and so on due to people's different roles in the social network. All this information is mapped to the internet through offline. Through interaction on the internet, the emotions of netizens are collected and integrated into the signal flow to form the online real-time signal of sensors of relevant companies [11]. The general intuitive external manifestation of this real-time signal is the company's online public opinion.

In the specific processing process, the company's sensor signals can be semantically analyzed, and these signal flows can be quantified through emotional indicators to form a comprehensive indicator of various behaviors. The specific data processing process is shown in Figure 2.

Netizens who play the role of "sensor" of the company have various role relationships with the company offline. According to the stakeholder theory, the interaction between these roles and the company will produce different responses, which will stimulate these roles to have different emotions toward the company [19]. Only by mapping the emotions of the group to the internet can this information be preserved and acquired by us. These different emotions are gathered, excluded, and integrated into the interaction process on the internet, and finally collective wisdom will be generated. A certain angle reflects a certain state of the company.

4. Establishment of Early-Warning Monitoring Model and Data Analysis

4.1. Sample Company Selection. When selecting the sample listed companies, in order to avoid the error caused by the enterprise scale, the sample enterprise scale is basically the same, and it is obtained by random sampling under the condition of meeting various requirements. The standard of crisis enterprises is that they have been listed for more than 5 years. This special treatment is the first time since listing [20]. The main reasons for the special treatment are losses for two consecutive years and negative net profit. The sample selection standard of normal enterprises is the enterprises that have been listed in Shenzhen and Shanghai for more than 5 years or have not been specially treated since listing.

When considering the extraction ratio of normal companies and crisis companies, in order to objectively study the availability of the early-warning model, we should not too subjectively assume the research conclusion. After combining the actual market situation, it is found that the proportion of ST enterprises in listed enterprises is very small, so the selection of research samples should also be in line with the market proportion as much as possible, but if the number of crisis enterprises is too small, it will affect the learning ability of the model. Therefore, 40 listed companies with the same scale of enterprises will be collected, including 27 normal enterprises and 13 crisis enterprises. The sample of crisis enterprises comes from the enterprises specially handled by Shanghai and Shenzhen stock exchanges in 2016 and 2017, including 5 crisis enterprises in 2016 and 8 crisis enterprises in 2017.

This study will collect online public opinion data related to 40 listed companies. The source of information is mainly through the collection of company-related public opinion information from the Oriental Fortune Forum [20]. The collected data are filtered for spam and obvious false information, and duplicate content is deleted. It is estimated that more than 60,000 pieces of effective online public opinion information will be obtained in the end. The details of ST sample companies and normal sample companies are shown in Tables 1 and 2.

4.2. Indicator Screening

4.2.1. Screening of Financial Indicators. The theoretical study of financial early warning is a complex process. Since the research needs huge theoretical support, there is no clear standard for which indicators should be selected as variables in the financial early-warning model, and researchers need to make specific investigations according to the research situation. In the face of this situation, many researchers at this stage build a financial index system based on the ability of enterprise development and improve the indicators in combination with the indicators concerned by enterprise managers in their actual work. After strict and careful screening, the financial indicators involved in the final study will involve six aspects of ability [12, 21].

(1) *Solvency.* Whether an enterprise has the ability to pay cash and repay debts is the key to its healthy survival and development. The solvency of an enterprise is an important symbol reflecting the financial situation and operating ability of an enterprise. The solvency of an enterprise is an important aspect of its credibility. If the solvency is good, it can not only reduce the difficulty and cost of raising funds in the future
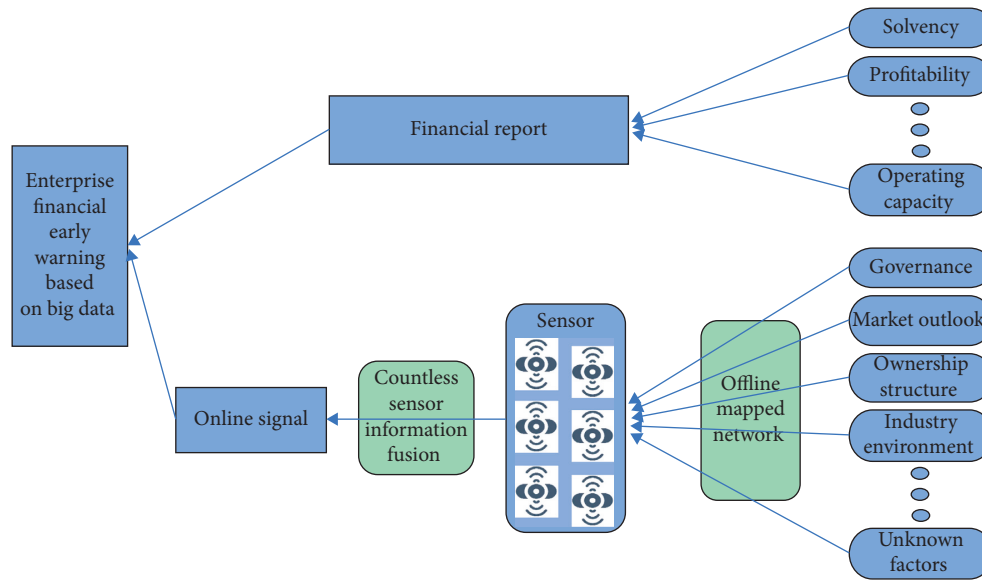
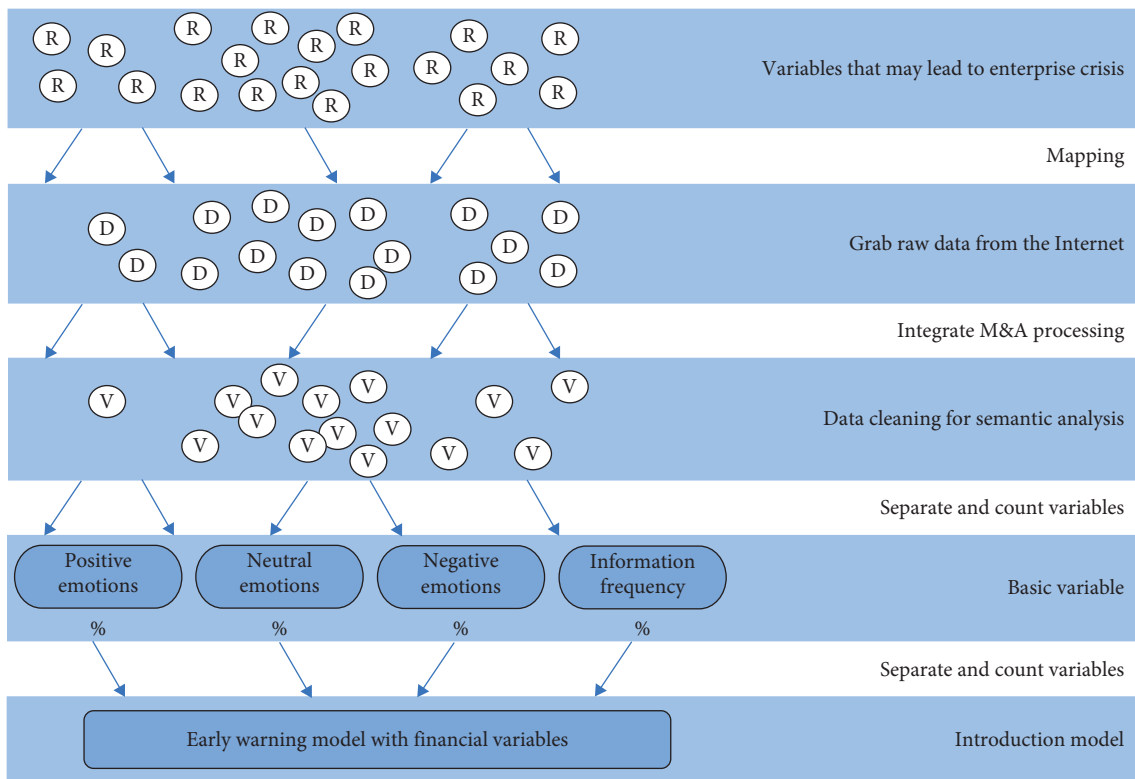FIGURE 1: Principles of corporate financial early-warning monitoring.

FIGURE 2: Data processing mechanism for financial early-warning monitoring.

but also prevent the enterprise from falling into a business crisis.

(2) *Profitability*. Profitability refers to the ability of enterprises to obtain profits, also known as the capital or capital appreciation ability of enterprises. It is usually expressed as the amount and level of enterprise income in a certain period of time. Profitability indicators mainly include operating profit margin, cost profit margin, surplus cash guarantee multiple, return on total assets, return on net assets, and return on capital. For operators, the higher the profit rate, the stronger the profitability. Through the analysis of the profitability, problems in the operation and management can be found. The analysis of the company's profitability is the in-depth analysis of the company's profit margin.

TABLE 1: ST sample company list.

Serial number	Listed company code	Stock code	Stock name
1	C600074	600074	ST Bao Qianli
2	C600289	600289	ST Xintong
3	C600680	600680	ST Shangpu
4	C002427	002427	ST Yuff
5	C002102	002102	ST Guanfu
6	C002147	002147	ST Xinguang
7	C002259	002259	ST Shengda
8	C002445	002445	ST Zhongnan
9	C002496	002496	Huifeng Co., Ltd.
10	C002680	002680	*ST Changsheng
11	C600421	600421	ST Yangfan
12	C603188	603188	Yabang Co., Ltd.
13	C002188	002188	*ST Bus

TABLE 2: Normal sample company list.

Serial number	Listed company code	Stock code	Stock name
1	C300092	300092	Kexin Electromechanical
2	C300100	300100	Shuanglin Co., Ltd.
3	C300112	300112	Wanxun Control
4	C300177	300177	Hi-Target
5	C002452	2452	Changgao Group
6	C300192	300192	Kingswood
7	C300351	300351	Yonggui
8	C002036	002036	Lianchuang Electronic
9	C002094	002094	Kingking
10	C002151	002151	BDStar Navigation
11	C002347	002347	Taier
12	C300274	300274	Sungrow
13	C300093	300093	Gorilla Glass
14	C300116	300116	Blivex
15	C300072	300072	SJ Environmental Protection
16	C300145	300145	Zhongjin Environment
17	C300153	300153	Cooltech Power
18	C300097	300097	Zhiyun Automation Co., Ltd.
19	C000612	000612	Jiaozuo Wanfang
20	C002031	002031	Greatoo Intelligent
21	C002046	002046	Sinomach Precision
22	C002084	002084	Seagull
23	C002111	002111	Weihai Guangtai
24	C002118	002118	Zixin Pharmaceutical
25	C002130	002130	Woer
26	C002182	002182	RSM
27	C002291	002291	ST&SAT

(3) *Growth Ability*. Enterprise growth capability refers to the growth and development of an enterprise in a specific period of time. Some scholars have found that compared with mature and stable enterprises, enterprises in the growth and the rising period grow faster and have stronger development capabilities. While the development capability is strong, the possibility of the financial crisis will be greater compared to those large enterprises with relatively mature and stable development. Financial early warning for these small and medium-sized enterprises can often get more information from online forums, because the more the uncertain factors of enterprises in vigorous development, the higher the public attention.

(4) *Operating Capacity*. Operational capacity is an indicator that reflects the efficiency of enterprise asset turnover. If a listed company wants to have a good operating ability, it needs to have a high-efficiency operation. If the asset turnover speed is fast, it means that the speed of various business links of the enterprise is fast, and the cycle of revenue and profit generated is shorter. Therefore, the asset turnover rate of listed companies will also affect the financial situation of listed companies.

(5) *Cash Flow*. Cash flow is an important indicator to measure the liquidity of assets. If the listed company has a good cash flow situation, it can indicate that the company is operating well at the current stage and has the ability to repay the corporate debt. Therefore, cash flow-related indicators are also important indicators to measure whether an enterprise will have a financial crisis. The higher the cash flow indicators, the lower the possibility of the financial crisis.

(6) *Capital Structure*. Enterprise capital structure can reflect the ability of enterprises to deal with various crises. Enterprises with a relatively high ratio of fixed assets to intangible assets have a higher ability to deal with risks [22]. In the preliminary selection of variables for financial indicators, this study selects 32 financial indicators from the six abilities concerned by enterprise managers and financial researchers as variables to be tested. The specific financial indicators are shown in Table 3.

The solvency of the enterprise is reflected by the indicators X1–X5, the profitability of the enterprise is reflected by the indicators X6–X12, the cash flow of the enterprise is reflected by the indicators X13-X14, the capital structure of the enterprise is reflected by the indicators X15-X16, the growth ability of the enterprise is reflected by the indicators X17-X28, and the operating capacity of the enterprise is reflected by the indicators X29–X32.

4.2.2. Big Data Indicators. The big data indicators used in this study are multiangle and multidimensional information related to enterprise development obtained through online public evaluation. This information is obtained by obtaining the evaluation of enterprises from many netizens. The evaluation information of many netizens is characterized by real time, many information sources, and complex structure. They can find out the situation of enterprise business activities from the network evaluation of people who pay attention to enterprise development. Such data are difficult to be manipulated by individuals, with relative objectivity

TABLE 3: Company financial indicators.

Financial indicator	Symbol	Indicator name
Solvency	X1	Working capital
	X2	Cash ratio
	X3	Current ratio
	X4	Quick ratio
	X5	Asset-liability ratio
Profitability	X6	EBIT
	X7	Operating net interest rate
	X8	Net profit margin of total assets
	X9	Return on net assets
	X10	Operating profit margin
	X11	Proportion of main business profit
	X12	EBIT/total assets
Cash flow	X13	Sales income cash flow
	X14	Return on total assets
Capital structure	X15	Intangible asset ratio
	X16	Fixed asset ratio
Growth ability	X17	Net profit growth rate
	X18	Operating income growth rate
	X19	Operating profit growth rate
	X20	Main business income growth rate
	X21	Growth rate of total profit
	X22	Total asset growth rate
	X23	Growth rate of net flow generated by operating activities per share
	X24	Growth rate of net assets per share
	X25	Growth rate of earnings per share
	X26	Retained earnings/total assets
	X27	Growth rate of net assets
	X28	Rate of capital accumulation
Operating capacity	X29	Accounts receivable turnover
	X30	Current asset turnover
	X31	Total asset turnover
	X32	Inventory turnover rate

and group intelligence, and the fragmentation of big data information, so many characteristics meet the relevant definitions of big data [20]. In order to further ensure the effectiveness and authenticity of online evaluation information, information collection has been made on the background information, enterprise scale, corporate governance, share structure, and audit opinions of each enterprise. When manually marking the comment samples, if you are not sure about the authenticity of individual comments, you can check the data in time. A few comments that cannot be confirmed will not be included in the data statistics.

In order to improve the efficiency and accuracy of emotion classification, this study adopts the method of artificial emotion classification. This method can also accurately judge the emotional bias of text information. In order to improve the efficiency of emotional assignment, the number of comments extracted from the network is controlled at about 60,000. This study will classify all online public opinion text data and mark the comments. The emotional bias of all effective comments shall be counted according to the established way for further analysis.

4.3. Model Establishment. The 40 samples selected in this study have 12 early-warning indicators, and a $40 * 15$ matrix will be formed at the input end, which is equivalent to inputting 15 feature vectors for the support-vector machine (SVM) model [15]. The indicator system includes two parts: financial indicators and emotional indicators of online comments, including 12 financial indicators and 3 emotional indicators of online comments. Among them, the financial indicators are enterprise solvency indicators X2, X3, X4, and X5, profitability indicators X7 and X10, cash flow indicators X13 and X14, capital structure indicators X15 and X16, and operating capacity through indicators X31 and X32. The emotional indicators of online comments are the positive-emotion index, negative-emotion index, and total comments. These vectors constitute a 15-dimensional feature vector. The judgment of the support-vector machine model is one of two choices. That is, enterprises will fall into financial crisis and enterprises will not fall into financial crisis. This means that the output vector of the model is a two-dimensional feature vector.

The support-vector machine cannot directly make selection judgment on existing samples. It needs to effectively learn the known samples first. Only after the model learns these features can it make an efficient judgment. Therefore, this study divides the overall sample into two parts, one part is used to train the model, and the other part is used to test the accuracy of the model. There will be two types of enterprises with and without a financial crisis in the two parts of the dataset. The support-vector machine model abstracts the problem of the enterprise financial early warning and uses the model to learn the data features in the training set, so as to determine the optimal classification hyperplane of the two enterprise samples and the kernel function and find the optimal related parameters. Finally, the decision function of enterprise financial early-warning model based on big data can be obtained according to these. The overall construction process of the support-vector machine model is shown in Figure 3.

4.4. Early-Warning Monitoring Analysis. The results of early-warning analysis based on traditional financial indicators are shown in Figure 4. The blue circle in the figure indicates the prediction result of the model, and the red triangle indicates the actual situation of the enterprise. If the position of the blue circle coincides with the position of the red triangle, it indicates that the prediction of the model is correct. The test focused on 12 normal enterprises, 0 were wrongly judged, 5 were ST enterprises, and 4 were wrongly judged. Therefore, it is found that the accuracy of the model in judging ST enterprises is low. The test results after integrating the early-warning indicators of comment big data are shown in Figure 5. The predictions of 12 normal companies and 5 ST companies are all correct, that is, the correct rate of this test set is 100%.

As can be seen from Figures 4 and 5, the use of financial indicators and the addition of big data indicator models to the judgment of normal enterprises have a very high
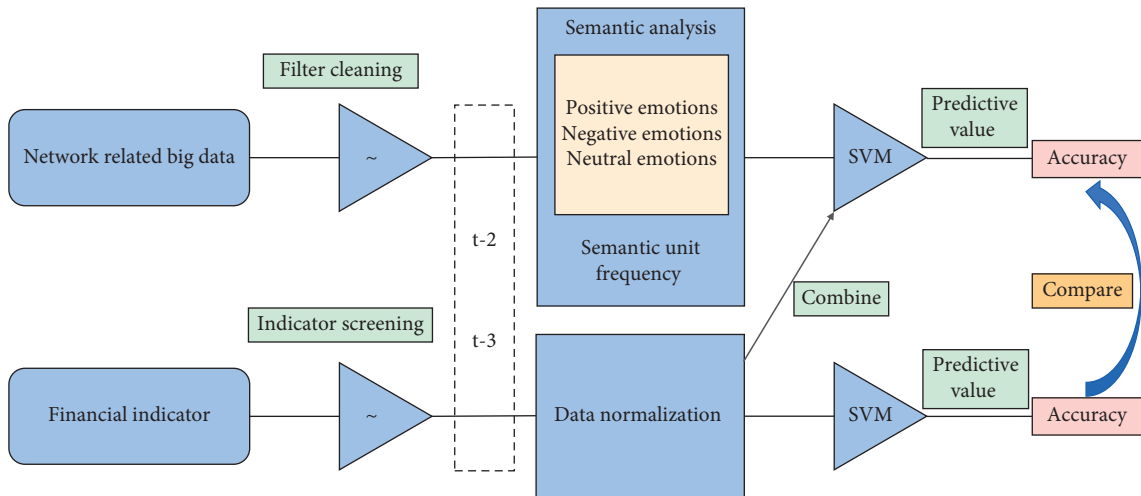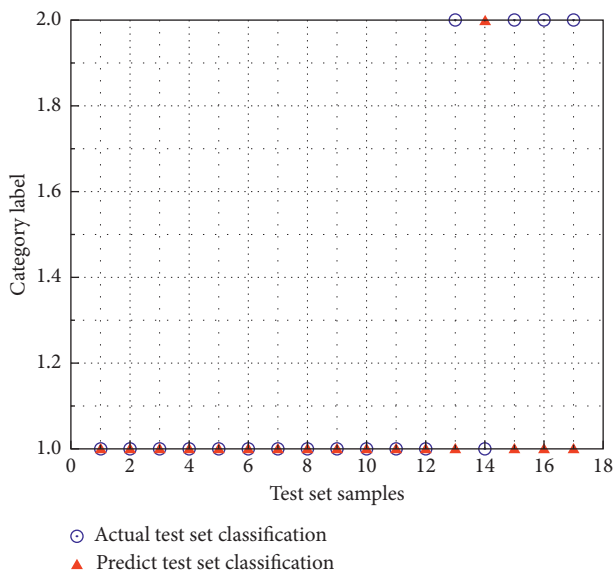
FIGURE 3: Model-building process.

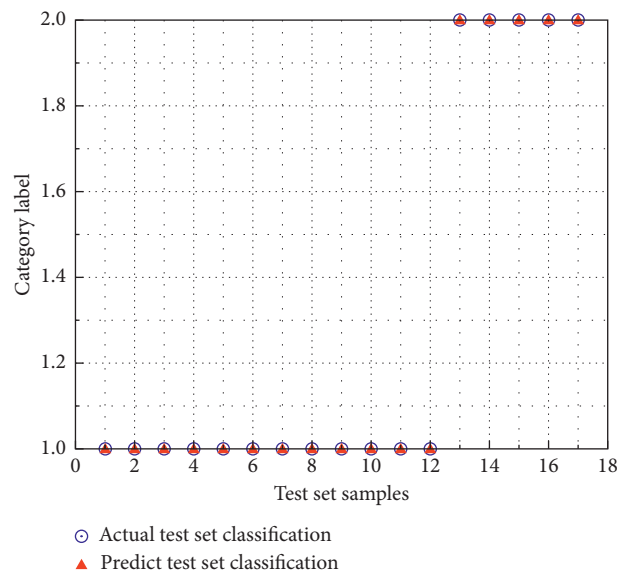FIGURE 4: Test results of financial indicator model.

FIGURE 5: Test results based on big data indicator model.

accuracy rate, and the accuracy rate is as high as 100%. However, in the correct rate of the judgment of ST companies, only the model with financial indicators only reached 20.00%, and the correct rate of the judgment of the overall sample was only 76.47%. When the big data indicators of network sentiment are integrated, the correct rate of the judgment of normal enterprises is still 100%, and the correct rate of the judgment of ST enterprises has also reached 100%.

Therefore, it can be seen that the financial early-warning model containing big data indicators has greatly improved the prediction accuracy. It is also obvious in our test that the accuracy rate is significantly better than that of the financial indicator model. This shows that the prediction model that introduces big data indicators has a certain degree of improvement in the prediction of ST enterprises. At the same time, the prediction ability of non-ST enterprises is not inferior to the financial indicator model.

5. Conclusions

The vigorous development of big data technology provides new ideas and technologies for research in many fields. Therefore, in terms of financial early warning, big data technology can also be used as an auxiliary prediction tool to improve prediction accuracy. This will help the research on financial early-warning indicators to overcome the bottleneck period and make network sentiment indicators become big data indicators to correct the deviation of financial indicator early warning. It has important theoretical value for breaking through the predicament of stagnant financial crisis warning effect and provides support for enterprise financial crisis management.

Data Availability

The dataset can be accessed upon request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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