
Research on integrated management of sales and inventory information in circulation enterprises based on case-based learning

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Abstract: Aiming at the problems of low classification accuracy, low recall rate and low efficiency of comprehensive information management of circulation enterprises, a case-based integrated management method of sales and inventory information of circulation enterprises was proposed. Taking a circulation enterprise in Hebei province as an example, this paper introduces the function of integrated management of sales and inventory information. This paper classifies the sales and inventory information of circulation enterprises, obtains the classification results of sales and inventory information by calculating the discriminant matrix, analyses the risk management of sales and inventory information of circulation enterprises, and expounds the relationship between the risk management of sales and inventory information of circulation enterprises and other fields. The accuracy and recall rate of information classification of this method are good, which can correctly and completely complete the classification of enterprise inventory information. Comprehensive information management efficiency is more than 90%, with higher efficiency of comprehensive management.

Keywords: case study; circulation enterprises; sales and inventory information; integrated management.

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1 Introduction

With the rapid development of network technology and the continuous expansion of scale, database management system has become more mature. Fuzzy mathematics and management science also provide a lot of methodological guidance and theoretical knowledge for information (Zhang et al., 2018). All of these lay a solid foundation for the management of information in circulation enterprises. Proper management, scientific utilisation and control of information resources can reduce the cost of circulation enterprises, and the efficiency will be improved, which is conducive to ensuring the position of enterprises in competition. Sales and inventory of circulation enterprises belong to the central links of enterprise management, which determines the benefits of enterprises, especially to reduce backlog, minimise inventory, and make timely sales and reasonable purchase (Meng et al., 2018; Zhu, 2018), so that enterprises will get the best benefits. From this, we can see that it can correctly manage the sales and inventory information, which has a direct impact on the efficiency of enterprises. Therefore, the integrated management of sales and inventory information in circulation enterprises has attracted the attention of a large number of scholars at home and abroad, mainly focusing on the research and analysis on the process of integrated management of sales and inventory information in enterprises.

Huang et al. (2016) propose a integrated management method for sales and inventory information of circulation enterprises based on mind map, which combines mind map with the characteristics of enterprise sales and inventory information. From the perspective of information management, according to the establishment of enterprise information architecture and the application of information coding design, this paper discusses the organisation and integrated management of enterprise sales and inventory information, and completes enterprise sales and inventory credit with digital and physical documents. The results of comprehensive information management show that the method can effectively reduce the repetitive work, but the method has the problem of low accuracy of information classification. Li et al. (2016) propose an integrated management method for sales and inventory information of circulation enterprises based on GIS technology. ArcGIS Engine component is used to manage the sales and inventory information of enterprises, and the function module of information management is constructed. According to the data of enterprises, the prediction model is constructed. The model is embedded in the information management system to realise the integrated management of sales and inventory information of enterprises. The results show that the method is effective and information processing speed is faster. However, this method has the problems of low classification accuracy and recall rate of inventory information, and can not complete and correct classification of information. Li et al. (2017) propose an integrated management method for sales and inventory information of circulation enterprises based on the compound weighted LDA model. LDA model is regarded as the representation model of enterprise information text. By combining the style structure of

enterprise information with the ability of classifying information, the feature weighting strategy of information can be realised, the compound weighting strategy can be established, and the category of enterprise sales and inventory information can be obtained. The results show that the method has a good classification effect, but the efficiency of the method is low. Duan et al. (2018) propose a integrated management method for sales and inventory information of circulation enterprises based on agricultural network information classification. The method of multi-label classification is used to classify the sales and inventory information of enterprises. A corpus is established according to the classification structure. Candidate words of information categories are extracted according to the method of information entropy, and the heat of information candidates is calculated by time-varying method. It can complete the integrated management of enterprise's sales and inventory information, but the efficiency and classification accuracy of this method are slightly lower.

Because the current method does not design the corresponding comprehensive management plan of sales and inventory information in circulation enterprises according to the actual situation, there are some problems, such as low accuracy classification, low recall rate and low efficiency of comprehensive management of sales and inventory information. Aiming at the problems existing in the existing methods, in order to achieve the purpose of high precision, high recall rate and efficient information synthesis of sales and inventory information classification of distribution enterprises. By introducing the case study method, based on the actual situation, this paper formulates the comprehensive management scheme of sales inventory information of circulation enterprises, and puts forward the case study method of comprehensive management of sales inventory information of circulation enterprises. The specific steps are as follows:

- 1 Taking a circulation enterprise in Hebei province as an example, this paper introduces the functions of integrated management of sales and inventory information, and gives a brief description of each function.
- 2 By classifying the sales and inventory information of circulation enterprises and calculating the discriminant matrix, the classification results of the sales and inventory information can be obtained, which is the basis to design the integrated management method for the sales and inventory information.
- 3 In this paper, the risk management of sales and inventory information in circulation enterprises is analysed, the relationship between the risk management of sales and inventory information in circulation enterprises and other fields are expounded, and case-based study method is used to conduct integrated management of sales and inventory information in circulation enterprises.
- 4 Experiments are conducted to compare the classification accuracy, recall rate and the efficiency of integrated information management by using different methods.
- 5 Conclusions.

Compared with traditional methods, the experimental results show that this method can effectively improve the accuracy and recall rate of enterprise information classification, as well as the efficiency of enterprise comprehensive information management. It shows that this method is feasible in practical application.

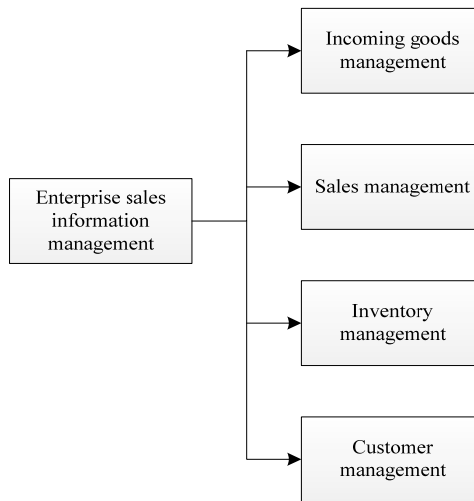
2 Integrated management of sales and inventory information in circulation enterprises based on case-based learning

2.1 Case-based study of integrated management function of sales and inventory information: a case study of a circulation enterprise in Hebei Province

Case-based learning is a method of incorporating research methods into case scenarios by simulating or utilising real-life cases. In the case, we can not only analyse and compare, but also study various successful and failed management experiences, from which we can abstract some general management conclusions or principles. Then verify the feasibility of the research method.

The integrated management functions of sales and inventory information of a circulation enterprise in Hebei province include customer management, inventory management, sales management and purchase management, respectively. The specific structure is shown in Figure 1.

Figure 1 Integrated management function structure of sales and inventory information of a circulation enterprise in Hebei province



1 Purchase management

This function combines the actual situation of sales and inventory with the demand of the market to purchase goods. Its functions include: inquiry of purchase information, payment of purchase money, registration of return of purchase, registration of purchase and storage, etc (González-Marcos et al., 2016; Luo, 2018). Sales volume is determined by the success or failure of commodity purchase. The key factor of purchase management is to make an accurate and timely purchase plan. The function of purchase management is shown in Figure 2.

2 Sales management

This function is an operation that needs to be carried out when selling. The success or failure of sales of circulation enterprises directly affects the success of enterprises. This function includes the ranking of best-selling and unsalable goods, inquiry of sales and returned goods (Lima et al., 2018), receipt of sales funds, registration of sales and out of warehouse, etc. The specific structure is shown in Figure 3.

3 Inventory management

This function is a module of managing and inquiring stock alarm, inquiring goods information from and into warehouse and basic commodity information. Inventory management can accurately provide inventory information to decision-makers and planners (Stefanović et al., 2016), which is conducive to the adjustment and sale of purchases. Repeated checking, easy management, accurate processing of goods and quick searching of information can avoid tedious work. The structure of this function is shown in Figure 4.

4 Customer management

This function includes the management report of the buyer and the supplier. It mainly manages and inquires the information of the company and the buyer, including the increase, modification and deletion of the customer information. The specific structure is shown in Figure 5.

Figure 2 Functional structure of purchase management

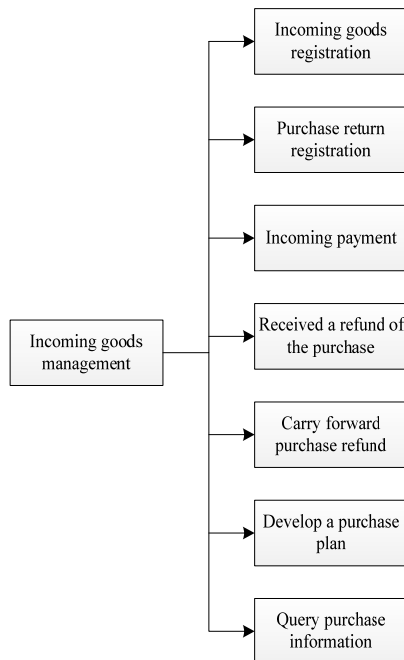


Figure 3 Functional structure of sales management

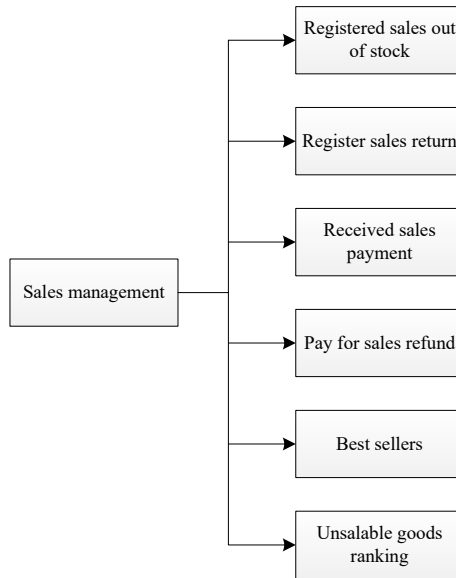


Figure 4 Functional structure of inventory management

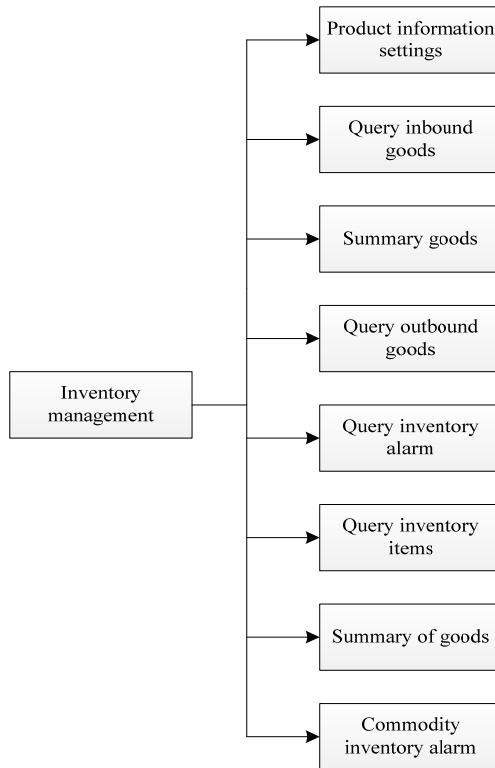
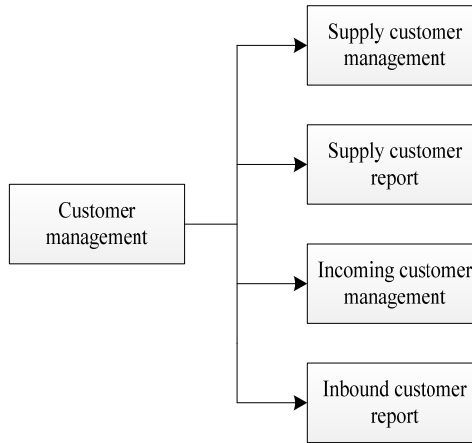


Figure 5 Functional structure of customer management



2.2 Classification of sales and inventory information of circulation enterprises

In order to simplify the data table in enterprise’s inventory information, assuming that f_1 and f_2 are fuzzy data and $SD(f_1, f_2)$ is the semantic distance between two data (Lušić et al., 2016), $SD(f_1, f_2)$ is characterised by the following three methods:

- Zade type: assuming that $f_1(X)$ and $f_2(X)$ are fuzzy values, the semantic distance from $f_1(X)$ to $f_2(X)$ can be expressed as:

$$SD(f_1, f_2) = \max \|f_1(X) - f_2(X)\| \tag{1}$$

- Interval number: assuming that $f_1 = [a_1, b_1]/p_1$ and $f_2 = [a_2, b_2]/p_2$ are two fuzzy values, the expression of interval number of f_1 and f_2 is:

$$SD(f_1, f_2) = u_1 [g(a_1, a_2) + g(b_1, b_2)] + u_2 |p_1 - p_2| \tag{2}$$

where u_1 and u_2 denote weight coefficient (Ryabko et al., 2017), $p_1, p_2 \in [0, 1]$ denotes confidence, and $u_1 + u_2 = 1, u_1, u_2 \geq 0$. $g(x, y)$ denotes a distance function from x to y , for example, $g(x, y) = |x - y|/\max(x, y)$.

- Centres: assuming that $f_1 = (c_1, r_1)/p_1$ and $f_2 = (c_2, r_2)/p_2$ are fuzzy values, then:

$$SD(f_1, f_2) = u_1 g(c_1, c_2) + u_2 (r_1, r_2) + u_3 |p_1 - p_2| \tag{3}$$

In the formula, u_1, u_2 and u_3 represent weight coefficients, and $u_1 + u_2 + u_3 = 1, u_1, u_2, u_3 \geq 0$.

The above three algorithms are SD features.

For the object in fuzzy information, assuming that the semantic distance of each attribute value is less than the error value, the object in the information is the same. Let $t_i(X_1, \dots, X_n)$ and $t_j(X_1, \dots, X_n)$ represents the coordinate vector corresponding to the attribute values of the object t_i and t_j (Bychkov et al., 2016). If the object t_i and t_j are the same, the following formula holds:

$$\max\{SD(t_i(X_1), t_j(X_1)), \dots, SD(t_i(X_n), t_j(X_n)) \leq \varepsilon\} \tag{4}$$

where ε is the allowable error value. Let $S = (U, A, V, f)$ be an information system, $A = \{a_1, \dots, a_n\}$ is a set of attributes, and the set of attributes X_p and X_q of attributes a_p and a_q related to t_i and t_j are called dependent functions (Sriadhi, 2017). They are denoted as $X_p \xrightarrow{FFD} X_q$. The following expressions are given:

$$SS(t_i(X_p), t_j(X_p))k, SS(t_i(X_q), t_j(X_q)) \tag{5}$$

Let $\{a_1, \dots, a_k\}$ represents the main set of attributes of enterprise information system $S = (U, A, V, f)$. According to the dependencies between functions, it is obtained that:

$$SD(t_i(X_1, \dots, X_k), t_j(X_1, \dots, X_k)) \geq SD(t_i(X_{k+1}, \dots, X_n), t_j(X_{k+1}, \dots, X_n)) \tag{6}$$

Next, the decision object can be represented according to the following formula:

$$\max\{SD(t_i(X_1), t_j(X_1)), \dots, SD(t_i(X_k), t_j(X_k)) \leq \varepsilon\} \tag{7}$$

In order to accurately calculate the enterprise information, assuming that the purchase management, sales management, inventory management and customer management in enterprise information are represented by t_1, t_2, t_3 and t_4 respectively, and the data among them are calculated, when the maximum allowable error is 0.5, the discriminant matrix of information can be obtained (Vatenmacher et al., 2017). The matrix expression is as follows:

$$B = \begin{pmatrix} 00101 \\ 00101 \\ 11111 \\ 00101 \\ 11110 \end{pmatrix} \tag{8}$$

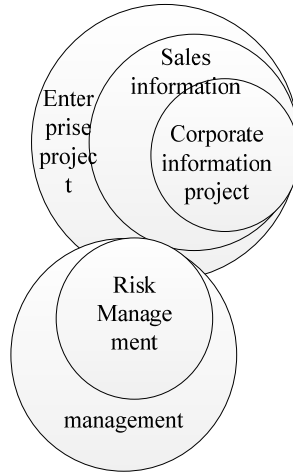
According to the discriminant matrix, the classification results of information can be obtained as follows: $\{t_1, t_2, t_4\}, \{t_3\}$. The classification of enterprise's sales and inventory information can lay a foundation for the integrated management of information.

2.3 Case-based study of integrated management of sales and inventory information in circulation enterprises

On the basis of classification of enterprise's sales and inventory information, it is necessary to analyse the risk management of enterprise's sales and inventory information, and use case-based study method to complete the integrated management of distribution enterprise's sales and inventory information.

According to the theory of information risk management, enterprise information risk management has risk identification, analysis, planning, tracking and control (Kim et al., 2016; Balta et al., 2017). Combining with the characteristics of enterprises, this paper briefly describes the relationship between the risk management of sales and inventory information and other fields in circulation enterprises, as shown in Figure 6.

Figure 6 The relationship between risk management of sales and inventory information and other fields in circulation enterprises



Supposing that U' denotes the finite set of the enterprise's sales and inventory information object, which is called the universe. For any subset $X' \in U'$, it can be called the concept of U' . Any family of concepts in U' is called abstract knowledge related to U' (Jung et al., 2016; Vernadat et al., 2018). Assuming that the set $R = \{X'_1, X'_2, \dots, X'_n\}$, where $X'_i \in U'$, $X'_i \in \emptyset$, $X'_i \cap X'_j = \Phi$, when $i \neq j$, $i, j = 1, 2, \dots, n$, then R is a classification and X'_i is the equivalent class in R . In order to find out the important attributes in the sales and inventory information, some attributes need to be removed first. The greater the change of attribute classification is, the greater the intensity is, the higher the importance is (Bensoussan et al., 2016). On the contrary, the smaller the attribute intensity is, the lower the importance is.

The importance of attribute subset $P_1 \subseteq P$ with respect to Q can be expressed as follows:

$$\sigma_{PQ}(P_1) = \gamma_P(Q) - \gamma_{P-P_1}(Q) \tag{9}$$

when evaluating a single attribute, and $P_1 = \{r\}$, the expression of the relative importance of attribute $r \in P$ and Q is as follows:

$$\sigma_{PQ}(r) = \gamma_P(Q) - \gamma_{P-\{r\}}(Q) \tag{10}$$

According to rough theory, $P \subseteq C \cup D$, $Q \subseteq C \cup D$, $\text{ind}(P) \subseteq \text{ind}(Q)$, it shows that knowledge Q is dependent on P (Calle et al., 2016). Usually, knowledge dependence is not all. It shows that knowledge Q is only derived from P , then Q 's dependence on P can be expressed as follows:

$$\gamma_P(Q) = \frac{\text{Card}(\text{Pos}_P(Q))}{\text{Card}(U)} \tag{11}$$

In the formula, $\text{Card}()$ represents the cardinality of the set and $\text{Pos}_P(Q)$ represents the positive region of the set P in $U/\text{ind}(Q)$. Let C' be a subset of attributes, and the

classification obtained by C' is D . When the attributes in C' are removed, the classification will change. Assuming that $\text{Sig}_{C'-a'}(a')$ represents the importance of attributes a' (Yang et al., 2016), there are:

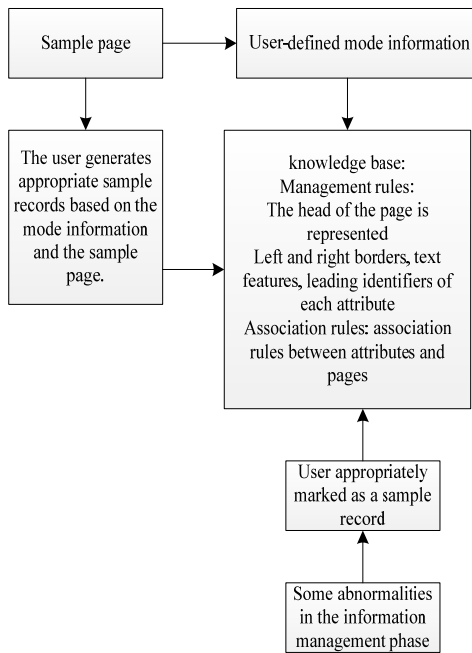
$$\text{Sig}_{C'-a'}(a') = \frac{r_{C'}(C') - r_{C'-a'}(C')}{r_{C'}(C')} = \frac{\text{Card}(\text{Pos}_{C'}(D)) - \text{Card}(\text{Pos}_{C'-a'}(D))}{\text{Card}(\text{Pos}_{C'-a'}(D))} \quad (12)$$

By normalising the importance of each attribute (Myers et al., 2016) the weight W_i will be obtained:

$$W_i = \frac{\text{Sig}_{C'-a'_i}(a'_i)}{\sum_{j=1}^n \text{Sig}_{C'-a'_j}(a'_j)} \quad (13)$$

After obtaining the weight, the risk management analysis of the enterprise's sales and inventory information is completed. Next, the case-based study method is used to realise the integrated management of the distribution enterprise's sales and inventory information.

Figure 7 Case-based learning



The purpose of case-based learning is to manage the knowledge base and pattern of information according to sample pages, including association and extraction rules. In the process of extraction, the information model and knowledge base obtained in case-based learning stage serve the information management stage by using association rules, text features and delimiters as well as the idea of assembler. As shown in Figure 7, it is necessary to determine the page of information management and select a small number of information samples to form the mode of managing the sales and inventory information

(Albrecht and Steinrücke, 2017). At the same time, users need to mark the information in the sample page to obtain the sample record of information, and finally form the knowledge base of management information. For the abnormalities appearing in the later stage of information management, they can also be used as sample record after marking ad then added it to the knowledge base.

The management of enterprise's sales and inventory information is divided into two parts and it's easy to manage in each part. The first part manages the same kind of information. In order to manage enterprise's sales and inventory information accurately, quickly and conveniently, we need to form rules and methods of management information quickly. For the integrated management of information, it needs a lot of management rules, to get rules in the case-based study stage. Then, for users, it is necessary to have the characteristics of accuracy, speed and convenience.

Through the analysis of the risk of enterprise's sales and inventory information management and the stage of case-based study, the integrated management of sales and inventory information in circulation enterprises is finally realised.

3 Result analysis

The comprehensive management of sales inventory information in circulation enterprises is of great significance in the field of e-commerce and in enterprises and enterprises. In order to verify the effect of the integrated management method of sales inventory information of circulation enterprises based on case study, the research method is compared with Huang et al. (2016) method, Li et al. (2016) method, Li et al. (2017) method and Duan et al. (2018) method, respectively. The operating environment and development software are as follows:

- 1 server: Windows Server 2008 operating system
- 2 development platform: Windows 7 operating system
- 3 browser environment: Firefox 43.0 or IE7 or above
- 4 the database of the system: MySQL 5.5
- 5 web server: Tomcat 7.0
- 6 development tools: MyEclipse 8.5
- 7 JAVA running environment: JDK 1.4
- 8 developed hardware: 3.3GHz CPU, 4G memory and 500G hard disk.

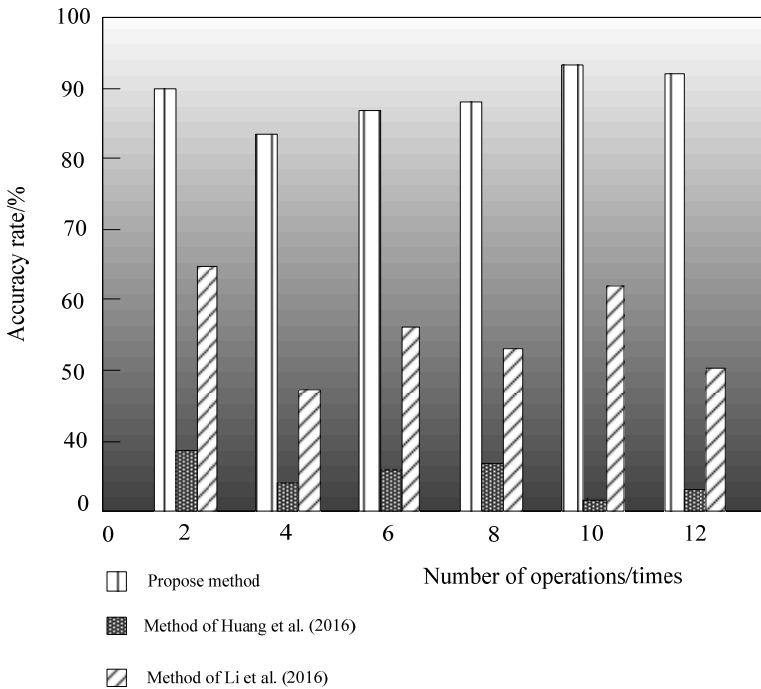
In this paper, the integrated management method for sales and inventory information of circulation enterprises based on case-based learning, the integrated management method for sales and inventory information of circulation enterprises based on mind map in Huang et al. (2016), the integrated management method for sales and inventory information of circulation enterprises based on GIS technology in Li et al. (2016), the integrated management method for sales and inventory information of circulation enterprises based on compound weighted LDA model in Li et al. (2017), and the integrated management method for sales and inventory information of circulation enterprises based on the classification of agricultural network information in Duan et al.

(2018) are selected as the experimental methods. Firstly, the accuracy of different methods is compared. The higher the accuracy is, the higher the accuracy is, the higher the accuracy of the method is. Then the recall rate of different methods is compared. The recall rate is the integrity of the test information classification. The higher the recall rate is, the higher the quality of information classification is. Finally, the management efficiency of different methods are compared. The higher the management efficiency, the better the practical application effect of this method.

Experiment 1: accuracy

The accuracy of the proposed method and the method in Huang et al. (2016) and Li et al. (2016) are tested, and the test results are shown in Figure 8.

Figure 8 Comparison of the classification accuracy of enterprise’s sales and inventory information by different methods

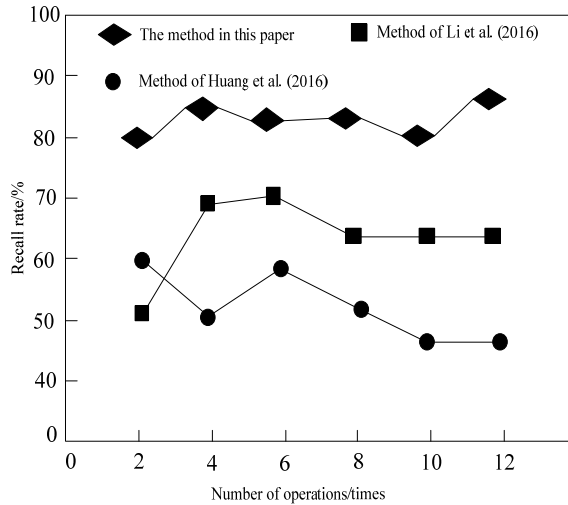


Analysis of Figure 8 shows that when classifying enterprise’s sales and inventory information, the proposed method has higher accuracy than the other two methods. The information classification accuracy of the method in Huang et al. (2016) is the lowest, the highest accuracy of this method is 40%, and the highest accuracy of the proposed method is about 95%, which is more than twice the accuracy of the method in Huang et al. (2016). By comparison, the proposed method can has a high accuracy in classifying enterprise’s sales and inventory information.

Experiment 2: recall rate

Based on the recall rate and the classification accuracy of enterprise sales and inventory information, the recall rate of information classification was tested by comparing the methods in Huang et al. (2016) and Li et al. (2016). The test results are shown in Figure 9.

Figure 9 Recall rate result comparison of enterprise’s sales and inventory information classification by different methods



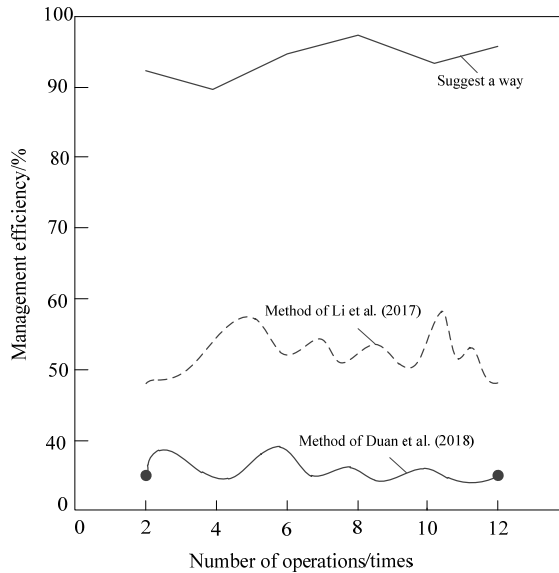
Analysis of Figure 9 shows that in the 12 operations of the proposed method, the recall rate of information classification is more than 80%, and the recall rate of the twelfth operation is the highest. In the 12 operations of the method in Huang et al. (2016), the recall rate of information classification is between 50% and 70%, and the recall rate of the sixth operation is the highest. In the 12 operations of the method in Li et al. (2016), the recall rate of information classification is between 0% and 50%, and the recall rate of the twelfth operation is the highest. By comparison, the proposed method has a higher recall rate of information classification and ensures the integrity of information. Combining with experiments, the proposed method has the highest accuracy rate of information classification and recall rate, while the recall rate of the method in reference Huang et al. (2016) is slightly higher and the accuracy rate is slightly lower, and the accuracy rate of the method in Li et al. (2016) is slightly higher and the recall rate is lower.

Experiment 3: management efficiency

Management efficiency tests the classification accuracy and recall rate of enterprise sales and inventory information, and compares the method in this paper with the method in Li et al. (2017) and the method in Duan et al. (2018) to test the efficiency of information integrated management. The test results are shown in Figure 10.

Analysis of Figure 10 shows that when testing the integrated management efficiency of enterprise’s sales and inventory information, we can see from the figure that the integrated management efficiency of information by the proposed method is above 90%, the integrated management efficiency of information is the highest, followed by the method in Li et al. (2017), the management efficiency is between 48% and 60%. And the integrated management efficiency of information by the method in Duan et al. (2018) is the lowest, the management efficiency ranges from 10% to 40%. By comparison, the efficiency of integrated management of information of the proposed method is higher, and it is proved that this method is valuable in the efficiency of comprehensive management.

Figure 10 Test results of integrated management efficiency of enterprise’s sales and inventory information by different methods



4 Conclusions

With the continuous development of information technology, information resources play an important role in social production and daily life. In the new period, the living environment of circulation enterprises is also changing. Under the situation of the integration of economy and knowledge, aiming at the problems of low classification accuracy, low recall rate and low efficiency of circulation enterprise information management, a comprehensive management method based on circulation enterprise sales and inventory information is proposed. To circulation enterprises in Hebei province as an example, this paper introduces the integrated management of sales and inventory information, calculate the discriminant matrix of sales and inventory information circulation enterprises, sales and inventory information classification results, analysis of the risk management of sales and inventory information circulation enterprises and other fields, the relationship between applied the method of case study to realise the integration

of circulation enterprises sales and inventory information management. Experimental results show that the maximum accuracy of this method is about 95%, and the recall rate of information classification is over 80%. Compared with traditional information classification, the accuracy and recall rate are higher, which can correctly and completely complete the classification of enterprise inventory information. The efficiency of integrated information management is more than 90%, which has high efficiency of integrated management. It is of scientific significance to improve the comprehensive management function of enterprises. The study of this paper is not very comprehensive, and will take enterprise management system cost as the direction of the next study.

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