Construction and Evaluation of Intelligent Logistics Support System Based on Rough Set and Support Vector Machine

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ABSTRACT
Aiming at the transmission of novel Coronavirus, it highlights the deficiency of the developing intelligent logistics system. Therefore, constructing an intelligent logistics system based on intelligent technology is an effective way and method to solve the deficiency of the traditional logistics system. On this basis, this article refer to documents, and combining with the reality of the present situation of logistics, building based on the macro conditions, technical conditions, human resources system, intelligent logistics development at the same time from the target layer, criterion layer and index layer three dimensions established the evaluation index system of intelligent logistics, and with rough sets and support vector machine (SVM), play to their respective advantages of the two methods, the development of intelligent logistics system is evaluated.

Keywords: *Intelligent logistics, Rough set, Support vector machine.*

1. INTRODUCTION

During the Spring Festival in 2020, novel coronavirus's pneumonia epidemic spread rapidly to the whole country. Affected by the epidemic, China's economy is expected to suffer a certain impact in the short term. Logistics connects production and consumption, and it is also the guarantee of urban pillar industries and advantageous industries. Urban logistics directly affects the traffic load of the city, and intelligent logistics will be a strong support for the construction and sustainable development of intelligent cities. As far as China is concerned, the construction of intelligent logistics system is inseparable from the support of artificial intelligence technology represented by "unmanned" technology. Through the fight against the epidemic, how to develop intelligent logistics, how to build a reasonable intelligent logistics system, and how to evaluate the suitability of the existing intelligent logistics system, all need to cause rethinking in the academic and practical fields. This paper tries to make a discussion in this aspect.

2. LITERATURE REVIEW

2009 is the first year of the development of intelligent logistics industry. IBM put forward the concept of "intelligent supply chain" and established an intelligent supply chain system based on the future through sensors, RFID tags, brakes, GPS and other devices and systems. The intelligent supply chain with advanced, interconnected and intelligent characteristics has attracted the attention of experts and scholars, resulting in the emergence of "intelligent logistics". In December of the same year, the Information Center of China Logistics Technology Association, Huaxia Internet of things and the editorial department of Logistics Technology and Application jointly put forward the concept of "smart logistics". A series of studies have been carried out around the conceptual characteristics, architecture, implementation framework, development trend and other issues.

Intelligent logistics refers to the effective integration and application of Internet of things technology, big data mining and analysis technology, perceptual identification technology, remote monitoring technology and artificial intelligence technology to all links and subjects of logistics activities, which is an efficient logistics system with the ability of thinking, perception, learning, reasoning and judgment and self-solving problems.

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At present, intelligent logistics has been studied at home and abroad and some results have been achieved. In foreign countries, Jenni Eckhardt, Jarkko Rantala studied the role of intelligent logistics in multimodal transport and cost-effective transportation system [1]; Matej Kovalsky, Branislav Micieta took the automobile industry as an example to plan and optimize the intelligent logistics system [2]; Duncan McFarlane, Vaggelis Giannikas, Wenrong Lu studied how to improve the role of customers in intelligent logistics operation [3]. The domestic research on intelligent logistics is mainly reflected in: he Liming, president of China Federation of Logistics and Purchasing, pointed out that at present, the policy environment for the development of intelligent logistics continues to improve, the logistics Internet has been gradually formed, and logistics big data has been applied. Logistics cloud services to strengthen security, collaborative sharing boost model innovation, artificial intelligence is in its infancy. In the future, there will be seven major upgrades, such as connection upgrade, data upgrade, model upgrade, experience upgrade, intelligent upgrade, green upgrade, supply chain upgrade and so on. Wang Zhitai believes that intelligent logistics is not only a technical problem, but also a systematic and comprehensive concept, especially it should be combined with urbanization [5]. Luo Renshu constructed the intelligent logistics information platform [6]. Wang Yu studied the real-time risk management mechanism of intelligent logistics from the perspective of "Internet +"[7]. Based on the analysis of the framework of intelligent logistics, a real-time risk management mechanism based on context awareness was constructed to improve the automation and intelligence level of logistics risk management. Zhu Lin explored the credit system and evaluation methods of the public information platform of intelligent logistics [8]. Xu Jun analyzed the concept and characteristics of intelligent logistics, and analyzed the implementation of intelligent logistics system in real life based on a case [9]. Dong Shuhua took the application of radio frequency identification (RFID) technology in warehouse monitoring as an example to analyze the problems existing in the development and application of intelligent logistics system [10]. Zhang Xiangyang believes that with the vigorous development of online shopping and cloud computing technology, intelligent logistics system can better integrate all kinds of resources and promote business model innovation [11]. Shi Yaping constructed an hourglass-type intelligent logistics architecture, which is based on the Internet of things and consists of perceptual interaction layer, network transport layer, application service layer and so on [12]. Shao Guangli put forward the development model of intelligent logistics, which is promoted by the government, promoted by industrialization, led by enterprises, led by standards, and promoted by market [13]. Zhang Lingling proposed an intelligent logistics architecture based on cloud computing technology platform to solve the problems of information sharing and cooperation [14]. Wang Yaling analyzed the vision of building the "wisdom belt" of the Silk Road, and pointed out that the construction of the "wisdom belt" of the Silk Road needs to formulate effective policies and measures in the light of the existing economic, industrial foundation and natural conditions of the western region, improve the level of western development with information construction [15]. Ying Linzhi proposed that the construction of intelligent logistics in Ningbo should take the construction of intelligent ports as the center, build a number of intelligent logistics parks, strengthen the application of information technology in enterprises, and improve the fourth-party logistics platform [16].

To sum up, intelligent logistics is the "intelligence" of the development of modern logistics industry by comprehensively introducing and making full use of emerging information technologies such as the Internet of things, cloud computing, big data, "Internet +" and so on. The development of foreign intelligent logistics industry is early and concentrated in the application field, while the research of domestic intelligent logistics industry is still in its infancy, mainly focusing on the concept of intelligent logistics, the construction of intelligent logistics information system, and the combination of intelligent logistics and other fields.

3. BRIEF INTRODUCTION TO HHE PRINCIPLE

3.1. Rough Set Theory

In 1982, Polish scientists first proposed rough set theory (Rough Set, RS), which is a new mathematical tool to deal with fuzzy and uncertain knowledge [17]. Rough set theory can better deal with empirical learning and obtain knowledge from experience. It forms a rule set by analyzing and dealing with the research objects with imprecise and incomplete information, so as to explain the information and rules implied in the data. The core of rough set theory is attribute reduction, that is, by calculating the dependence of decision attribute value on feature attribute, the index with zero importance is deleted, and the expression ability of knowledge expression system is not affected. Rough set theory can effectively solve the problems of fuzziness and uncertainty in evaluation, calculate the relative importance of indicators, and make evaluation and strategy selection more reasonable. Rough set theory can be understood by the following definitions:

- Definition 1 usually denotes the knowledge representation system by S = {Ujinomi R, R, V, f}, where U represents the research sample, R represents the set of attributes, V represents the set of attribute values, and f: UxR V is called the information function, which represents the mapping relationship between U and V, that is, $r \in R$, $x \in U$, where $f(x\_r) \in Vr$, where Vr is the index value. If Runce C U D, C and D are feature attribute set and decision attribute set respectively, then the knowledge representation system S = {Uforce R ·V ·F} is called decision information system, which is a special case of knowledge representation system, and the corresponding two-dimensional data table is called decision table.

- Definition 2 for the subset P < R, then the indiscernibility relation of P on U is defined as: IND (P) = {(x < y) | x ∈ U, y ∈ U < f (x, α) = f (y, α), α ∈ P}, U/IND (P) means that all samples in U are effectively divided according to the index set P.
- Definition 3 Aknowledge representation system such as S = (RPowerU) is given. For any object set X (U) and attribute set P (R), the P lower approximation set of X is defined as: PX= {x | [x] p approximate X}, and the P upper approximation of X is defined as: BX= {x | [x] Bauer X (φ)}.
- Definition 4: for the knowledge representation system S = (RMagne U), any minimum set P ∈ R and IND (P) = IND (R) is a reduction of the knowledge representation system. Write it down as the kernel of the knowledge representation system of the intersection representation of all attribute reduction sets, RED (R) represented by RED (R). The positive field relative to the decision attribute D is: POSR (D) = {PXX∈ U / IND (D), where U/IND (D) is the set of equivalence classes obtained from the partition of D to U.

3.2. Support Vector Machine Theory

Statistical learning theory is a machine learning method with solid theoretical foundation developed on the basis of traditional statistics. Since the 1990s, other learning methods such as neural network have encountered difficulties. It has formed a relatively perfect theoretical system-statistical learning theory, and put forward a new pattern recognition method-support vector machine, so this research has been paid more and more attention [18].

Support Vector Machines(SVM) is a new machine learning method proposed by V. Vapnik et al based on Statistical Learning Theory (referred to as SLT). It shows many unique advantages in solving the problems of small sample, nonlinear and high-dimensional pattern recognition, and can effectively realize the accurate fitting of high-dimensional nonlinear system based on small sample. Good results have been achieved in pattern recognition, function approximation and probability density estimation[19, 20]. The regression function can be expressed as follows:

$$y_i[(w \bullet x_i)+b]-1 \geq 0 \quad i=1,...,n \tag{1}$$

In this case, the classification interval is equal to $2/\|w\|$, so that the maximum interval is equivalent to the minimum. The classification surface that satisfies the condition and minimizes is called the optimal classification surface, and the training sample point on H1 and H2 is called support vector. By using the Lagrange optimization method, the above optimal classification surface problem can be transformed into its dual problem, the maximum values of the following functions can be solved.

$$Q(\alpha)=\sum_{i=1}^{n}\alpha_i-\frac{1}{2}\sum_{i,j=1}^{n}\alpha_i\alpha_j y_i y_j\left(x_i \bullet x_j\right) \tag{2}$$

For the Lagrange multiplier corresponding to each sample, the corresponding sample is the support vector, and the optimal classification function is obtained.

$$f(x)=\operatorname{sgn}\left\{\left(w^* \bullet x\right)+b^*\right\}=\operatorname{sgn}\left\{\sum_{i=1}^{n}\alpha_i^* y_i\left(x_i \bullet x_j\right)+b^*\right\} \tag{3}$$

For the nonlinear problem, it can be transformed into a linear problem in a high-dimensional space by nonlinear transformation, and then the optimal classification plane in the space can be transformed. Select the appropriate kernel function to meet the Mercer condition to transform into a high-dimensional space, and the objective function is transformed into:

$$Q(\alpha)=\sum_{i=1}^{n}\alpha_i-\frac{1}{2}\sum_{i,j=1}^{n}\alpha_i\alpha_j y_i y_j K\left(x_i,x_j\right) \tag{4}$$

The corresponding classification function becomes:

$$f(x)=\operatorname{sgn}\left\{\left(w^* \bullet x\right)+b^*\right\}=\operatorname{sgn}\left\{\sum_{i=1}^{n}\alpha_i^* y_i K\left(x_i,x_j\right)+b^*\right\} \tag{5}$$

The kernel functions commonly used in support vector machines are as follows:

- Gaussian radial basis kernel function.
  $$K(x_i,x_j)=\exp(-\gamma\|x_i-x_j\|^2) \tag{6}$$
- Polynomial kernel function.
  $$K(x_i,x_j)=\left(\left(x_i \bullet x_j\right)+1\right)^d \tag{7}$$
- Linear kernel function.
  $$K\left(x_i,x_j\right)=\left(x_i \bullet x_j\right) \tag{8}$$
- One-dimensional Fourier kernel function.
  $$K(x_i,x_j)=\left(1-q^2\right)\Big/\left[2\left(1-2q\cos\left(x_i-x_j\right)+q^2\right)\right] \tag{9}$$

Among these four kinds of kernel functions, the radial basis kernel function is the most widely used, which has a wide convergence domain and is an ideal classification basis function. Gaussian radial basis kernel function is used in this study.

3.3. Complementary Analysis of Rough Set Theory and Support Vector Machine

For the data information mining of limited samples, the traditional statistical theory based on the infinite number of samples has no advantage. Support vector machine does not need strict data samples and excellent learning ability, but when there are many characteristic indexes of samples, it will undoubtedly increase the computational load of support vector machine and affect the prediction accuracy [21].

The main idea of rough set is to delete the index with zero relative importance and to ensure that the classification ability does not change when the redundant index is deleted. Therefore, using rough set to preprocess the index data can improve the accuracy and effectiveness of support vector machine in the model [22].

Rough set has advantages and potential in knowledge reduction and dealing with inaccurate and imprecise knowledge, which can reduce the dimension of SVM data and reduce the complexity of system structure. The algorithm process of RS-SVM: firstly, rough set is used to reduce the evaluation index, delete the redundant index, establish a new decision table, and support vector machine is used to train the sample data.

4. CONSTRUCTION OF THE EVALUATION SYSTEM OF THE DEVELOPMENT OF INTELLIGENT LOGISTICS AND THE COMPOSITION OF THE EVALUATION INDEX

4.1. System Construction

Based on the related theories of industrial development and modern logistics, this paper constructs the intelligent logistics development support system from six aspects: policy, law and financing, key technologies and facilities, personnel training and talent management.

First, the macro conditions involve two aspects:

- First, laws and regulations are the support and guarantee for the effective implementation of intelligent logistics norms.
- The second is the financing of intelligent logistics by the government. The capital needed for the construction of intelligent logistics system is much larger than that of traditional logistics system, including the purchase of basic equipment, means of transport and loading and unloading equipment, technology development, human resources investment and so on.

Second, the technical aspect mainly includes two aspects:

- One is the key technology, that is, through the real-time information generated by sensors, RFID tags, brakes, GPS and other equipment and systems, we can realize the efficient allocation and optimization of logistics resources in all aspects and fields of logistics, especially in the fields of unmanned vehicles, unmanned warehouses, unmanned cabinets, logistics robots and so on.
- Second, infrastructure equipment, especially facilities and equipment such as unmanned warehouses, intelligent distribution stations and intelligent load vehicles, is an important basis for ensuring the long-term development of logistics. At the same time, the establishment of land, sea and air three-dimensional transportation network is also very important.

Third, in terms of human resources:

- The development of intelligent logistics needs professionals with professional logistics knowledge and rich practical experience, which requires not only the management of logistics talents, but also the training and education of logistics professionals. to build a solid talent foundation for the construction of intelligent logistics system.

In addition to the above hardware preparation, but also need to upgrade the software, in order to achieve the overall coordination and optimization of the intelligent logistics system.

The construction of the support system for the development of intelligent logistics is shown in Figure 1.

4.2. Establishment of Evaluation Index System

There are few domestic scholars on the evaluation of the construction of intelligent logistics development support system, and most scholars focus on the influencing factors of regional logistics development, the evaluation of regional logistics efficiency or development level, the comparison of regional logistics competitiveness and so on. Based on the previous scholars' research results and the construction principles of the index system, combined with the basic characteristics and development characteristics of intelligent logistics and the above support system analysis, according to the system engineering theory, it can be determined to build an index system to evaluate the current situation of intelligent logistics development support system from three dimensions: policy and financial support system, technology and facilities and equipment support system, and talent factor support system[23]. See Table1.

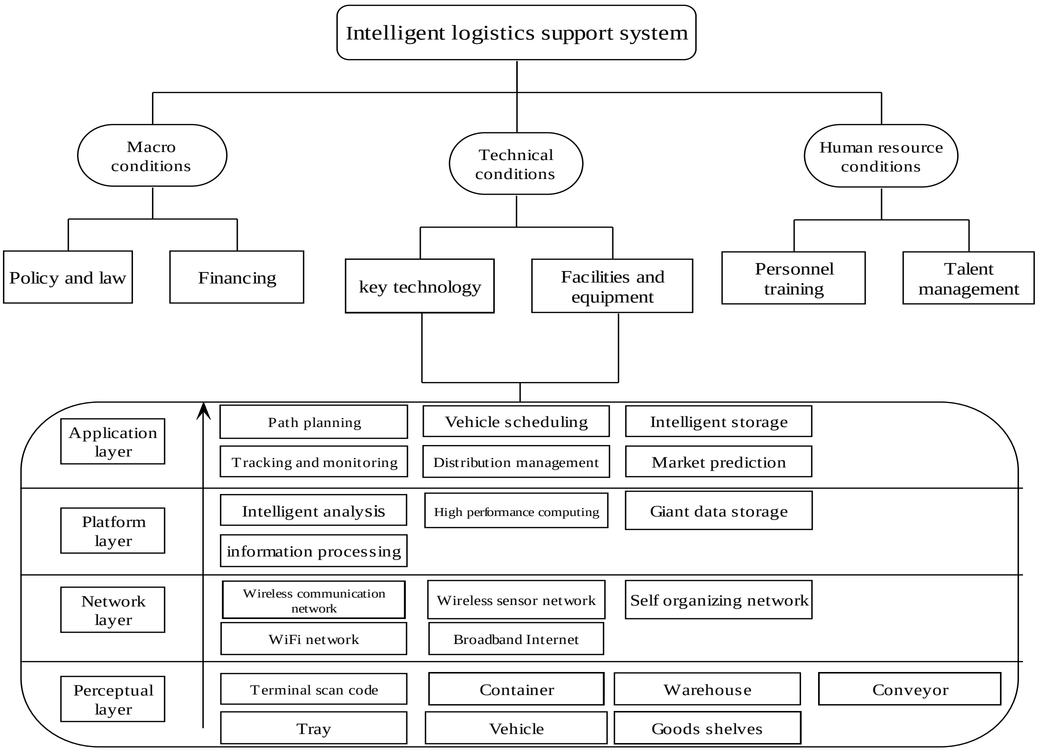

Figure 1 The Construction of Intelligent Logistics System

Table 1. Evaluation index system for the construction of intelligent logistics development support system

Target layer	Criterion layer	Index layer	serial number
Intelligent logistics system	Policy and financial support system	Density of logistics network	C1
		Gross domestic product)	C2
		Disposable income of urban residents	C3
		General financial expenditure (logistics industry)	C4
		Proportion of fixed assets investment in logistics industry in the whole society	C5
		Regional R & D expenditure (100 million yuan)	C6
	Technology, facilities and equipment support system	Internet penetration rate (%)	C7
		Technical market turnover per researcher (10000 yuan)	C8
		Mobile phone penetration rate	C9
		Number of patents authorized	C10
		Output value rate of civil truck	C11
	Talent element support system	Full time equivalent of Regional R & D personnel	C12
		Number of people with college degree or above	C13
		Number of employees in logistics industry	C14

According to the basic situation of the intelligent logistics development support system, the index evaluation system is established. After the evaluation index system is established, the safety grade is divided into five levels, namely, unqualified, qualified, medium, good and excellent. The range of the safety grade is [0, 0.2], (0.2, 0.4], (0.4, 0.6), (0.6, 0.8] and (0.8, 1]. From this, the set of evaluation criteria is determined. See Table 2.

5. EVALUATION OF INTELLIGENT LOGISTICS SYSTEM BASED ON RS-SVM

Table 2. Evaluation Grade Standard Of Intelligent LogisticsSupport System

Grade	Level	Grade interval
I	Excellent	[1.0, 0.8)
II	Good	[0.8, 0.6)
III	Secondary	[0.6, 0.4)
IV	Qualified	[0.4, 0.2)
V	Unqualified	[0.2, 0.0]

Through the joint discussion of the expert group, this paper classifies, deletes, merges and reconstructs thecharacteristic items of the development level of intelligent logistics, and finally obtains 14 evaluation indexes of the development level of intelligent logistics.

The sample data comes from the data collection in 2019, and the data that cannot be completely quantified and missing are collected by experts, including 50 training samples and 50 prediction samples, and the initial data table of intelligent logistics indicators is established, as shown in Table 3.

5.1.RS Reduction Processing

Table 3. Evaluation index data and evaluation grade

Sample	Serial number	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	Overall grade
Train sample	1	0.4	0.7	0.5	0.3	0.6	0.4	0.2	0.5	0.2	0.4	0.7	0.4	0.3	0.6	High
	2	0.5	0.3	0.6	0.4	0.7	0.5	0.1	0.4	0.5	0.6	0.5	0.3	0.5	0.4	Secondary
	···															···
	50	0.6	0.7	0.5	0.3	0.5	0.3	0.6	0.4	0.8	0.7	0.4	0.8	0.3	0.5	Low
Test sample	1	0.4	0.2	0.5	0.5	0.3	0.6	0.4	0.7	0.3	0.2	0.3	0.2	0.6	0.6	High
	2	0.7	0.5	0.4	0.2	0.5	0.3	0.6	0.2	0.7	0.4	0.6	0.6	0.4	0.2	Secondary
	···															···
	50	0.1	0.4	0.2	0.5	0.3	0.6	0.4	0.3	0.4	0.6	0.5	0.7	0.7	0.3	Low

In the process of the development level of intelligent logistics, in order to avoid the omission of important characteristic items, we will generally choose as many influencing factors as possible, but too many factors will increase the training input of SVM, increase the difficulty of calculation, and affect the speed and efficiency of training. Moreover, the use of these factors is not very useful for the prediction of unknown data. Therefore, the feature selection method is used to select the useful factors for classification as the input of SVM, and RS is a good method to solve this problem. In this paper, Johnson's algorithm is used for attribute reduction, and the minimum conditional attribute set composed of 10 feature items is obtained. These 10 influencing factors are the key factors. The corresponding original data form a new sample training set and test set, and the data are dimensionless and normalized. Through the attribute reduction of the data, the isometric discretization method is used to get the discretization decision table (the length of the article is limited, the decision table is brief), and then consult the relevant experts to adjust the discrete interval appropriately.

5.2. Training and Testing of SVM

After the training set is determined, the SVM knowledge acquisition, decision function construction and result verification are realized by programming on Matlab7.01 platform and SVMlab1.5 toolbox, and the risk prediction results are output. In order to verify the practicability and accuracy of RS-SVM model for evaluation. Through repeated training and learning, the training results are obtained.

Model training uses Matlab7.0 language programming to realize the training of SVM model, and chooses radial basis (RBF) function as the kernel function of the model, which has a wide convergence domain and is an ideal classification basis function, so it uses Gaussian radial basis kernel function for operation, and determines two parameters: penalty parameters and kernel parameters, and the parameters are selected by cross-verification method. Using 50 training samples as the learning set, it is found that the error is the smallest when the parameter values take the penalty parameter Cure 1.1647 and the kernel function k = 0.6507 respectively, and the SVM model is the optimal model.

According to the basic flow of the RS-SVM combination model, SVM, as the post-information recognition system of the prediction model, calculates the training samples through the cognition of the operation results of the training samples, and obtains the results.

After the training of the SVM model, the untrained samples were used to test the optimized SVM model. By testing the last 50 groups in Table 1, the test results are obtained, and the coincidence rate between the test level and the actual grade is 91.1657%, indicating that it is feasible to use support vector machine to evaluate the level of intelligent logistics, and the evaluation grade is qualified. It has good application and promotion value in the actual evaluation.

6. CONCLUSION

In this study, the framework of support system for the development of intelligent logistics is established, and through literature analysis and expert group discussion, the evaluation index system of intelligent logistics level is established, and a smart logistics level evaluation method based on support vector machine is proposed.

Rough set method does not need to provide any prior information outside the data set that the problem needs to deal with, and can express and deal with incomplete information only by using the information provided by the data itself, while SVM has good generalization ability; combining the advantages of the two methods is applied to the evaluation of intelligent logistics level.

Through empirical research and analysis, the level evaluation of intelligent logistics based on RS-SVM has higher accuracy and faster operation speed, so it can be applied to practical evaluation.

Although the application of support vector machine to the evaluation of intelligent logistics level is still in the exploratory stage, the intelligent logistics level evaluation model based on rough set attribute reduction and support vector machine proposed in this paper is easy to operate and has a good man-machine interface. It provides a way to evaluate the level of intelligent logistics under the background of epidemic resistance.

AUTHORS' CONTRIBUTIONS

In this paper, the authors refer to literature and combining with the reality of the present situation of logistics, building based on the macro conditions, technical conditions, human resource condition of intelligent logistics system, at the same time from the target layer, criterion layer and index layer three dimensions established the evaluation index system of intelligent logistics, and with rough sets and support vector machine to the intelligent logistics system is evaluated.

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REFERENCES

[1] Eckhardt J, Rantala J. The Role of Intelligent Logistics Centres in a Multimodal and Cost-effective Transport System[J]. Procedia Social & Behavioral Sciences, 2012, 48(07): 612–621.

[2] Kovalsky M, Mi I B. Support Planning and Optimization of Intelligent Logistics Systems[J]. Procedia Engineering, 2017, (192): 451-456.

[3] McFarlane D, Giannikas V, Wenrong L.Intelligent Logistics: Involving the Customer[J] .Computers in Industry, 2018, 81(9): 105-115.

[4] Liming H. Development Trend of Intelligent Logistics in China[J]. China's Circulation economy, 2017, (6): 3-7. "in Chinese". DOI:https://doi.org/10.14089/j.cnki.cn11-3664/f.2017.06.001.

[5] Zhitai W. Urbanization Needs Intelligent Logistics[J]. China's Circulation economy,2014, (3): 4-8. "in Chinese". DOI:https://doi.org/10.3969/j.issn.1007-8266.2014.03.001.

[6] Renshu L. The Construction of Intelligent Logistics Information Platform[J]. Logistics Engineering and Management,2014,(1):80-81. DOI:https://doi.org/10.3969/j.issn.1674-4993.2014.01.031.

[7] Yu W, Lifang G, Jiaqi M. Research on Real-time Risk Management Mechanism of Intelligent Logistics from the Perspective of Internet +[J]. Management Modernization, 2018,(1):98-101."in Chinese". DOI:https://doi.org/10.19634/j.cnki.11-1403/c.2018. 01.028.

[8] Lin Z. Research on Credit System and Evaluation Method of Intelligent Logistics Public Information Platform[D]. Chongqing: Chongqing Jiaotong University, 2017.

[9] Jun X, Jin L, Zhiyong Z. Research on the Theory, Technology and Application of Intelligent lLogistics System[J]. Scientific and Technological Innovation and Productivity, 2011, (4): 13-18. DOI:https://doi.org/10.3969/j.issn.1674-9146.2011.04.005.

[10] Shuhua D, Jingjia L. Intelligent Logistics System Architecture and Solution[J]. Information Research, 2012, (10): 6-10.

[11] Xiangyang Z, Zepei Y. Research on China's "Smart Cloud Logistics" Platform System and Collaborative Operation Mode in the Era of Online Shopping[J]. China Science and Technology Forum, 2013, (7): 99-104. "in Chinese". DOI:https://doi.org/10.3969/j.issn.1002-6711.2013.07.017.

[12] Yaping S. Intelligent Logistics Based on Internet of Things[J]. Logistics Technology, 2011, (9): 44-49. "in Chinese". DOI:https://doi.org/10.3969/j.issn. 1005-152X.2011.09.013.

[13] Guangli S. Research on the Development Model of Intelligent Logistics based on Internet of things[J]. Logistics Engineering and Management, 2015, (11): 111-114."in Chinese". DOI:https://doi.org/10.3969/ j.issn.1674-4993.2015.11.043.

[14] Lingling Z, Ming Z. Construction of Intelligent Logistics System Based on Cloud Platform[J]. Information and Computers, 2016, (4): 15-17. "in Chinese". DOI:https://doi.org/10.3969/j.issn.1003-9767.2016.04.009.

[15] Yaling W. A Probe into the Construction Path of Xi'an Intelligent City Based on the Conception of Digital Silk Road[J]. Economic Forum, 2017, (11): 47-51. "in Chinese". DOI: https://doi.org/10.3969/j.issn.1003-3580.2017.11.012.

[16] Linzhi Y, Haihong Y, Hejie Z. Research on the Construction Strategy of Intelligent Logistics in Ningbo[J]. Modernization of shopping malls, 2011, (6): 94-96."in Chinese". DOI: https://doi.org/10.3969/ j.issn.1006-3102.2011.17.054.

[17] Ronghe Y, Zonghui L, Xiangqian W. Study on Safety Management Risk Prediction Model of Coal Mine Enterprises---Based on SVM and RS[J] . East China Economic Management, 2014, 28(10): 159-163. DOI:https://doi.org/10.3969/j.issn.1007-5097.2014.10.030.

[18] Mamunur Rahman, Yuan Zhou, Shouyi Wang, Jamie Rogers. Wart Treatment Decision Support Using Support Vector Machine[J]. International Journal of Engineering and Manufacturing, 2020, 2(8): 1-11, DOI: 10.5815/ijisa.2020.01.01

[19] Vapnik V N. The Nature of Statistical Learning Theory[M]. NY: Springer-Verlag, 1995.

[20] Xuegong Z. On Statistical Learning Theory and Support Vector Machine[J]. Acta Automatica Sinica. 2000, 26 (1): 32-42.

[21] Ahmed Abdal Shafi Rasel, Mohammad Abu Yousuf. An Efficient Framework for Hand Gesture Recognition based on Histogram of Oriented Gradients and Support Vector Machine[J]. International Journal of Engineering and Manufacturing, 2019, 12(8): 50-56, DOI: 10.5815/ijitcs.2019.12.05

[22] Neela A G. Implementation of Support Vector Machine for Identification of Skin Cancer[J]. International Journal of Engineering and Manufacturing, 2019, 11(8): 42-52, DOI: 10.5815/ijem.2019.06.04

[23] Cheng P. Research on the Support System of Anhui Intelligent Logistics Development[D]. Hefei: Anhui University, 2019.