Research on the Construction of Cooperative Production Risk Prevention and Control Management Mechanism Based on MQPT Fuzzy Analytic Hierarchy Process

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Abstract. Strengthening the cooperative production of cigarette brands is to actively promote the reform of the resource allocation method centered on the brand. It is an important measure to promote the rational flow of production factors and the optimal allocation of industry resources. It is also to promote the rapid development of key brands in the industry, and it is truly a leading an important guarantee for the new pattern of brand development. However, due to many reasons, the cooperative production of cigarettes will inevitably produce various risks, which will endanger the brand reputation. How to achieve the common and sustainable development of cooperative production of cigarettes, strive to promote the high-quality development of cooperative production, and carry out risk prevention of cooperative production Research is very necessary. This subject research and the actual situation of cooperative production to carry out specific research. From a qualitative point of view, the possible risks of cooperative production are classified according to work attributes and work cycles, and the cooperative production is analyzed from the aspects of quality (equipment hardware and technology and key processes), material management, and basic management (plan and personnel). Quality risk sources and identification methods; from a quantitative perspective, combined with some possible risk sources proposed by qualitative analysis, a risk assessment model for cooperative production is constructed.

1. Introduction

1.1. The inevitable requirement of the development trend of cooperative production among cigarette manufacturers

Cigarette manufacturers need to cooperate in production and develop big brands. Judging from the current trend of cooperation between domestic cigarette manufacturers, it is an inevitable way for cigarette manufacturers to cooperate in production to form big brands. It will greatly promote the optimal allocation of resources for cigarette manufacturers. Strengthened, brand concentration will be further increased. Only by ensuring that the quality of the company’s output brand is guaranteed, will it win market recognition.

1.2. The Realistic Demand of Cooperative Production Risk Management

At present, the cooperative production of the cigarette industry is not only to meet the inevitable requirements of the cigarette industry to become bigger and stronger, but also to improve the competitiveness of cigarette brands by cigarette manufacturers. The cooperative production quality
risk early warning system can realize the dynamic monitoring of the cigarette production process [1], make the cigarette production management from a static and passive state to a dynamic and active state, realize the advancement of cigarette production control, reduce the risk and harm of cigarette production, and improve cigarettes the risk and return of production.

2. Cooperative risk management organization framework and current status of risk management

2.1. Cooperative production risk organization structure

Zhejiang China Tobacco's production risk management is relatively complicated, and it is divided into two major management entities and three levels: the two major management entities are Zhejiang China Tobacco and its partner companies. Zhejiang China Tobacco is the client, and as the brand owner, it has the final decision on quality risks. The partner enterprise is the producer, and as the main body of product manufacturing, it is mainly responsible for the process. The three levels are: the first level is the system level [2]. As the competent department of quality management, the technical center of China Tobacco Zhejiang has the power to formulate process technical standards, product quality dispute determination, and product quality supervision and random inspection. The second level is a multi-point level, Zhejiang China Tobacco's Cooperative Production Department has process stability management and supervision of multi-point production, and timely handles various abnormal situations. The third level is the factory level. Zhejiang China Tobacco dispatches a project team in each cooperative enterprise to monitor the entire production process, supervise process quality risks, timely discover and eliminate risks, and control risks within a controllable range. The specific structure is shown in the figure. Level 1: System Management Zhejiang China Tobacco Technology Center; Level 2: Cooperative Production Division Multi-point Management Group; Level 3: Cooperative Production Project Team Management. The organizational structure of cooperative production risk prevention is shown in Figure 1.

![Figure 1. Cooperative production risk prevention organization structure](image)

2.2. Current status of cooperative production risk management

At present, in the process of cigarette cooperative production management of Zhejiang China Tobacco Company, the Ministry of Foreign Cooperation exercises the overall management of cooperative...
production. Based on the actual risk management system of Zhejiang China Tobacco Company's cigarette cooperative production itself, there are still some needs in the process. Specific content, Zhejiang China Tobacco Co., Ltd. needs to improve the quality risk management of cigarette production. It is necessary to clarify the quality system requirements of the licensor: transform the original vague, unsystematic, and non-standard requirements into specific requirements [3], so that the licensor can clearly understand the requirements of Zhejiang China Tobacco Company, and easily accept them. Improve the process assurance system to reduce process risks. Judging from the existing measures and methods, they are relatively simple and subjective. To further promote the risk prevention of cigarette cooperative production in the future, it is necessary to adopt more scientific measures and establish a standardized prevention method system.

3. Identification and classification of risk sources in cooperative production

In view of the insufficient identification of risks in cooperative production and the urgent need to establish a quality risk management process, the establishment of a cooperative production MQPT risk prevention and control management mechanism is proposed. This mechanism is to identify and prevent risks in four aspects: plan, quality, materials, and personnel the formulation of preventive measures. Among them, MQPT means "M", material; "Q", quality; "P", plan; "T", team.

4. Cooperative production risk assessment model and application based on fuzzy analytic hierarchy process

4.1. Construction of Index System for Cooperative Production Risk Prevention

Collect data from the first to third quarters of 2020 from 11 processing units of cooperative production for analysis and construct a reasonable evaluation system. The target layer of the evaluation system (a) is divided into the evaluation value of the risk prevention ability of cooperative production [4]; the criterion layer (b1-b9) is divided into the quality improvement rate%, the qualification rate%, the retrospective rate%, and the market complaint settlement rate ppm, reduce the number of complaints per 10,000 cases/10,000 cases; raise the completion rate of cooperative production plan %, reduce the deviation rate of cooperative production arrival %; the weighted average of personnel support ability %; The weighted average value of material support capability%; the activity index layer (c1-c21) is divided into the weighted average value of process packaging and rolling prevention capability%, the weighted average value of process silk prevention capability%, the timeliness of realism problem rectification%, and the process retrospective response Timeliness%, timeliness of delivery inspection retrospective response%, market complaint response timeliness%, correction and prevention rectification rate%, material inspection capability evaluation value%, material inventory accuracy rate%, material storage inspection completion rate%, material problem rectification Timeliness rate%, material use error rate%, material quality compliance rate%, data statistics accuracy%, agreement plan implementation rate%, source matching rate%, emergency production and arrival response timeliness rate%, personnel matching rate%, personnel response 21 indicators including positivity rate%, personnel innovation rate%, personnel training completion rate%. See Figure 2 for details.
4.2. Constructing the judgment matrix of fuzzy analytic hierarchy process for risk prevention in cooperative production

The value of the elements of the judgment matrix reflects people's understanding of the relative importance of each element. Generally, the scale method of 1-9 and its reciprocal is adopted. When the importance of the mutual comparison factors can be explained by a ratio with practical significance, the value of the corresponding element of the judgment matrix takes this ratio [5]. The weights in the evaluation system are determined by a combination of expert evaluation method and analytic hierarchy process. Experts score the importance of each index in the index category of the upper level on a scale of 1-9, and pass every two factors of the same level index factor. The importance of "ratio" constructs a judgment matrix [6]. The index matrix adopts additive synthesis method to evaluate the risk prevention of 11 processing units in cooperative production. The evaluation model is:

$$Y = \sum_{i=1}^{P} W_i X_i$$  \hspace{1cm} (1)

Among them, $Y$ is the comprehensive evaluation value, $W_i$ is the weight of the $i$th index; $X_i$ is the evaluation value of the $i$th index; $P$ is the number of indexes.
The factors of each layer are named in alphabetical order of A, B,... The total target AB is placed in the first form, and the sub-level BC is placed in the second form, and so on, and each level is output with factor codes. Use fuzzy analytic hierarchy process to run and output results. See Figure 3-Figure 5 below.

Figure 3. Judgment matrix elements of cooperative production index system

Figure 4. Fuzzy AHP result output type A

Figure 5. Fuzzy Analytic Hierarchy Process Result Output Type C

With the help of 11 cooperative unit data, the fuzzy analytic hierarchy process is used for evaluation [7], and the factor set of the evaluation object is determined to determine the evaluation index system of cooperative production risk prevention ability.

Table 1. Evaluation index system

| Comprehensive index | Evaluation index | Weights |
|---------------------|------------------|---------|
| Cooperative production risk prevention capability evaluation value (1.0) | B1 Quality improvement rate% | 0.084 |
|                      | B2 Qualified rate% | 0.0699 |
|                      | B3 Reduce retrospective rate% | 0.0748 |
|                      | B4 Decrease the market complaint settlement rate ppm | 0.0867 |
|                      | B5 Reduce the number of complaints per Ten thousand cases/ Ten thousand cases | 0.0985 |
|                      | B6 The completion rate of the cooperative | 0.1442 |
4.3. Constructing a C1-C21 secondary index evaluation system for risk prevention in cooperative production

4.3.1. Calculate the correspondence between various risks and the index system. Corresponding to the C1-C21 indicator system and the seven major risk identification lists.

Table 2. C1-C21 index system corresponds to the seven major risk identification lists

| Source of risk |
|----------------|
| Quality        |

| Possible risk results | S | O | D | RP | N |
|-----------------------|---|---|---|----|---|
| Air leak              | m | n | q | h  | c |
| Explosion             |   |   |   |    |   |

4.3. Constructing a C1-C21 secondary index evaluation system for risk prevention in cooperative production
4.3.2. Use the risk RPN value to measure various index data as the basis for evaluation

- Assume that C1-C21 (indices such as the weighted average % of process packaging and coiling prevention capabilities) are Ci(i=1,2,3……………); The number of risk items is N(1,2,3………….).

- Risk factor (RPN value). Indicates the level of risk. Mathematically expressed as the product of severity (S), occurrence (O), and detection (D), namely RPN (R) = S × O × D. Among them: Severity (S): The severity of the consequences of the quality risk; Occurrence (O): The probability of occurrence of the quality risk; Detectability (D): The reason for the occurrence of the quality risk, under the existing detection and control measures the probability of being discovered [8].

- Risk rating. The risk level is divided into three levels: high risk, medium risk and low risk. It is determined by comprehensively evaluating the severity (S), occurrence (O) and detection degree (D) of the risk point. The evaluation basis is divided into low to high (Level 1-5), the severity (S) is evaluated and scored according to the worst consequences of the risk: large-volume customer complaints (retrospective), small-volume customer complaints (not traceable), unqualified products will not flow in the market, sporadic customer complaints are generated, and the probability of triggering customer complaints is very low; Occurrence degree (O) is based on the existing technical measures for evaluation and scoring: frequent occurrence, intermittent occurrence, sometimes occurrence, occasional occurrence, and almost no occurrence: detection degree (D) evaluation and scoring based on existing monitoring technology and detection devices. The table is basically difficult to find by people, and must be talented by professionals. It is difficult for ordinary operators to find, and ordinary operators can find.

- Risk level determination and risk assignment.

| Inspection device risk | detector | leaking smoke cannot be eliminated | average of process packaging and rolling prevention capability % |
|------------------------|----------|-------------------------------------|---------------------------------------------------------------|
| Empty thin head detector | Empty thin cigarettes cannot be eliminated | m n q h c | m n q h c |
| Missing filter detector | Unfiltered cigarettes cannot be removed | m n q h c | m n q h c |
| Tipping paper joint detector | The tipping paper joint smoke cannot be removed | m n q h c | m n q h c |
| Hob brush condition | Tipping paper is not cut well to produce secondary cigarettes | m n q h c | m n q h c |

- Calculate the evaluation basis of C-item secondary index
\[ C_i(i = 1, 2, 3 \ldots \ldots \ldots \ldots ) = \sum_{i=1}^{N} \frac{R_i}{N} \times 100\% \]  \hspace{1cm} (2)

### 4.4. Evaluation result analysis

According to the above evaluation method and index system, the output of the index system evaluation model is as follows.

\[ Y = \sum_{i=1}^{9} y_{bi} \times B_i \]  \hspace{1cm} (3)

\[ y_{bi} = \sum_{i=1}^{m} w_{ci} \times x_{ci} - T \]  \hspace{1cm} (4)

\( m \) is the C-level index included in the B-level index, and \( T \) is the reverse activity index.

| Cooperating company | Quality risk prevention capability assessment | Plan risk prevention capability assessment | Personnel risk prevention capability assessment | Material risk prevention capability assessment | Cooperative production risk prevention capability evaluation value |
|---------------------|---------------------------------------------|------------------------------------------|-----------------------------------------------|-----------------------------------------------|---------------------------------------------------|
| Nanning             | 40.64                                       | 28.96                                    | 13.89                                         | 11.32                                         | 11.34                                             |
| Bijie               | 39.99                                       | 28.90                                    | 13.57                                         | 11.04                                         | 11.20                                             |
| Lanzhou             | 40.60                                       | 29.01                                    | 13.78                                         | 11.40                                         | 11.35                                             |
| Wuhu                | 40.54                                       | 28.75                                    | 13.82                                         | 10.74                                         | 11.21                                             |
| Mianyang            | 40.37                                       | 28.48                                    | 13.84                                         | 10.46                                         | 11.12                                             |
| Hanzhong            | 40.84                                       | 28.98                                    | 13.85                                         | 10.99                                         | 11.31                                             |
| Jinggangshan        | 40.88                                       | 28.96                                    | 13.94                                         | 10.87                                         | 11.30                                             |
| Nanchang            | 40.28                                       | 28.70                                    | 13.68                                         | 10.34                                         | 11.10                                             |
| Fuling              | 41.11                                       | 28.91                                    | 13.80                                         | 10.64                                         | 11.26                                             |
| Zhangjiakou         | 39.85                                       | 28.74                                    | 13.60                                         | 10.23                                         | 11.04                                             |
| Luohe               | 39.72                                       | 28.74                                    | 13.64                                         | 11.13                                         | 11.17                                             |

According to the evaluation model of the index system, the comprehensive evaluation value of the cooperative production risk prevention ability of 11 cooperative production units is obtained [9], in descending order: Lanzhou, Nanning, Hanzhong, Jinggangshan, Fuling, Wuhu, Bijie, Luohe, Mianyang, Nanchang, Zhangjiakou.

### 5. Cooperative production risk prevention strategy

The specific process of constructing the risk management mechanism of the cooperative production process: first expand the process (operation) to the end vertically, and then expand the process (step) horizontally to the side. The process is decomposed into sections, the sections are expanded to processes, and the processes are refined to steps/actions, and the granularity is as refined as possible. Dynamically identify risks, and if necessary, convene relevant departments of the partner for joint analysis. It is determined by comprehensively evaluating the severity (S), occurrence (O) and detection degree (D) of the risk points, and the evaluation of each risk point is output. The cooperative production project team shall regularly organize the evaluation of the risk control activities of the cigarette production process and make improvements based on the evaluation results. The cooperative production department shall conduct irregular inspections of the production process risk control of each cooperative processing point and provide improvement suggestions for the problems found.

### 6. Conclusion

The topic is based on the analysis of the current situation of cooperative production risk prevention management, systematic research on the identification factors of cooperative production quality risk, establishment of a risk assessment model based on fuzzy analytic hierarchy process, and formulation
of risk prevention measures. Through the four stages of risk factor identification, risk factor analysis, risk planning, and risk control, the partner's operating system is finally mature and the risk prevention of cooperative production meets the ideal requirements. In the future work, we will continue to study the specific cooperative production quality risk operation plan, the specific implementation steps, and the improvement of the risk assessment method.

References
[1] Hu, Y. H., He, E. H. (2000) Comprehensive evaluation method. Beijing: Science Press, pp.167-188.
[2] Yang, L. B. (2000) Principles and Applications of Fuzzy Mathematics. Guangzhou: South China University of Technology Press, pp.67-80.
[3] Xie, J. J., Liu, C. P. (2000) Fuzzy Mathematics Method and Its Application. Wuhan: Huazhong University of Science and Technology Press, pp.205-211.
[4] Zhang, L. (2006) Analysis and Research on the Environmental Quality Evaluation System of Colleges and Universities. Gansu Science and Technology, 22: 120-121.
[5] Ge, J., Ge, L. Y. (2003) Analytic hierarchy process to determine the weight of water quality indicators. Contemporary Architecture, 3: 22-23.
[6] Chen, E., Gu, D. L., Li, X. et al. (2009) Research on the early warning system of cigarette production quality risk. Contemporary Economy, 4: 64. 66.
[7] Xie, C. Q. (2010) Study on the stability of cigarette production quality at multiple points. Modern Agricultural Science and Technology, 22: 11-12.
[8] Wang, J. (2013) Research on product quality and safety risk identification and assessment...Take the production of licensed industrial products as an example. Science and Technology and Industry, 7: 127-129.
[9] Yu, Y. G., Zheng, H. Y. (1996) The change and prospect of quality management thinking. China Industrial Economy, 10: 56-59.