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Application of RFID technology in the construction and design of quasi automatic warehouse management system for electric power company

LI YUAN¹, QIU XIAOPING^{2,3}, TAN GANG¹, ZU XUEYING¹

Abstract. The quasi-automated warehouse management system based on RFID technology plays an important role in improving the turnover efficiency and the comprehensive level of enterprises. At present, China's RFID technology quasi-automated warehouse management system research still has some shortcomings. In order to solve this situation, the research on the relevant theory and concept were clarified and summarized, on this basis, RFID technology was used, and quasi-automated warehouse management system was constructed and designed and applied to the actual power company applications. Finally, the influence factors of quasi-automated warehouse management system of RFID technology and traditional technology were analyzed and compared by gray relational analysis. The results show that the quasi-automated warehouse management system of RFID technology has a positive impact on the development of enterprises.

Key words. RFID technology, quasi-automation, warehouse management system, electricity company.

1. Introduction

With the development of the times, the operation mode and result of every industry begin to be more complicated. The further improvement of the industrial chain structure makes the warehousing management in the industry become the key link of the normal operation of the industry, which has important influence and positive influence on the connection between the main body and the consumer group. In particular, in the context of the gradual increase in the competitiveness of various industries today, reasonable warehouse management system is very important for

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the promotion and development of enterprise competition ability. Under the background of the rapid development of the industry, the traditional warehouse management system has been unable to meet the needs of enterprise development, which urgently requires enterprises and individuals to further advance the overall level of the enterprise through some advanced concepts and technologies. In the high-speed process of the times, many advanced technologies have begun to emerge and combine with the traditional warehouse management system, such as the popularity of computer computing, many companies have begun to apply the technology to its warehouse management system construction process. Because computer technology has the characteristics of large amount of data and large sharing, the reference of this kind of technology effectively improves the management efficiency of warehouse management system and makes the operation period of the whole enterprise be guaranteed. Therefore, the comprehensive level of the whole enterprise or industry has been greatly improved. This research will mainly take the electric power company as the research object, design and study the construction of its quasi automatic warehouse management system, so as to determine the operation advantages of the warehouse management system. The research results are mainly aimed at providing some reference and scientific support for the development of the industry.

2. State of the art

As an important hub for manufacturers and consumers in every industry or industry in today's era, the warehouse management system has a very important impact on the development of a company or business [1]. With the increasing competition level of various industries in recent years, some companies or enterprises have begun to study warehouse management system as an important direction of their future development [2]. Some research suggests that a more reasonable warehouse management system can effectively reduce the cost of manpower during the operation of the company, and can effectively promote the efficiency of product and capital turnover during the development of the industry, and thus have a positive effect on the enhancement of enterprise competitiveness. Many scholars have begun to study more scientific and systematic warehouse management system, and combine the current practical computer technology with the traditional system construction to form a relatively new management system [3]. Some related theories have also been put forward and applied, such as the development of RFID technology and quasi-automated warehouse management system, this technology is based on the traditional enterprise warehouse management system, and introduces more popular computer technology and RFID theory technology [4]. In the perspective of electronic management information, it has a reasonable return on the warehousing products, which has brought some positive effects on the improvement of the final efficiency of warehouse management. It has been found that the warehouse management system based on the technology can directly or indirectly promote the level of comprehensive competition for the enterprise [5].

3. Methodology

Since entering the new century, China's comprehensive national strength and social status have been a certain degree of improvement and progress, various industries have a higher development. In the development of some industries in China, as the key link of the whole industry, the warehouse management system has been continuously improved, which has brought positive effects on the progress of related industries in China. However, due to the scale of development of some enterprises in China is not perfect, the enterprise started relatively late, so the management of the warehouse is only based on the traditional warehouse management system [6]. The system mainly records the relevant data of the warehouse in and out, and uses the paper record method to track the actual running path of the product. However, due to the complete reliance on manual completion, the traditional warehouse management system lacks a certain automation process. With the continuous development of the company and the expansion of the scale, the amount of product storage in a company or enterprise is increasing, which creates some difficulties and obstacles for manual product recording. This is likely to be influenced by certain subjective factors due to simple reliance on artificial methods, resulting in errors in path information tracking of late related products, thus affecting the overall efficiency of the entire process of operation [7]. Therefore, the traditional warehouse management system has begun to seriously hinder the improvement of the competition level of some enterprises or companies in China, and make these companies or enterprises operating costs continue to increase, directly or indirectly caused the company's service quality decline [8]. Although the quasi automatic warehouse management system in some industries in China has a high degree of development and progress, but China's introduction of this technology is relatively late, some theories are still not perfect. Therefore, some of the quasi automated warehouse management systems in some of our enterprises still have some problems, mainly summarized as presented in [9].

The quasi automated warehouse management system under RFID technology is not enough to monitor the related ways of the whole product import and export, because the development of the degree of automation is relatively slow, so there is still the possibility of product storage error in the whole management system.

This has an impact on the increase in the probability of searching and verifying errors in the post-system for product-related information. And with the continuous increase in the scale of production of certain enterprises or companies, in order to better meet the individual needs of customers, the categories of related products produced by the company are also increasing, which makes the storage of the warehouse more pressure. The promotion of people's economic level has also led to the increase of the frequency of the relevant products in and out of the warehouse.

Compared with the traditional warehouse management system, today's warehouse management system began to be more complex and diversified, which requires the development and application of technologies that have a faster and more accurate record of the import and export records of the relevant warehouse products.

In order to better study the construction of quasi-automated warehouse man-

agement system in our country, and to provide reference for improving the comprehensive strength of Chinese enterprises, this study first analyzed and summarized the relevant composition and principle of the quasi-automatic management system of enterprise warehouse in China, and then analyzed and summarized the related characteristics of RFID technology. First of all, through the reading and analysis of relevant documents, the relevant composition of RFID-based technology is shown in Fig. 1 [10].

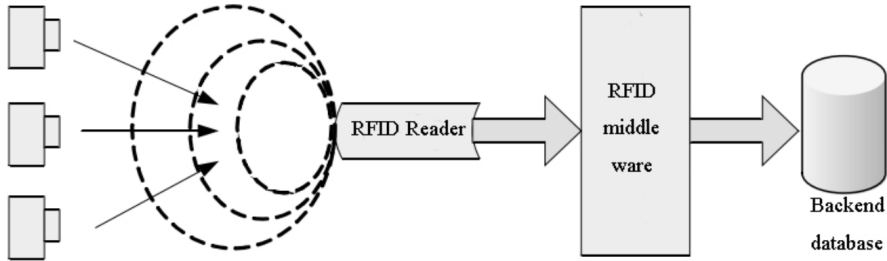


Fig. 1. System composition of RFID technology

On the basis of the relevant theory, the paper summarizes the comparative advantages of the quasi-automated warehouse management system based on RFID technology and the traditional warehouse management system. On this basis, the design goals, construction systems, and the final workflow of the relevant of the automatic management system of electric warehouse based on RFID technology system were designed and discussed, so as to construct RFID technology automatic warehouse management system used in this study.

Then, this study took a power company as the actual test case design, designed the automatic warehouse management system for the power company to introduce RFID Technology. The related RFID technology automatic warehouse management system used the computer language to carry on the programming, finally through the computer programming formed the correlation system construction.

The quasi-automated warehouse management system of the power company designed by the above process was applied to the actual power company warehouse management, and the relevant parameters were statistically and compared, and then the advantages of the quasi-automated warehouse management system were determined. The main influencing factors are shown in Table 1 [11].

Finally, the above parameters were statistical and survey, grey correlation analysis theory was used to synthetically analyze the influence factors of warehouse management system of different technology, so as to determine the influence coefficient of each influence factor in the process of warehouse management of power companies, which provides some scientific reference for the construction and development of the related automation system, and then provides the scientific basis for the optimization and improvement of the existing system. The relevant gray relational analysis model is described below.

Table 1. The main influencing factors required for this study

Primary evaluation parameter	Two stage evaluation parameter	Number
Running cost	The reuse of electronic tags	X1
	Automatic recognition technology	X2
Outbound speed	Outbound speed	X3
	Storage speed	X4
Accuracy	Receiving operation processing	X5
	Picking job handling	X6
	Transport operations processing	X7
	Resource mastery	X8
Stocktaking time	Account alignment	X9
Item query	The state of the object	X10
	Storage status	X11

$$X_b(K) = \frac{X_b^{(0)}(K)}{\frac{1}{n} \sum_{a=1}^n X_a^{(0)}(K)}, \quad b = 1, 2, \dots, n, \quad K = 1, 2, \dots, n. \quad (1)$$

Here, $X_b(K)$ represents the dimensionless value of the final survey of each data, $X_b^{(0)}(K)$ and $X_a^{(0)}(K)$ represent the average values and the actual survey value of the actual survey of each parameter, respectively.

$$\varepsilon_a(K) = \frac{\min \min |X_b^{(0)}(K) - X_a^{(0)}(K)| + \rho \max \max |X_b^{(0)}(K) - X_a^{(0)}(K)|}{|X_b^{(0)}(K) - X_a^{(0)}(K)| + \rho \max \max |X_b^{(0)}(K) - X_a^{(0)}(K)|}. \quad (2)$$

Here, $\varepsilon_a(K)$ stands for the correlation coefficients between the parameters designed in this study and the automated warehouse management system, while ρ represents the resolution coefficient.

Finally,

$$\gamma_a = \frac{1}{m} \sum_{k=1}^m \varepsilon_a(K), \quad a = 1, 2, \dots, n). \quad (3)$$

Here, γ_a represents the relevance of the relevant parameters involved in this study and quasi-automated warehouse management system. The greater the value is, the greater the effect of the parameter on the construction of the warehouse management system is, and vice versa.

4. Result analysis and discussion

The emergence of computer technology has provided some opportunities for the development of certain industries in China. Many companies in China began to

introduce computer technology into their warehouse management system, and further formed a new warehouse management system which can store and share large amounts of data, brought a more positive impact on the comprehensive development of China's enterprises to a certain extent, made our country's many industrial structure constantly improved and developed, as a result, many of our industry has been able to survive in the growing competition among enterprises (Fig. 2) [12].

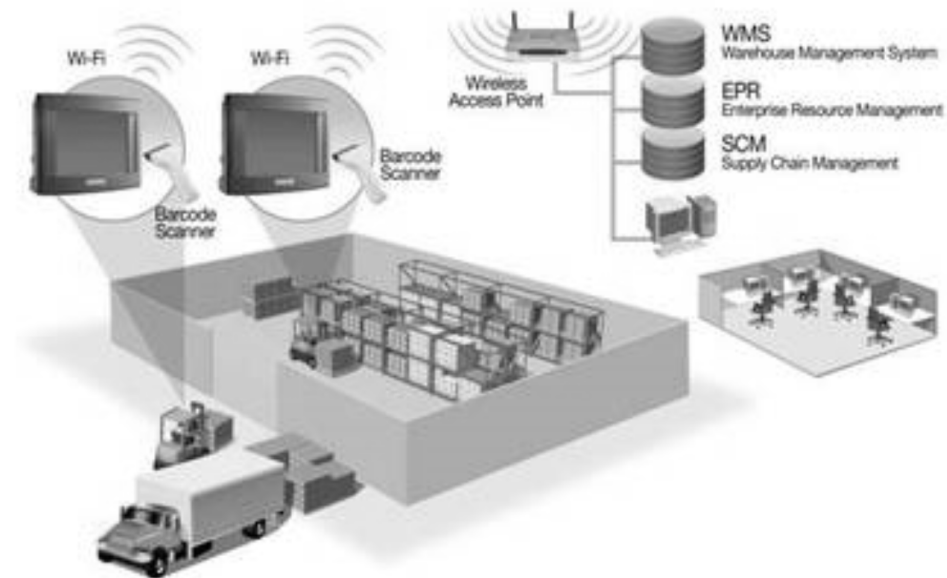


Fig. 2. Application model of enterprise automated warehouse management system in China

Based on the analysis of the application pattern of the automated warehouse management system in our country, the paper further analyzed the advantages and disadvantages of the automated management system under different technologies through the analysis of the relevant data. The analysis results are shown in Table 2 [13]. The results show that the warehouse management system under RFID technology is obviously superior to the traditional warehouse management system in terms of anti-collision technology, storage capacity, inner code recognition and locking of inevitable information, because the warehouse management system of RFID technology has a longer service life, it can adapt to the bad working environment, and the material of relative components is more flexible, so it can be used in different occasions [14].

Based on the clarity of the relevant theory, this study further designed the application of the quasi automated warehouse management system through the relevant programming language, further used the computer to run through the use of the relevant programming language. The interface of the final design inventory management system is shown in Fig. 3 [15]. The performance of the automatic warehouse management system was verified by following up.

Table 2. Comparison and analysis of warehouse storage technologies with different technologies

	RFID technology	Traditional techniques
Anti-collision technology	Without linear scanning, the speed of reading and writing is fast, and it can be used in multi-object identification and motion recognition, with the maximum recognition of 50 at the same time	The scan must be straight, the reading and writing speed is relatively slow, and the recognition target is less
Internal storage space	The production department can produce different types of product storage capacity and the number of bytes per sector according to its needs, and the read and write device can read the memory configuration information, easy to operate in a comprehensive application of different label products	The production department may not be able to obtain more accurate actual demand information, and the storage space is limited, and it can't carry out comprehensive operation on more product information
Identification code	Using the internationally unified and non-repeating 8-byte unique identification of the inner code: the 1-48bit consists of 6 bytes, encoding for product manufacturers, one byte of the 49th to 56th bits is the vendor code	No fixed code recognition, so the relevant statistical information may cause confusion and loss of relevant information
Critical information lock	Read and write again and the sector can be locked independently	Unable to lock information according to user's actual requirement
A sector	4 bytes	2 bytes
Memory	512 bit~2048 bit	less
Service life	More than 10 years long	short
Read and write times	More than 100,000 times	Less than 50,000 times
Operating temperature	-25 degrees to +70 degrees	Constant temperature state
Material	Flexible package	Simple package
Application	Wide range of applications	Narrow use

The figure for inventory management software Excel file contains the A column for the warehouse only in a product name, B column for the product of production costs, the C column represents the average daily rent expense of certain products, D represents the product transport costs, and E contains the product sales platform rental fee.

On the basis of the design of the related management system, a power company

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
19	Laughing Lumberjack Lager	\$ -	\$ 518.00	\$ 390.00	\$ 42.00											
20	Longlife Tofu	\$ 488.00	\$ -	\$ -	\$ 512.50											
21	Louisiana Fiery Hot Pepper Sauce	\$ 1,347.36	\$ 2,750.69	\$ 1,375.62	\$ 3,899.51											
22	Louisiana Hot Spiced Okra	\$ 1,509.60	\$ 530.40	\$ 68.00	\$ 850.00											
23	Mozzarella di Giovanni	\$ 1,390.00	\$ 4,488.20	\$ 3,027.60	\$ 2,697.00											
24	Northwoods Cranberry Sauce	\$ -	\$ 1,300.00	\$ -	\$ 2,960.00											
25	Ravioli Angelo	\$ 499.20	\$ 282.75	\$ 390.00	\$ 994.75											
26	Sasquatch Ale	\$ 551.60	\$ 665.00	\$ -	\$ 890.40											
27	Sir Rodney's Marmalade	\$ -	\$ 4,252.50	\$ 3,061.80	\$ -											
28	Sir Rodney's Scones	\$ 1,462.00	\$ 644.00	\$ 1,733.00	\$ 1,434.00											
29	Steeleye Stout	\$ 1,310.40	\$ 1,368.00	\$ 1,323.00	\$ 1,273.50											
30	Teatime Chocolate Biscuits	\$ 943.89	\$ 349.60	\$ 841.80	\$ 851.46											
31	Uncle Bob's Organic Dried Pears	\$ 1,084.80	\$ 1,575.00	\$ 2,700.00	\$ 3,876.50											
32	Veggie-spread	\$ 3,202.87	\$ 263.40	\$ 842.88	\$ 2,590.10											
33	Grand Total	\$ 24,612.91	\$ 43,435.04	\$ 41,640.74	\$ 44,803.26											
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Fig. 3. Output data table output of automatic warehouse management system of electric power company

was taken as the actual research object, and the main influence parameters of the quasi-automated warehouse management system based on RFID technology and the traditional management system were analyzed statistically. In the study, 100 employees conducted a random survey, and the percentage of the impact of the factors was recorded, the results shown in Table 3.

Table 3. Statistical results of the influencing factors required for this study

Secondary evaluation parameters	Numbering	RFID technology	Traditional technology
Repetitive Usability of Electronic Labels	X1	0.57	0.46
Automatic reading technology	X2	0.84	0.68
The speed of the library	X3	0.77	0.74
Storage speed	X4	0.86	0.82
Receiving operation processing	X5	0.81	0.79
Picking operation	X6	0.58	0.48
Handling of transportation operations	X7	0.63	0.61
Resource Mastery	X8	0.73	0.64
Account alignment	X9	0.82	0.74
The state of an object	X10	0.55	0.49
Storage status	X11	0.45	0.41

Then, the gray correlation analysis model was used to calculate the correlation percentage. The correlation degree of each influencing factor is shown in Table 4. The results show that the main influencing factors of warehouse management system with different application technologies are different. For the RFID technology warehouse management system, automatic reading technology is its most important influencing factors, followed by the handling of receiving operations and further control of some information resources; and for the traditional technology warehouse management system, the influential factors are the statistics of the status of the product, the operation process of product receipt and the control of relevant information resources. Therefore, when using different technologies to build warehouse management system, it is necessary to consider the related factors so as to obtain a more perfect system model.

Table 4. Analysis and sequencing of the correlation degree of the influencing factors of the warehouse management system of RFID technology and traditional technology

Technology factor	RFID technology		Traditional technology	
	Correlation degree r	Sorting	Correlation degree r	Sorting
X1	0.577	4	0.467	9
X2	0.774	1	0.481	8
X3	0.550	5	0.624	4
X4	0.490	8	0.393	11
X5	0.765	2	0.686	2
X6	0.537	6	0.571	5
X7	0.513	7	0.527	6
X8	0.686	3	0.637	3
X9	0.443	9	0.511	7
X10	0.356	10	0.732	1
X11	0.311	11	0.397	10

5. Conclusion

As an important link in the development of modern industry, warehouse management can effectively combine the production of enterprises with the needs of consumers, and provide more accurate development planning for the future development of enterprises. A reasonable warehouse management can effectively improve the efficiency of enterprise operation. The development of RFID technology has provided some positive influence to the improvement of warehouse management system. However, there are still some defects and deficiencies in the warehouse management system of RFID technology in our country, which has restricted the development of the whole enterprise. In this study, the related concepts of RFID technology were sorted out by reading and summarizing the relevant data. On this basis, the quasi-automated warehouse management system of RFID technology was further designed and applied to the actual electric power enterprise. The automatic warehouse management system of RFID technology and traditional technology was contrasted and analyzed, and the gray relational analysis model was used to determine its main influencing factors. The research shows that the quasi-automated warehouse management system of RFID technology has more advantages than traditional technology, and has a positive effect on the development of related enterprises in China. Due to the author's level, there are some shortcomings in this study, but it can provide theoretical basis and reference for the follow-up study.

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