Research on Risks of ERP System in the Application of Electric Power Logistics

Jiaquan Liu*

(College of Business Administration, Liaoning Technical University, Huludao, Liaoning, 125105, China)
*L1747248716@outlook.com

Abstract. The integration of Enterprise Resource Planning (ERP) systems in the field of electric power logistics presents both opportunities and challenges due to the complex nature of the industry. This research explores the risks associated with ERP system implementation in electric power logistics and proposes a risk assessment model to evaluate these risks effectively[1]. By constructing a comprehensive risk evaluation index system and utilizing the entropy weight method along with fuzzy comprehensive evaluation, the research aims to provide insights into managing risks related to environmental factors, management issues, software challenges, and data integrity. Additionally, strategies for risk control in ERP application within power logistics are discussed, emphasizing the importance of addressing environmental risks such as price fluctuations and selecting reliable software and consulting service providers[2]. Furthermore, effective management risk control strategies are highlighted, stressing the need for organizational restructuring, process optimization, and change in management perceptions to ensure successful ERP system implementation. This research contributes to enhancing the understanding of ERP system risks in electric power logistics and offers recommendations for mitigating these risks to support sustainable and efficient industry operations.

Keywords: ERP systems, power logistics, risk assessment

1 INTRODUCTION

The integration of Enterprise Resource Planning (ERP) systems in the field of electric power logistics has been a significant area of interest due to its potential to streamline operations, enhance efficiency, and improve overall performance. As the electric power industry involves complex supply chains, large-scale infrastructure, and critical timelines, the implementation of ERP systems presents both opportunities and challenges[3].

Given the critical role of electric power in supporting essential services and economic activities, it is imperative to undertake a thorough investigation into the risks that may emerge from ERP system integration within the domain of electric power logistics. Addressing these risks is essential to ensure the seamless operation of vital energy supply chains and to mitigate any adverse impacts that may arise from the adoption of ERP systems in this context. Therefore, this research aims to provide valuable insights

V. Vasilev et al. (eds.), *Proceedings of the 2024 5th International Conference on Management Science and Engineering Management (ICMSEM 2024)*, Advances in Economics, Business and Management Research 306,
https://doi.org/10.2991/978-94-6463-570-6_4

into the risks associated with the implementation of ERP systems in electric power logistics and to offer recommendations for effective risk management strategies to support the sustainable and efficient functioning of the industry[4].

2 CONSTRUCTION OF POWER LOGISTICS ERP APPLICATION RISK EVALUATION INDEX SYSTEM

There are many scholars who have studied the risk evaluation index system of enterprise ERP system. From the perspective of risk management, some scholars put forward five types of uncertainty factors that affect the application of ERP system in enterprises, namely, system risk, implementation risk, transformation risk, management risk and personnel risk[5]. Some scholars have divided the uncertainty factors of enterprise ERP system application into four categories: external risk, software risk, implementation risk and transformation risk, which can be further subdivided, so as to build a complete ERP system application risk evaluation index system. On the basis of previous research results, In view of the key influencing factors in the process of ERP implementation and application[6], various uncertain factors that enterprises may encounter in the process of ERP application are divided into four categories: environmental risk, management risk, software risk and data risk, and thus the power logistics ERP application risk evaluation index system is constructed, as shown in Table 1.

Table 1. Power logistics ERP application risk evaluation index system

Primary index	Secondary index
Environmental Risk R1	Price volatility risk R11
	Software Vendor Risk R12
	Consulting service Provider Risk R13
Managing Risk R2	Managing perception change risk R21
	Organizational restructuring risk R22
	Risk of internal control failure R23
	Process optimization and reorganization risk R24
Software Risk R3	Software technical risks R31
	Software functional risk R32
	Software Security Risk R33
Data risk R4	Data integrity risk R41
	Data normative risk R42
	Data correctness risk R43
	Data timeliness risk R44

3 RISK ASSESSMENT MODEL OF ERP APPLICATION IN POWER LOGISTICS

Combining entropy weight method and fuzzy comprehensive evaluation, this paper assesses ERP application risk in electric power logistics. By integrating quantitative and qualitative approaches, it enhances objectivity. However, each method has inherent strengths and weaknesses, necessitating careful consideration in risk evaluation.

3.1 Overview of Model-Related Theories

Fuzzy comprehensive evaluation (FCE) employs fuzzy mathematics to assess quantitative indicators, making it suitable for risk assessment and product quality evaluation. It constructs hierarchical fuzzy subsets, calculates affiliation ranges, and determines comprehensive results. Information entropy weighting reduces subjective influence, aiding in ERP application risk assessment[7].

3.2 Entropy Weight Method is Used to Calculate Index Weights

When examining a certain attribute Aj, with a calculated value of Xij, and assuming that the computed value belongs to k categories, denoted by Φij1, Φij2, ..., Φijk, where $0 \leq \Phi ijk \leq 1$, {Φijk} represents the probability distribution of the calculated values of this attribute. In this case, the formula for calculating the entropy corresponding to these probability values is:

$$H_{\text{ij}} = -\sum_{k=1}^{k} \Phi_{\text{ijk}} \bullet \log_{10} \Phi_{\text{ijk}} \tag{1}$$

When Φijk=1/k, the value of log10Φijk is maximized, indicating the highest degree of uncertainty. From a probabilistic perspective, if we represent the measure of any category as 1/k, it would render each specific attribute ineffective in distinguishing the samples, and may even lead to situations where a particular attribute value simultaneously belongs to several measures. On the other hand, if there is a value in Φijk that represents a probability of 1, with the remaining values being 0, it would result in a definitive classification, allowing for the determination of the measure in which the value falls. Therefore, the more concentrated the values of the kth measure in Φijk are, the smaller the resulting calculated entropy will be, indicating reduced uncertainty that the indicator can reflect, and thus yielding a more precise outcome.

$$\eta_{\text{ij}} = 1 + \log_{10} k \sum_{k=1}^{k} \Phi_{\text{ijk}} \bullet \log_{10} \Phi_{\text{ijk}} \tag{2}$$

Clearly, there exists $0 \leq \eta ij \leq 1$, satisfying the following: the larger the value of ηij, the smaller the entropy. When ηij=1, it is certain that there will be a measure in Φijk that equals 1. In other words, if the obtained samples are divided into k categories, it can be completely determined which measure they belong to. Therefore, as Φij becomes more concentrated, the influence of attribute values on identifying the category to which a sample belongs increases. It is precisely due to this property that we define:

$$\Phi_{ij} = \frac{\eta_{ij}}{\sum_{i=1}^{n} \eta_{ij}} \tag{3}$$

Φij satisfies 0 ≤ Φij ≤ 1, and at the same time $\sum_{j=1}^{n} \Phi ij = 1$, the larger Φij is, the greater influence the calculated value of the indicator has on identifying the category to which the sample belongs. Therefore, we can use the vector Φi=(Φi1, Φi2, ..., Φin) to represent the weighting of a certain attribute. Once the weights of the secondary indicators are determined, the weights of the primary indicators need to be established. Since information entropy is also a form of entropy, the same principle applies when using entropy weight method to calculate the weights of primary indicators. Assuming there are l primary indicators, the formula for calculating the entropy weight of the primary indicators based on the definition of entropy and the entropy weight of the secondary indicators is as follows:

$$w_i = \frac{\sum_{j=1}^{n} (1 - H_{ij})}{\sum_{i=1}^{l} \sum_{j=1}^{n} (1 - H_{ij})} \tag{4}$$

4 SPECIFIC CALCULATION PROCESS OF THE MODEL

In this paper, entropy weight method is used to calculate the weight of each level of indicators, and then fuzzy comprehensive evaluation is used to evaluate each level of indicators. Finally, the membership degree of total risk assessment is calculated, and the global risk can be evaluated according to this value.

The first step: Construct the factor set and the comment set of the evaluation object.

If there are P evaluation indicators, denoted as u={u1, u2, ..., up}; the comment set is v={v1, v2, ..., vp}, with a fuzzy subset corresponding to each level. The risk assessment comment set is shown in the table below:

Table 2. power logistics ERP application risk assessment set

Risk level	Value-at-risk set	Risk description
Lower risk	(0,0.2)	The index risk is low and can be ignored
Low risk	[0. 2, 0.4)	The index risk is low and within an acceptable range
General risk	[0. 4, 0.6)	The index risk is moderate and belongs to the edge risk, but it needs to attract the attention of policymakers
High risk	[0.6, 0.8)	The index risk is high, it is unacceptable risk, and measures should be taken to prevent it
Higher risk	[0. 8,0.1)	The index risk is high, which belongs to disaster risk.

		Once it occurs, the system will be seriously damaged. The decision maker should build a conventional prevention mechanism to avoid such risks

The second step: single factor evaluation and construction of fuzzy relation matrix.

The calculation of the membership degree for the first type of indicator begins by determining the optimal and worst values for the indicator, assumed to be rmax and rmin (where rmin<rmax). Then, three equidistant points a1, a2, and a3 are inserted into this interval. The process for determining the membership degree of the indicator is as follows:

$$r_{ij}^{(1)} = \begin{cases} 1 & I \geq r_{max} \\ \frac{(r_{max} - a_3)}{D}, & a_3 \leq I \leq r_{max} \end{cases}$$

$$r_{ij}^{(2)} = \begin{cases} \frac{(r_{max} - I)}{D}, & a_3 \leq I \leq r_{min} \\ \frac{(I - a_3)}{D} & a_2 \leq I \leq a_3 \end{cases}$$

$$r_{ij}^{(3)} = \begin{cases} \frac{(a_3 - I)}{D} & a_2 \leq I \leq a_3 \\ \frac{(I - a_2)}{D} & a_1 \leq I \leq a_2 \end{cases},$$

$$r_{ij}^{(4)} = \begin{cases} \frac{(a_3 - I)}{D} & a_4 \leq I \leq a_3 \\ \frac{(I - r_{min})}{D} & r_{max} \leq I \leq a_3 \end{cases},$$

$$r_{ij}^{(5)} = \begin{cases} \frac{(a_1 - I)}{D}, & r_{min} \leq I \leq a_3 \\ 1 & I \leq r_{min} \end{cases} \quad (5)$$

The determination of the second type of indicators is consistent with the solution method of the previous type of indicators, but the attributes of this type of indicators determine its calculation process is slightly different, the specific calculation process is as follows:

$$r_{ij}^{(1)} = \begin{cases} 1 & I \leq r_{min} \\ \frac{(a_1 - 1)}{D}, & r_{min} \leq I \leq a_1 \end{cases}$$

$$r_{ij}^{(2)} = \begin{cases} \dfrac{(I - r_{max})}{D}, & r_{min} \le I < a_1 \\ \dfrac{(a_1 - I)}{D} & a_1 \le I < a_2 \end{cases}$$

$$r_{ij}^{(3)} = \begin{cases} \dfrac{(I - a_1)}{D}, & a_1 \le I \le a_2 \\ \dfrac{(a_3 - I)}{D} & a_2 \le I \le a_3 \end{cases}$$

$$r_{ij}^{(4)} = \begin{cases} \dfrac{(I - a_2)}{D}, & a_2 \le I \le a_3 \\ \dfrac{(a_4 - I)}{D} & a_3 \le I \le r_{max} \end{cases}$$

$$r_{ij}^{(5)} = \begin{cases} \dfrac{(I - a_1)}{D}, & a_3 \le I \le r_{max} \\ 1 & I \ge r_{max} \end{cases} \tag{6}$$

If the evaluation index is difficult to be expressed numerically, the evaluation experts need to score the evaluation index according to the content specified in the evaluation set to determine, and the fuzzy matrix R' of the experts for the evaluation index can be obtained.

$$R' = (r_{ij}^{'})_{l \times m} \begin{bmatrix} r_{11}^{'} & r_{12}^{'} & L & r_{1m}^{'} \\ r_{21}^{'} & r_{22}^{'} & L & r_{2m}^{'} \\ L & L & L & L \\ r_{l1}^{'} & r_{l2}^{'} & L & r_{l1}^{'} \end{bmatrix} \tag{7}$$

Where i=1,2L,1; J = 1, 2, L, m

Step 3: Determine indicator weights.

The entropy weight method is used to calculate the weights of each index.

Step 4: Make a comprehensive evaluation

The rows in R 'represent the membership degree of each risk level determined by each expert for different single-factor indicators. At the same time, the fuzzy comprehensive evaluation vector (wi') of each level of indicators can be obtained by synthesizing the weight of each level of indicators obtained in the third step (set as w) with this fuzzy matrix, namely:

$$\mathrm{w_i} \bullet R' = (w_1, w_2, L, w_i)\begin{bmatrix} r'_{11} & r'_{12} & L & r'_{1m} \\ r'_{21} & r'_{22} & L & r'_{2m} \\ L & L & L & L \\ r'_{l1} & r'_{l1} & L & r'_{lm} \end{bmatrix} = (\mathrm{w}'_1, \mathrm{w}'_2, L, \mathrm{w}'_\mathrm{i}) = \mathrm{w}' \tag{8}$$

If $\sum \mathrm{w_i} \neq 1$, normalization is performed. After calculating the fuzzy comprehensive evaluation vector, it is necessary to analyze the result. Since the fuzzy comprehensive evaluation vector obtained at last is derived from the weight of first-level indicators and their membership degree through fuzzy calculation, each component in w represents the extent to which each level of indicators belongs to a certain risk level, and the risk level of each level of indicators can be obtained according to the review set of risk levels. Finally, according to the principle of maximum membership degree of fuzzy evaluation, the application risk of ERP system of power logistics is evaluated as a whole.

5 RISK CONTROL OF ERP APPLICATION IN POWER LOGISTICS

5.1 Control of Environmental Risks

The environmental risk control of power logistics ERP application mainly includes the risk of commodity price fluctuation and software and consulting supplier selection. Dynamic changes in commodity prices will have a risky impact on ERP, so ensuring that ERP procurement, settlement and other price information can be synchronized with market price information in a timely manner is the key to controlling this risk[8]. In addition, according to the principle of "information quality leverage", the importance of choosing the right software vendors and consulting service providers is ten or even a hundred times more important than choosing software packages. Therefore, careful selection of high-quality hardware and software vendors and consulting service providers is the key to the success of enterprise management informationization[9].

5.2 Management Risk Control

ERP system is not only a set of software, but also a set of advanced management concepts. Many enterprises in the application of ERP systems, senior decision makers did not realize that the application of ERP systems need to change the concept of thinking and management mode, and optimize business processes. If the application of ERP system is only regarded as a technical work, it may lead to errors in the selection, implementation and application of ERP system. Therefore, it is necessary to pay attention to learning new management concepts and methods, and to unify the thinking of all employees to the goal of ERP application. In the process of implementing ERP, the quality and even the attitude of the system users can be a decisive factor affecting the success of ERP system application. Therefore, it is necessary to strengthen the training of personnel to ERP, but also need to have a leader with strong authority responsible for the implementation of ERP applications.

6 CONCLUSION

The application of ERP system in the field of power logistics faces a number of risks, including environmental risks, management risks, software risks and data risks. In the face of these risks, a series of risk management measures need to be taken to ensure the smooth implementation and operation of the ERP system. For environmental risks, attention needs to be paid to commodity price fluctuations and the choice of software service providers. For management risk, enterprises need to recognize that ERP system is not only a technical work, but also need to introduce modern management concepts at the same time. In addition, training of system users and firm support from leaders are also critical. For software risk and data risk, it is necessary to use a comprehensive evaluation model combining the fuzzy comprehensive evaluation method and the information entropy weighting method for risk assessment and to develop corresponding risk control strategies. In general, effective risk management is crucial for the application of ERP systems in the field of power logistics[10]. Only through scientific risk assessment and accurate risk control can the smooth operation of the ERP system be ensured, thus improving the logistics management efficiency and promoting the sustainable development of the power logistics industry.

REFERENCES

1. Xu Xiangnan, Meng Xin. Research on the Application of ERP in Electric Power Logistics Informatization [J]. Science and Technology Wind, 2019, (33): 228. DOI:10.19392/j.cnki.1671-7341.201933196.
2. Ma Yuepeng. On the Application of ERP in Informationization of Electric Power Logistics [J]. Modern Industrial Economy and Informatization, 2017, 7 (23): 36-37+53. DOI:10.16525/j.cnki.14-1362/n.2017.23.14.
3. Sun Hao. Research on Problems and Countermeasures of Electric Power Logistics Management [J]. Logistics Engineering and Management, 2015, 37 (02): 22-23+38.
4. Chen Liang. Research on the Application of ERP in Informationization of Electric Power Logistics [J]. Computer CD Software and Applications, 2013, 16 (24): 129-130.
5. Dai Qinghui, Zhang Nan. Research on the Application of ERP in Informationization of Electric Power Logistics [J]. Science and Technology Innovation Guide, 2011, (05): 198. DOI:10.16660/j.cnki.1674-098x.2011.05.094.
6. Nugraha Diki Wahyu, Ismail Hariadi, Wardhana Aditya, et al. A systematic literature review: implementation of ERP systems in logistics companies supply chain management in developed and developing countries. 2023, 12936:129360W-129360W-8.
7. Reyes Abanto Nayely, Medina Perez Jenifer, Zapata Paulini Joselyn, et al. Implementation of an ERP System for the Improvement of the Logistics Process in an SME. 2023, :387-398.

8. Wang Xuejiao, Zhao Jie, Zhang Hongjun, et al. The Impact of the Scale of Third-Party Logistics Guaranteeing Firms on Bank Credit Willingness in Supply Chain Finance: An ERP Study
[J]. Frontiers in Psychology, 2022, 13:853888-853888.
9. Li Qingping, Wu Guoqiang, . ERP System in the Logistics Information Management System of Supply Chain Enterprises[J]. Mobile Information Systems, 2021, 2021
10. Kliestik T., Polivka Martin, Dvorakova Lilia, et al. Selection of the ERP System with Regard to the Global 4th Industrial Revolution[J]. SHS Web of Conferences, 2021, 92:04019-04019.