Research on the Risk Management of Disposal of Abandoned Tobacco Monopoly Products Based on the AHP-FCE Comprehensive Evaluation Model

Yuanzhen Zhou, Shaoxia Lin*, Yong Zhang

Zhejiang Tobacco Industry Co., Ltd., Hangzhou, China

*359016@qq.com

Abstract. At present, cigarette manufacturing enterprises are confronted with the management challenge of disposing of waste tobacco monopoly products, with prominent management risks. Based on the cigarette manufacturing enterprise where the author works, this paper uses a combination model of the Analytic Hierarchy Process and the Fuzzy Comprehensive Evaluation Method to stratify and assess the management risks of the disposal process of waste tobacco monopoly products. Combined with expert opinions, a new risk assessment index system is constructed. Through data collection and analysis, the results show that the current disposal risk of waste tobacco monopoly products is relatively high. Based on the assessment results, targeted measures such as software and hardware upgrades, increased monitoring coverage, and the application of innovative technologies and platforms have been taken, significantly reducing the management risks of the disposal of waste tobacco monopoly products.

Keywords: Abandoned Tobacco Monopoly Products, Analytic Hierarchy Process, Fuzzy Comprehensive Evaluation Method, Risk Assessment, Risk Prevention and Control Introduction

1 Introduction

Waste tobacco monopoly products refer to the waste materials and auxiliary materials generated during the cigarette production process. The disposal and management of waste tobacco monopoly products is a key task for cigarette manufacturing enterprises. Given the current situation where the tobacco industry lacks unified standards for the disposal and supervision of waste tobacco monopoly products[1], the traditional disposal of waste tobacco monopoly products relies on manual labor, which has significant drawbacks such as large regulatory loopholes, high human error rates, and low coordination efficiency.

For a long time, various illegal production and sales of tobacco monopoly products have persisted despite repeated prohibitions, seriously affecting the interests of the state and enterprises. In the era of rapid development of big data and artificial intelligence, various new types of tobacco-related criminal cases keep emerging, posing a severe

A. Bhattacharjya et al. (eds.), *Proceedings of the 2026 4th International Conference on Management Innovation and Economy Development (MIED 2026)*, Advances in Economics, Business and Management Research 405,
https://doi.org/10.2991/978-94-6239-787-3_33

challenge to the management situation of tobacco enterprises in various regions[2]. This study takes the cigarette manufacturing enterprise where the author works as a pilot, and uses the AHP and FCE analysis and evaluation methods[3] to identify and assess the risks in the disposal process of waste tobacco monopoly products. Combined with expert opinions, a new risk assessment index system has been constructed. Through a combination of qualitative and quantitative methods, the important risk points and comprehensive risk values in the current disposal process have been obtained, and targeted and operable prevention and control measures have been proposed.

2 Identification of Risks in the Disposal of Abandoned Tobacco Products

2.1 Disposal Process for Abandoned Tobacco Products

The disposal process of discarded tobacco monopoly products generally includes nine steps: classification, measurement, destruction, transfer, loading, transportation, unloading, destruction and record-keeping, as shown in Figure 1. Various types of waste are produced in the production workshop. Through classification, measurement and pre-treatment, they are transformed into waste materials that have no practical use and are then transferred to a third-party transportation and disposal unit for destruction.

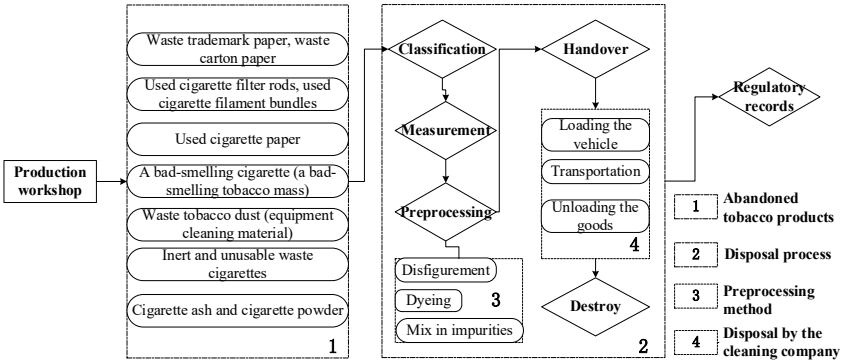


Fig. 1. Flowchart for the Disposal of Discarded Tobacco Monopoly Products

2.2 Disposal Risks of Abandoned Tobacco Products

Risk Stratification for the Disposal of Abandoned Tobacco Products. Based on expert opinions, this study has summarized and stratified the above disposal process, setting up five first-level risk indicators and fifteen second-level risk indicators, respectively as the criterion layer and the index layer, as shown in Figure 2.

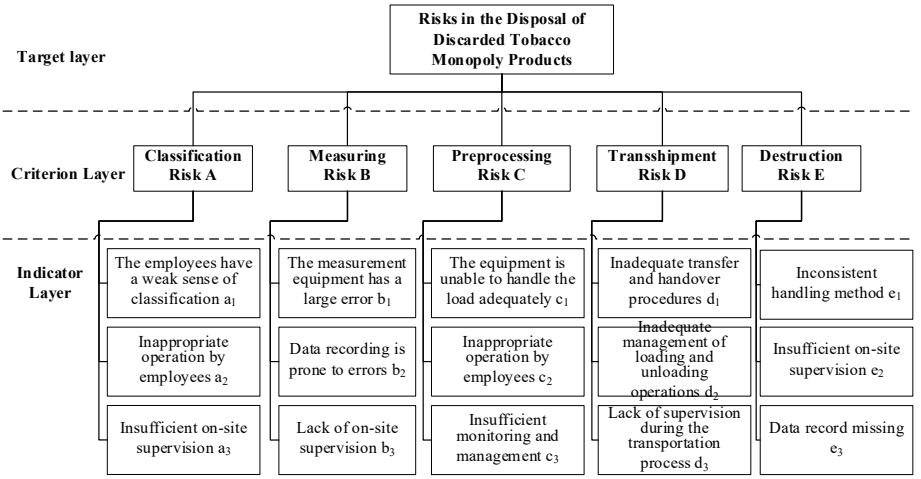


Fig. 2. Risk Stratification Diagram for the Disposal of Abandoned Tobacco Monopoly Products

Risk Assessment of Disposal of Abandoned Tobacco Monopoly Products. On the basis of stratifying the disposal risk of discarded tobacco monopoly products and establishing the indicators, the data sources for the disposal risk evaluation were obtained through a questionnaire survey from experts and risk managers, thereby constructing an AHP-FCE risk assessment index system[4-6]. And based on the analysis of the risk assessment index system, targeted control measures were implemented for some process nodes with higher risk coefficients in the disposal of discarded tobacco monopoly products, thereby reducing the overall risk.

2.3 Construction of Risk Assessment Index System

This paper conducted a questionnaire survey of 25 people, including 10 risk assessment experts and 15 managers. A total of 25 valid questionnaires were collected, with an effective questionnaire rate of 100%. Through data analysis, the weights of each risk indicator were obtained, as shown in Table 1.

Table 1. Risk Weighting Table for the Disposal of Abandoned Tobacco Monopoly Products

Primary Indicator	Weight	Secondary Indicator	Weight	Composite Weight
Classification Risk A	0.0950	The employees have a weak sense of classification a_1	0.3025	0.0287
		Inappropriate operation by employees a_2	0.3310	0.0314
		Insufficient on-site supervision a_3	0.3665	0.0348

Measuring Risk B	0.1560	The measurement equipment has a large error b_1	0.2513	0.0392
		Data recording is prone to errors b_2	0.3591	0.0560
		Lack of on-site supervision b_3	0.3896	0.0608
Preprocessing Risk C	0.1349	The equipment is unable to handle the load adequately c_1	0.3110	0.0420
		Inappropriate operation by employees c_2	0.2324	0.0314
		Insufficient monitoring and management c_3	0.4565	0.0616
Transshipment Risk D	0.2956	Inadequate transfer and handover procedures d_1	0.2372	0.0701
		Inadequate management of loading and unloading operations d_2	0.2797	0.0827
		Lack of supervision during the transportation process d_3	0.4831	0.1428
Destruction Risk E	0.3185	Inconsistent handling method e_1	0.2386	0.0760
		Insufficient on-site supervision e_2	0.3936	0.1254
		Data record missing e_3	0.3678	0.1172

The weights of each first-level indicator in Table 1 were plotted as a bar chart, as shown in Figure 3. It can be seen that in the disposal process of discarded tobacco monopoly products, the risks of "transportation" and "pre-treatment" are much higher than those of others. Among them, the risk of "classification" is the lowest, and the risk of "destruction" is the highest, reaching 31.9%.

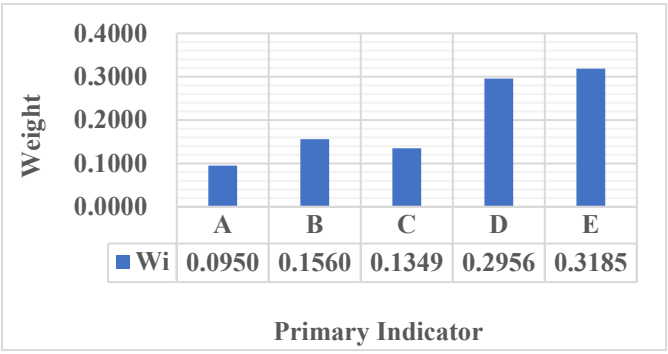


Fig. 3. Risk Weight Chart for Disposal of Abandoned Tobacco Monopoly Products
Note: The horizontal axis represents the first-level indicators, as shown in Table 1.

The comprehensive indicators of each second-level risk indicator were calculated and plotted as a bar chart, as shown in Figure 4. It can be seen that the indicators of "lack of supervision during transportation process d3" in "transportation risk D" and

"inadequate on-site supervision e2" and "lack of data record e3" in "destruction risk E" stand out in the AHP assessment.

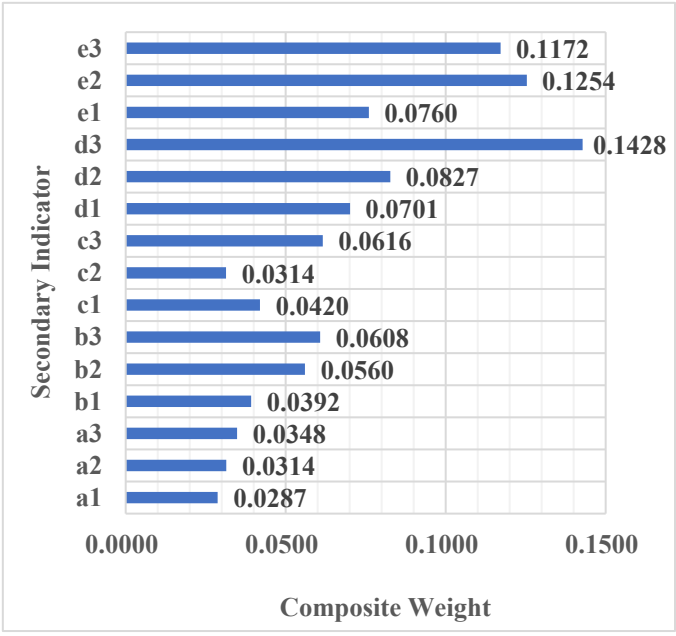


Fig. 4. Comprehensive Weight Chart of Risk Indicators for the Disposal of Abandoned Tobacco Monopoly Products

Note: The vertical axis represents the secondary indicators, as shown in Table 1.

3 Risk Assessment of Disposal of abandoned Tobacco Monopoly Products

3.1 Construction of Evaluation Index Model

The fuzzy comprehensive evaluation method uses the membership degree theory of fuzzy mathematics to convert qualitative evaluation into quantitative evaluation, which is an effective method in risk assessment. In this paper, a five-level[7] risk fuzzy evaluation set is established, denoted by the letter V, with the evaluation set V = {V1, V2, V3, V4, V5} = {1, 2, 3, 4, 5}, representing the five levels of "very low risk", "low risk", "moderate risk", "high risk" and "very high risk" in the disposal risk of discarded tobacco monopoly products.

3.2 AHP-FCE Combined Weighting Method

Calculation of Fuzzy Membership Matrix. Based on the evaluations provided by 20 expert group members and the data from the above-mentioned questionnaire survey,

the membership degree corresponding to each risk level of the risk indicators at each level was calculated. A fuzzy comprehensive evaluation matrix for each indicator was established, denoted as R_i, where i represents a, b, c, d, and e.

$$R_a = \begin{bmatrix} 0.05 & 0.15 & 0.5 & 0.3 & 0 \\ 0 & 0.1 & 0.6 & 0.3 & 0 \\ 0 & 0 & 0.5 & 0.5 & 0 \end{bmatrix} \tag{1}$$

$$R_b = \begin{bmatrix} 0 & 0.2 & 0.55 & 0.25 & 0 \\ 0 & 0.1 & 0.4 & 0.5 & 0 \\ 0 & 0 & 0.4 & 0.6 & 0 \end{bmatrix} \tag{2}$$

$$R_c = \begin{bmatrix} 0 & 0.3 & 0.3 & 0.4 & 0 \\ 0.05 & 0.5 & 0.4 & 0.05 & 0 \\ 0 & 0 & 0.55 & 0.4 & 0.05 \end{bmatrix} \tag{3}$$

$$R_d = \begin{bmatrix} 0 & 0.15 & 0.5 & 0.35 & 0 \\ 0 & 0 & 0.1 & 0.6 & 0.3 \\ 0 & 0 & 0 & 0.4 & 0.6 \end{bmatrix} \tag{4}$$

$$R_e = \begin{bmatrix} 0 & 0.1 & 0.65 & 0.25 & 0 \\ 0 & 0 & 0.05 & 0.45 & 0.5 \\ 0 & 0.05 & 0.05 & 0.5 & 0.4 \end{bmatrix} \tag{5}$$

Multi-level Fuzzy Comprehensive Evaluation. The first-level fuzzy evaluation Fi for each first-level risk indicator can be calculated based on its second-level indicator weights w_i and the corresponding membership degree matrix R_i, that is, $F_i = w_i \circ R_i$. Here, w_i represents the weights of the second-level indicators. In this paper, the fuzzy synthesis operator "$\circ$" adopts the commonly used weighted average operator for calculation. The calculation results are as follows:

$$F_a = w_a \circ R_a = \begin{bmatrix} 0.0151 & 0.0785 & 0.5331 & 0.3733 & 0 \end{bmatrix} \tag{6}$$

$$F_b = w_b \circ R_b = \begin{bmatrix} 0 & 0.0862 & 0.4377 & 0.4761 & 0 \end{bmatrix} \tag{7}$$

$$F_c = w_c \circ R_c = \begin{bmatrix} 0.0116 & 0.2095 & 0.4374 & 0.3186 & 0.0228 \end{bmatrix} \tag{8}$$

$$F_d = w_d \circ R_d = \begin{bmatrix} 0 & 0.0356 & 0.1466 & 0.4441 & 0.3738 \end{bmatrix} \tag{9}$$

$$F_e = w_e \circ R_e = \begin{bmatrix} 0 & 0.0423 & 0.1932 & 0.4207 & 0.3439 \end{bmatrix} \tag{10}$$

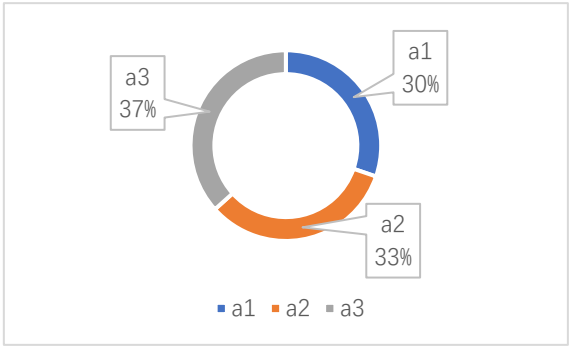
The first-level fuzzy evaluation result vectors F_i of each indicator risk obtained above are used as row vectors to form a new fuzzy matrix R_{total}. The second-level fuzzy comprehensive evaluation is conducted using the weights of the criterion layer to the target layer. The final comprehensive evaluation result is:

$$T = W_T \circ R_{total} = [0.0030 \quad 0.0731 \quad 0.2828 \quad 0.4180 \quad 0.2231] \tag{11}$$

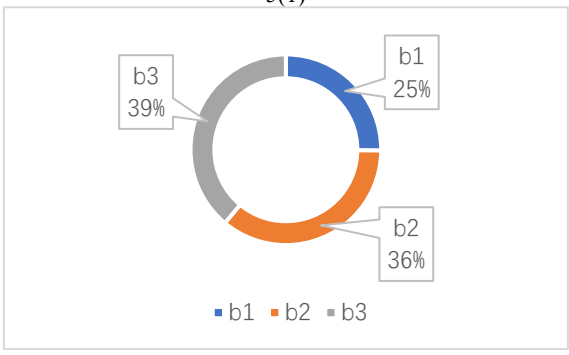
Therefore, the comprehensive assessment risk of the current disposal of waste tobacco monopoly products can be calculated as 3.785, which is between general and relatively high.

3.3 Evaluation Results and Data Analysis

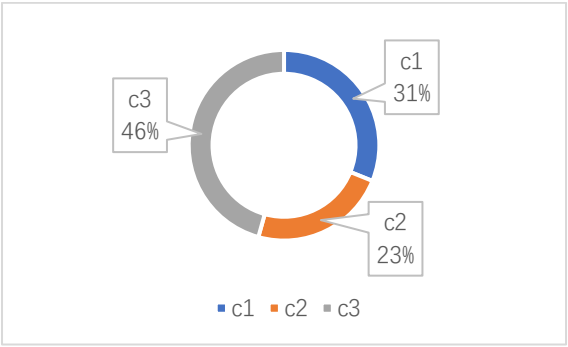
The weights of each second-level indicator in Table 1 are presented in a circular chart, as shown in Figure 5.



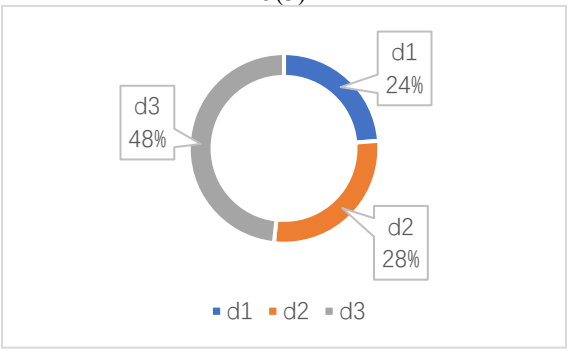
5(1)



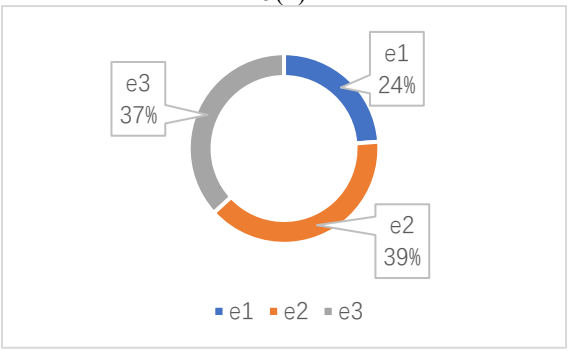
5(2)



5(3)



5(4)



5(5)

Fig. 5. Risk Weight Chart for the Disposal of Abandoned Tobacco Monopoly Products

From the above Figure 5, it can be seen that the risk proportions of each indicator under different criterion layers also vary. For example, in the classification process of waste tobacco monopoly products, on-site supervision is more effective in reducing risks; during the measurement process of waste tobacco monopoly products, the weights of each second-level indicator are relatively close; in Figures 5(3) and 5(4) of Figure 5, the weight proportions of “c3” and “d3” are much larger than the other two,

indicating that on-site supervision plays a decisive role in the pre-treatment and transportation process of waste tobacco monopoly products.

Combining the above second-level fuzzy comprehensive evaluation index values, the current disposal risk of waste tobacco monopoly products is close to relatively high, which is consistent with the fact that the disposal risk has been alleviated under various regulatory measures, but the risks in some important disposal processes and nodes are still prominent. Therefore, it is very important and necessary to strengthen the prevention and supervision of high-risk points in the disposal process of waste tobacco monopoly products.

4 Risk Prevention Strategies for the Disposal of Abandoned Tobacco Products

Based on the risk assessment results, targeted improvement measures and upgrade plans are proposed. From the perspectives of digitalization and big data, information silos are broken, and enterprise management process data is integrated to achieve data penetration and full supervision[8].

Through platform construction, seamless integration of the weighing system, weighbridge data management system, and waste room data management system is achieved. Weighing data is automatically collected and uploaded to the relevant data management systems in the cloud, effectively eliminating "information silos" and laying the foundation for cross-departmental data integration and sharing. This enables precise association and binding of weighing data with monitoring videos and images. At the same time, it supports the synchronous display and cross-validation of multi-modal data, ensuring strict consistency between key business operations (such as weighing) and corresponding data. Key data during the disposal process is fully stored, forming a true, unalterable, and traceable evidence chain, and supports convenient query and traceability of the full life cycle data of any batch of waste materials.

5 Conclusion

Based on the analytic hierarchy process and fuzzy comprehensive evaluation, this paper constructs a risk assessment model for the disposal of waste tobacco monopoly products based on the AHP-FCE combined weighting method. By using the AHP to calculate the subjective weights of disposal risks through questionnaire surveys, it can more reasonably determine the high-risk points in the disposal process of waste tobacco monopoly products and construct a more accurate weight judgment matrix, obtaining satisfactory consistency test results. By introducing the fuzzy comprehensive evaluation of risks and using the membership degree theory of fuzzy mathematics, qualitative evaluations are transformed into quantitative evaluations to determine objective indicators. Finally, by combining the advantages of the two methods, the comprehensive assessment risk value of the current disposal of waste tobacco monopoly products is calculated as 3.785, which is close to the relatively high risk evaluation index.

References

1. Lei Chen, Xinwei Liu, Ping Wang, Yuran Wang. Design and Application of Digital Intelligence Supervision Platform for Abandoned Tobacco Monopoly Products[J]. Digital Technology and Application, 2025, 43(02): 99-102.
2. Lei Chen, Ping Wang. Research on Regulatory Measures for Disposal of Abandoned Tobacco Monopoly Products in Cigarette Manufacturing Enterprises[J]. Technological innovation and productivity, 2023, 44(06): 7-9+15.
3. Qian Wang, Rong Han, Qilu Huang, et al. Research on energy conservation and emissions reduction based on AHP-fuzzy synthetic evaluation model: A case study of tobacco enterprises[J]. Journal of Cleaner Production, 2018, 20188-97. DOI: 10.1016/j.jclepro.2018.07.270.
4. Muhammad Ateeq, Nan Zhang, Wenbo Zhao, et al. Enhancing Construction Waste Transportation Management Using Internet of Things (IoT): An Evaluation Framework Based on AHP–FCE Method[J]. Buildings, 2025, 15(8): 1381-1381. DOI: 10.3390/BUILDINGS15081381.
5. Amine Sarhrani, Mohamed Sadiki, Brahim Jaafar, et al. Broad-scale coastal dune vulnerability along the northwestern Atlantic coast of Morocco: An AHP-based index and machine learning[J]. Regional Studies in Marine Science, 2026, 98105051-105051. DOI: 10.1016/J.RSMA.2026.105051.
6. Francis Sangma, Balamurugan Guru. Spatial analysis of neo-tectonics signatures in lower Subansiri sub-basin using morphometric parameters and Fuzzy-AHP[J]. Discover Geoscience, 2026, 4(1): 179-179. DOI: 10.1007/S44288-026-00534-1.
7. Shengshan Chen, Hanxiang Wang, Hao Jiang, et al. Risk assessment of corroded casing based on analytic hierarchy process and fuzzy comprehensive evaluation[J]. Petroleum Science, 2021, 18(02): 591-602.
8. Ping Wang, Lei Chen. Design and Implementation of Disposal Supervision System for Abandoned Tobacco Monopoly Products[J]. Technological Innovation and Application, 2023, 13(13): 146-149. DOI:10.19981/j.CN23-1581/G3.2023.13.034.