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Risk Assessment of Production Resumption Based on Improved Multi-Level Fuzzy Evaluation Method

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Abstract— *The struggle of humanity against infectious diseases represents a long-term dynamic equilibrium. In anticipation of the next pandemic, proactive emergency preparedness for foreseeable challenges is imperative. This paper focuses on the research concerning the risk assessment of resuming business operations during the course of an infectious disease pandemic. We apply Best Worst Method (BWM) to improve multi-level fuzzy comprehensive evaluation model. According to the policy and the actual situation of the epidemic, we establish an evaluation system for the production resumption, and take Enterprise A as an example to verify the feasibility of the model. It is found that Enterprise A has poor preparation for production resumption, and is at a high-risk level. It is not recommended to resume work and production when it is not necessary. When it is necessary, enterprises can resume production. They need to pay attention to strict prevention and control, and return to work to participate in daily nucleic acid testing within three days. This research is universal and can be extended to other enterprises to provide reference for the government and enterprises to make prevention and control decisions.*

Keywords— *Production resumption; Best Worst Method; improved multi-level fuzzy evaluation; risk assessment.*

I. Introduction

COVID-19 is the most widespread global pandemic which has affected mankind in the past centuries, and it is a crisis and a severe test for the whole world. While the recent pandemic has largely subsided, humanity's struggle with infectious diseases continues unabated. Currently, at least 10,000 virus species possess the capability to infect humans. Global warming is increasing the likelihood of cross-species viral transmission, with projections suggesting at least 4,000 new instances of such transmissions by the year 2070. This phenomenon significantly heightens the risk of novel infectious diseases emerging on a global scale [1]. In the face of pandemics, a critical issue is the rapid resumption of business operations to safeguard economic growth and ensure societal stability. Thus, this paper focuses on the assessment of risks associated with the resumption of business activities during a pandemic. It aims to provide emergency preparedness for the swift recovery of business operations and the stabilization of socio-economic development.

Emergency management generally includes four stages: prevention, preparation, response and recovery. Many scholars have carried out a lot of research on prevention [2,3], preparation [4,5], and response [6-8]. At present, there are few studies on the recovery stage of the epidemic situation, and scholars in different fields explore the decision-making of resuming work and production from different perspectives. Hu et al studies it from the perspective of behavioral economics [9]. Chen et al adopts the Mahala Nobis Taguchi system and set pair analysis method to establish assessment model [10]. Zheng et al. create a new job planning problem, in which a subset of firms are selected from a large number of applicants applying for restart production and determine their order to restart under the epidemiological methods [11]. Li et al establishes an epidemiological model for risk assessment [12]. Wang et al formulated the COVID-19 transmission model on complex networks for Wuhan city and the 15 surrounding cities with severe epidemics, and analyzed the possible times for resumption of work in Wuhan and its surrounding areas [13]. Zhang et al used the autoregressive distributed lag-error correction model to generate baseline forecasts and performed Delphi adjustments based on different recovery scenarios to reflect different levels of severity in terms of the pandemic's influence [14]. A few researchers are using a slow comprehensive assessment approach that has been improved to assess the risk of recurrence and activity during the next epidemic.

The improvement of the comprehensive evaluation method has not attracted many researchers and can be divided into the following areas. Jin et al proposes a new approach to use the judgement matrix in analytic hierarchy process according to the fuzzy relative membership degree matrix of single evaluation index [15]. Li et al designs a fuzzy comprehensive evaluation model base on Analytical Hierarchy Process (AHP) and information entropy [16]. Yang et al establishes evaluation model based on improved AHP, entropy method and fuzzy comprehensive evaluation method [17]. Chen et al considers that factor analysis method determines the objective weights for the improved fuzzy comprehensive evaluation model [18]. Zhang et al. propose a better approach for a comprehensive multi-system-based assessment of spring earthquake risk by incorporating a cloud model [19]. Zhuang and Liu improved the fuzzy comprehensive evaluation method based on the characteristics of the structural equation model [20]. However, there are no scholars to improve the fuzzy comprehensive evaluation method based on Best-Worst-Method (BWM).

Compared with AHP, the number of pairwise comparison values needed by BWM is less. The weight result obtained by BWM is more reliable and consistent with the actual situation, and the calculation process of BWM is also simpler. Therefore, BWM has stronger maneuverability and practicability [21] In view of this, on the basis of constructing the index system of production resumption risk, this paper determines the weight of each evaluation index with the help of BWM to improve the fuzzy comprehensive evaluation. We give specific evaluation values to enterprises with different actual conditions to guide them to return to work scientifically and rationally, so as to provide reference for the policies of government epidemic prevention and control.

The main contributions of this paper are as follows:

(1) This paper comprehensively integrates the risk assessment indicators of production resumption, which are in line with the practice and policy. We construct a new comprehensive evaluation system of resuming work and production, which has 4 first-level indexes and 15 second-level indexes.

(2) In this paper, an improved multi-level fuzzy comprehensive evaluation risk assessment method based on the combination of Best-Worst-Method (BWM) and fuzzy comprehensive evaluation is proposed firstly. The risk assessment method is universal and can be applied to other enterprises that need to resume work and production, so as to provide reference for the prevention and control decision-making of the government and enterprises.

II. Materials and Methods

2.1 Risk assessment index system of production resumption

(1) Index selection

The construction of risk assessment index for the resumption of work and production mainly comes from the policies promulgated by the government. The policies are *the guidance on the regular prevention and control of Covid-19 epidemic situation* issued by the State Council and *the COVID-19 diagnosis and treatment Plan (trial Ninth Edition)* issued by the National Health Commission. In addition, by referring to the research of Scholar Chen [10], we supplement and improve the index system of enterprise resumption of work and production. It is noted that since the risk assessment of enterprise resumption of work and production is to guide the government to arrange for low-risk enterprises to resume work and production properly, the assessment is a measure that occurs before the resumption of work and production. Furthermore, the evaluation indicators focus on the preparation of enterprises to resume work and production.

(2) Evaluation index framework

This section follows the comprehensive and practical principles, combined with the characteristics of epidemic prevention and control, to establish a risk assessment system for resumption of work and production. It mainly includes four aspects: management system, emergency materials, personnel situation and preparation of prevention and control measures. We take the risk assessment of production resumption and as the target layer A, and comprehensively extract 4 first-level indicators B, 15 second-level indicators C, as shown in Table 1.

TABLE 1. Risk assessment index system of resuming work and production

First-level index	Second-level index	Explanations
Management system A1	Emergency plan C1	The more perfect the emergency plan, the lower the risk of resuming work and production.
	Prevention and control policy C2	The epidemic prevention and control work of the enterprise is guided by the latest policy of the local government. The more comprehensive the policy is grasped and the more thoroughly the policy is implemented, the less the risk is.
	Epidemic surveillance C3	Daily health sign-in system for employees. The more perfect the content, the lower the risk.
	Dining system C4	Detailed dining process include off-peak queuing, partition, shunt, contactless meal picking up, etc. The more reasonable the process, the lower the risk.
Emergency materials A2	Emergency supplies reserve C5	Emergency supplies include masks, hand sanitizers, disinfectant, protective clothing, protective masks, etc. The more abundant the material reserve, the lower the risk.
	Medical resources match C6	It refers to the matching degree between health care workers and employees of the enterprise. The higher the matching degree, the lower the risk.
	Nucleic acid testing arrangement C7	The arrangement includes nucleic acid testing site, nucleic acid testing frequency, key population testing, etc. The more reasonable the arrangement, the lower the risk.
	Temporary quarantine site C8	Whether the temporary isolation place meets the epidemic prevention requirements, the closer to the requirements, the lower the risk.
Personnel situation A3	Health report C9	The report information mainly includes health code, route code, vaccination, nucleic acid test report and so on. The more information, the lower the risk.
	Employee source distribution C10	The wider the distribution of people returning to work and production, the higher the risk.
	Enterprise population density C11	Population density can be characterized by the ratio of the number of workers prepared to return to work in the enterprise to the number of public places. The lower the population density, the less the risk.
	Epidemic prevention consciousness C12	The stronger the employees' awareness of epidemic prevention, the less the risk.
Preparation of prevention and control measures A4	Epidemic prevention publicity C13	Enterprises can publicize epidemic prevention knowledge through WeChat, Weibo, official website and radio. The greater the intensity of epidemic prevention publicity, the lower the risk.
	Epidemic prevention training C14	Enterprises organize employees to learn epidemic prevention policies and personal protection knowledge online. The better the training effect is, the lower the risk is.
	Public disinfection C15	The fuller the eliminate virus, the lower the risk.

2.2 Risk assessment model of production resumption

The fuzzy comprehensive evaluation method measures some of the useful and ineffective factors using the principle of the

IJSES
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synthesis of cell relations based on cell mathematics. The membership grade of the evaluation object is evaluated comprehensively from the point of view of many factors. There are many fuzzy uncertainties in the evaluation criteria of resumption of work and production such as the improvement degree of the management system, the adequacy of emergency materials, the staff's awareness of epidemic prevention, and the intensity of epidemic prevention propaganda. The fuzzy comprehensive evaluation method can well solve the uncertainty caused by fuzzy evaluation criteria in the process of resuming work and production. Moreover, BWM is used to calculate the weight to improve the fuzzy comprehensive evaluation method.

The concrete steps of improving the multi-level fuzzy comprehensive evaluation model based on BWM are as follows.

(1) Determine the index factor set

As described in the previous risk assessment index system for resumption of work and production, we have summarized 4 first-level indicators and 15 second-level indicators. On this basis, the specific set of indicators is determined as follows:

First indicator set:

$u = \{u_1, u_2, u_3, u_4\}$
$= \{$Management system, Emergency materials, Personnel situation, Preparation of prevention and control measures $\}$

Second indicator set:

$u_1 = \{u_{11}, u_{12}, u_{13}, u_{14}\}$
$= \{$Emergency plan, Prevention and control policy, Epidemic surveillance, Dining system$\}$

$u_2 = \{u_{21}, u_{22}, u_{23}, u_{24}\}$
$= \{$Emergency supplies reserve, Medical resources match, Nucleic acid testing arrangement, Temporary quarantine site$\}$

$u_3 = \{u_{31}, u_{32}, u_{33}, u_{34}\}$
$= \{$Health report, Employee source distribution, Enterprise population density, Epidemic prevention consciousness$\}$

$u_4 = \{u_{41}, u_{42}, u_{43}\}$
$= \{$Epidemic prevention publicity, Epidemic prevention training, Public disinfection$\}$.

(2) Determine the index judgment set

This paper investigates the preparation degree of 4 first-level indicators and 15 second-level indicators. The index judgment set is determined as

$v = \{v_1, v_2, v_3, v_4, v_5\} =$ $\{$Very good, Good, Middle, Poor, Very poor$\}$. Each evaluation set is equivalent to a fuzzy subset.

(3) Set up fuzzy relation matrix (membership degree matrix)

Based on the fuzzy subset constructed by the index judgment set, the evaluation object is quantified from a single factor. Fuzzy relation matrix R is induced by fuzzy mapping so as to determine the membership degree of the evaluation object to the fuzzy subset.

$$R = \begin{bmatrix} r_{11} & r_{12} & \cdots & r_{1m} \\ r_{21} & r_{22} & \cdots & r_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ r_{n1} & r_{n2} & \cdots & r_{nm} \end{bmatrix}_{n\times m}$$

The element r_{ij} in row i and column j in the fuzzy relation matrix represents the degree of membership of an evaluation object to the fuzzy subset v_j from the point of view of factor u_i. Therefore, the fuzzy relation matrix is also called membership matrix. The matrix R is used to display the performance of an evaluation object in a certain index u_i. It is better than the previous method in which the index is reflected by only one numerical value. Furthermore, it shows that a slower comprehensive review can provide more comprehensive information.

(4) Determine the index weight set

BWM was first proposed by Jafar Rezaei in 2015 [21] to solve the problem of multi-criteria decision-making and to determine the weight between criteria. Compared with AHP, BWM requires less data for pairwise comparison. BWM is easier to pass consistency and can achieve more reliable results. The specific steps of using BWM to determine the weight of each index are as follows:

Step 1: Determine the set of indicators. For example, the first set of indicators for the resumption of work and production is $u = \{u_1, u_2, u_3, u_4\}$.

Step 2: Determine the best (or the most ideal or the most important) indicators and the worst indicators (or the least ideal or the least important), and no comparison is made at this time. For instance, in the first index of risk assessment for resuming work and production, the most important is the management system, and the least important is the personnel situation.

Step 3: Determine the bias degree of the best indicators relative to other indexes. Participants used the 1-9 scale to describe the importance of the best indicator relative to other indicators. The generated vector is $E_{best} = (e_{best\ 1}, e_{best\ 2}, \ldots, e_{best\ n})$. Obviously, $e_{best\ best} = 1$.

Step 4: Determine the bias degree of the worst indicators relative to other indexes. Participants used the 1-9 scale to describe the importance of the worst indicator relative to other indicators. The generated vector is $E_{worst} = (e_{1\ worst}, e_{2\ worst}, \ldots, e_{n\ worst})$. Apparently, $e_{worst\ worst} = 1$.

Step 5: The optimal weight $(w_1^*, w_2^*, \cdots, w_n^*)$ is solved by constraint optimization. The following constraint optimization model is established.

$$min\ \max_j \left\{ \left| \frac{w_{best}}{w_j} - e_{best\ j} \right|, \left| \frac{w_j}{w_{worst}} - e_{j\ worst} \right| \right\}$$

$$s.t. \begin{cases} \sum_j w_j = 1 \\ w_j \geq 0,\ \forall j \end{cases}$$

The following model can be obtained by linearizing the objective function.

$$min\ \varepsilon$$

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$$s.t.\begin{cases}\left|\frac{w_{best}}{w_j}-e_{best\ j}\right|\le \varepsilon,\forall j\\ \left|\frac{w_j}{w_{worst}}-e_{j\ worst}\right|\le\varepsilon,\forall j\\ \sum_j w_j=1, w_j\ge 0,\ \forall j\end{cases}$$

The optimal weight $(w_1^*, w_2^*, \cdots, w_n^*)$ and ε^* can be obtained by CPLEX solution. In addition, the consistency test is shown in Table 2.

TABLE 2. Consistency index table of BWM

$e_{best\ worst}$	1	2	3	4	5	6	7	8	9
Consistency Index (CI)	0.00	0.44	1.00	1.63	2.30	3.00	3.73	4.47	5.23

The calculation method of BWM consistency index is referred to [21]. The formula for calculating the Consistency Ratio (CR) is as follows:

$$Consistency\ Ratio=\frac{\varepsilon^*}{Consistency\ Index}$$

When CR is closer to 0, the weight result error is smaller. Generally, when $CR<0.1$, it can be considered to pass the consistency test.

(5) Synthetic fuzzy comprehensive evaluation result matrix

Using the classical simple Zadeh operator to calculate is the most common synthesis method of fuzzy comprehensive evaluation. However, this method has some shortcomings, such as losing information, unreasonable results and so on. Which operator is more suitable for risk assessment of resumption of work and production is worthy of further discussion.

There are many operators about fuzzy comprehensive evaluation. Common operator relation models are shown in Table 3.

Table 3 lists four fuzzy operators, each of which has different scope of application. Operator 2 is suitable for single factor evaluation. It can be seen from the formula that operator 2 only considers the information of the main factors, while the information of other factors is ignored, which can easily lead to unreasonable or even meaningless results. Operator 1 and operator 3 are improved on the basis of operator 2, taking into account not only the main factors but also other factors. Operator 1 belongs to the main factor prominent type. Operator 2 belongs to the main element determining type. Operator 3 belongs to the type of unbalanced average. If the factor with the largest weight is dominant, the three operators can be selected for calculation.

TABLE 3. Fuzzy operator

Serial number	Operator	Model	Calculation formula	Utilization degree of Fuzzy Matrix
1	$\cdot\ \vee$	$M(\cdot,\vee)$	$b_j=\vee_{i=1}^n(a_i r_{ij})$	Low
2	$\wedge\ \vee$	$M(\wedge,\vee)$	$b_j=\vee_{i=1}^n(a_i\wedge r_{ij})$	Low
3	$\wedge\ \oplus$	$M(\wedge,\oplus)$	$b_j=\sum_{i=1}^n(a_i\wedge r_{ij})$	Lower
4	$\cdot\ \oplus$	$M(\cdot,\oplus)$	$b_j=\sum_{i=1}^n(a_i r_{ij})$	High

Operator 4 has high utilization to fuzzy matrix. The result calculated by it covers the weight of each element. Operator 4 can fully depict the overall characteristics of the evaluation object which is called weighted average operator. Operator 4 is suitable for the optimization of the overall index. There are many evaluation indexes in the risk assessment of resumption of work and production, and the weights are different. In order to evaluate the risk comprehensively and realistically, the fourth weighted average operator is used to calculate the comprehensive evaluation results. The weight W of each factor and the fuzzy relation matrix R of the evaluation object are synthesized by the weighted average operator. We get the fuzzy comprehensive evaluation result vector of the evaluation object.

$$W\circ R=(w_1^*,w_2^*,\cdots,w_n^*)\begin{bmatrix}r_{11}&r_{12}&\cdots&r_{1m}\\ r_{21}&r_{22}&\cdots&r_{2m}\\ \cdots&\cdots&\cdots&\cdots\\ r_{n1}&r_{n2}&\cdots&r_{nm}\end{bmatrix}=(b_1,b_2,\dots,b_n)=B$$

Where, b_i represents the membership degree of the evaluation object to the fuzzy subset v_j as a whole.

III. RESULTS

Due to the improvement of the epidemic, activities and activities are on the agenda again. In order to scientifically and effectively evaluate the risk level of resumption of work and production in an industrial enterprise, this paper takes the Enterprise A as an example for evaluation and analysis. To gain an in-depth understanding of a particular company's readiness for resumption of operations, we convened an expert panel of 50 individuals. This panel comprised 15 corporate executives, 20 exemplary employees, and 15 government officials specializing in pandemic prevention and control. The panel evaluated the company's preparedness for resuming operations against 15 secondary indicators, using a five-point scale (Very good, Good, Middle, Poor, Very poor). These evaluations serve as the key data source for this study.

(1) Membership degree calculation

The original evaluation data are classified and normalized, so that each index can get the corresponding fuzzy subset. Fifteen fuzzy subsets are combined to form a membership calculation table (fuzzy evaluation matrix), as shown in Table 4.

TABLE 4. Membership degree calculation table

Evaluation index	Very good	Good	Middle	Poor	Very poor
Emergency plan C1	0.24	0.02	0.29	0.26	0.19
Prevention and control policy C2	0.24	0.22	0.28	0.18	0.08
Epidemic surveillance C3	0.18	0.23	0.27	0.3	0.02
Dining system C4	0.26	0.02	0.1	0.3	0.32
Emergency supplies reserve C5	0.05	0.03	0.38	0.24	0.3
Medical resources match C6	0.12	0.1	0.28	0.19	0.31
Nucleic acid testing arrangement C7	0.08	0.09	0.1	0.5	0.23

International Journal of Scientific Engineering and Science
Volume 8, Issue 9, pp. 71-77, 2024. ISSN (Online): 2456-7361

Temporary quarantine site C8	0.01	0.15	0.39	0.41	0.04
Health report C9	0.18	0.3	0.28	0.04	0.2
Employee source distribution C10	0.02	0.2	0.03	0.37	0.38
Enterprise population density C11	0.15	0.24	0.23	0.07	0.31
Epidemic prevention consciousness C12	0.14	0.3	0.21	0.31	0.04
Epidemic prevention publicity C13	0.07	0.34	0.21	0.2	0.18
Epidemic prevention training C14	0.16	0.25	0.17	0.32	0.1
Public disinfection C15	0.34	0.11	0.16	0.32	0.07

(2) Index weight calculation

The weights of 4 first-level indicators and 15 second-level indicators are calculated by BWM, and the specific results are shown in Table 5.

(3) Fuzzy comprehensive evaluation of the second-level index

Make a fuzzy comprehensive evaluation on the preparation of the management system. The single factor fuzzy evaluation matrix is as follows:

$$R_1 = \begin{bmatrix} 0.24 & 0.02 & 0.29 & 0.26 & 0.19 \\ 0.24 & 0.22 & 0.28 & 0.18 & 0.08 \\ 0.18 & 0.23 & 0.27 & 0.3 & 0.02 \\ 0.26 & 0.02 & 0.1 & 0.3 & 0.32 \end{bmatrix}$$

The weights of management system in Table 5 are $W_1 = (0.18\ \ 0.27\ \ 0.37\ \ 0.08)$.

The result of single factor evaluation is calculated as follows:

$$B_1 = W_1 \circ R_1 = \begin{pmatrix} 0.213 & 0.173 & 0.263 & 0.260 & 0.091 \end{pmatrix}$$

By the same calculation, we can get:

$$B_2 = W_2 \circ R_2 = \begin{pmatrix} 0.087 & 0.084 & 0.283 & 0.274 & 0.272 \end{pmatrix}$$

$$B_3 = W_3 \circ R_3 = \begin{pmatrix} 0.144 & 0.282 & 0.221 & 0.166 & 0.187 \end{pmatrix}$$

$$B_4 = W_4 \circ R_4 = \begin{pmatrix} 0.265 & 0.17 & 0.169 & 0.305 & 0.091 \end{pmatrix}$$

(4) Fuzzy comprehensive evaluation of the first level index

We make a fuzzy comprehensive evaluation on the risk of resuming work and production of Enterprise A. The single factor fuzzy comprehensive evaluation matrix is as follows:

$$R = \begin{bmatrix} 0.213 & 0.173 & 0.263 & 0.260 & 0.091 \\ 0.087 & 0.084 & 0.283 & 0.274 & 0.272 \\ 0.144 & 0.282 & 0.221 & 0.166 & 0.187 \\ 0.265 & 0.17 & 0.169 & 0.305 & 0.091 \end{bmatrix}$$

TABLE 5. Index weight table

First-level index	Weight	Second-level index	Weight
Management system A1	0.55	Emergency plan C1	0.18
		Prevention and control policy C2	0.27
		Epidemic surveillance C3	0.47
		Dining system C4	0.08
Emergency materials A2	0.21	Emergency supplies reserve C5	0.26
		Medical resources match C6	0.49
		Nucleic acid testing arrangement C7	0.175
		Temporary quarantine site C8	0.075
Personnel situation A3	0.08	Health report C9	0.5
		Employee source distribution C10	0.14
		Enterprise population density C11	0.07
		Epidemic prevention consciousness C12	0.29
Preparation of prevention and control measures A4	0.16	Epidemic prevention publicity C13	0.125
		Epidemic prevention training C14	0.225
		Public disinfection C15	0.65

The weight in Table 5 is $W = (0.18\ \ 0.27\ \ 0.37\ \ 0.08)$.

The results of fuzzy comprehensive evaluation are as follows

$$B = W \circ R = \begin{pmatrix} 0.189 & 0.162 & 0.249 & 0.263 & 0.137 \end{pmatrix}$$

According to the principle of maximum membership degree of fuzzy comprehensive evaluation, the fuzzy evaluation value of the preparation degree of enterprise A for returning to work and production is 0.263. It shows that the preparation degree of Enterprise A for resuming work and production is in a poor grade. The risk degree of resumption of work and production in Enterprise A is in a higher risk level. The feasibility and effectiveness of the improved multi-level reporting comprehensive evaluation model will be validated.

TABLE 6. Preparation degree, risk level and response measures

Preparation degree	Risk level	Acceptability	Seal and control	Nucleic acid testing	Reference for production resumption
Very poor	Very high	Unacceptable	Attach great importance to and strictly prevent and control	Full staff testing	No resumption
Poor	Higher	Acceptance on a small scale	Attach importance to and strictly control	daily testing within three days	A small number of people return to work if necessary.
Middle	Medium	Partially acceptable	Appropriate measures	Five times testing within seven days	Resumption in batches
Good	Lower	Acceptable	No need	Normalized testing	Resumption
Very good	Very low	Negligible	No need	No testing	Resumption

In addition, according to *the guidance on the regular prevention and control of Covid-19 epidemic situation* issued by the State Council and *the COVID-19 diagnosis and treatment Plan (trial Ninth Edition)* issued by the National Health Commission, the corresponding risk levels, acceptance and countermeasures were formulated according to the preparation degree of resumption of work and production. There are three kinds of countermeasures, which are the degree of sealing and control, the frequency of nucleic acid detection and the suggestion of resuming work. For example, when the preparation level of the enterprise is in a good level, the risk level is relatively low and acceptable, and there is no need for strict closed control. It is suggested that the enterprise should resume work and production and only need to carry out normal nucleic acid testing. The details are shown in Table 6.

As can be seen from Table 6, in terms of acceptability, the higher risk of resuming work and production of Enterprise A belongs to acceptance on a small scale. If it is not necessary, for most workers, it is not recommended to return to work and return to work. If the enterprise is about to go bankrupt at this time, a very small number of employees in the core departments can be allowed to return to work and production. Enterprise A should attach importance to the prevention and control of epidemic situation in the enterprise, and strictly control the contact between internal personnel and external personnel. Personnel who return to work and return to production are required to participate in nucleic acid testing daily nucleic acid testing within three days.

IV. Conclusion

This paper addresses the issue of risk assessment for business resumption during an infectious disease pandemic. Utilizing the Best-Worst Method (BWM) to determine the weight of various resumption indicators, we refine the multi-level fuzzy comprehensive evaluation method. Taking Company A as a case study, we scientifically and rationally assess its readiness for resumption, risk level, and propose corresponding response measures. This approach effectively validates the feasibility and efficacy of the model. The results show that the preparation degree of Enterprise A for resuming work and production is poor, and it is in a higher risk grade, so it is not recommended to resume work and production if it is not necessary. When necessary, enterprises that resume work and production need to pay attention to strict prevention and control and those who return to work should participate in daily nucleic acid testing within three days. By inputting data from other companies into the refined fuzzy comprehensive evaluation method, direct assessment results can be obtained. Therefore, this comprehensive evaluation approach demonstrates a broad applicability.

In addition, the theoretical contribution and practical value of this paper are mainly as follows:

(1) This paper comprehensively integrates the risk assessment indicators of production resumption, which are in line with the practice and policy. We construct a new comprehensive evaluation system of resuming work and production, which has 4 first-level indexes and 15 second-level indexes.

(2) In this paper, an improved multi-level fuzzy comprehensive evaluation risk assessment method based on the combination of Best-Worst-Method (BWM) and fuzzy comprehensive evaluation is proposed firstly. The risk assessment method is universal and can be applied to other enterprises that need to resume work and production, so as to provide reference for the prevention and control decision-making of the government and enterprises.

However, there are still some limitations in this study. First, after putting forward the improved method, there is a lack of comparative analysis with the existing evaluation methods. In the future, we can compare and evaluate the methods of this paper from different angles. Second, the index system of this paper has more subjective indicators and less objective indicators. All the above deficiencies are worthy of further research in the future.

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

No potential conflict of interest was reported by the author (s).

Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

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