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Article

Risk Prevention and Control and Value Realization Path of Enterprise Operation Based on Blockchain Technology under AI Generated Music Copyright Confirmation Mechanism

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Abstract: The rapid development of artificial intelligence technology has promoted significant changes in the field of music creation, and AI-generated music has commercial-grade creative ability, but there is still a legal gap in its copyright attribution. This study constructs a risk assessment model of enterprise operation under the copyright confirmation mechanism of AI-generated music, determines the weights of the indicators by combining the hierarchical analysis method and entropy weighting method, and applies the fuzzy comprehensive evaluation method to assess the risk level. By distributing 500 questionnaires and obtaining 100 valid questionnaires, a risk identification system containing five primary indicators and 20 secondary indicators for technology, law, society, company and external environment was constructed. The study investigated 200 cases of enterprise operation risk in the copyright confirmation mechanism of AI-generated music, with objective data ranging from 60 to 100. The results showed that the objective weight distribution range of the second-level indicators was 0.0231-0.0895, and the weight distribution range of the first-level indicators was 0.1415-0.2813, and the final risk evaluation level was medium risk. Based on the evaluation results, an operational risk control mechanism and value realization path based on blockchain technology are proposed, including four aspects of copyright registration, copyright trading, music authorization, and usage tracking, providing a complete solution for AI-generated music copyright confirmation.

Keywords: AI-generated music; copyright confirmation mechanism; blockchain technology; operation risk assessment; fuzzy comprehensive evaluation; value realization path

1. Introduction

With the rapid development of artificial intelligence technology, AI musical works have brought new vitality to the music industry with its unique creation method and style. However, like traditional music works, AI music works also need to be protected by law, and copyright recognition is a crucial part of it [1]. When AI puts aside the commonly used algorithms and training modes, and completely relies on its own understanding and creative ability to create music, how to determine the copyright attribution of its works and the identification criteria has become a focus of attention for both the music industry and the legal profession [2-3]. In traditional copyright law, the author is the natural person who creates the work. For AI music, it is not a human being, whether it can be recognized as the author is very controversial, on the one hand, AI did create a musical work, from the results of which it seems to have some characteristics of the author; on the other hand, it does not have human consciousness and emotions, does not comply with the definition of the author of the traditional law [4-7]. When AI music creation involves multi-party cooperation, which may include multiple subjects such as algorithm developers, data providers, music producers, singers, etc., the problem of copyright allocation is more complicated [8].

After the relevant laws are formulated, the copyright of AI-generated music may be determined through contractual agreements, the contribution of the creative subject, the claim of the development enterprise, the user-led claim, etc., and the mechanism of its confirmation of rights is not fixed [9].

Currently, the market competition in the music industry is very fierce, and enterprises not only need to have high-quality music works and artists, but also need to have good marketing and operation strategies. Among them, music copyright is the operation key concern link. According to UNESCO estimates, more than 80% of the global digital music is spread without authorization, which is due to the characteristics of digitization and networking, music works are easily copied and disseminated, resulting in the music creators can not get the income they deserve, which seriously affects the enthusiasm of music creation and the quality of life of the creators, as well as the effect of enterprise operation [10-12]. Therefore, it is worth studying the operational risk prevention and control and value realization of enterprises for AI music copyright.

Blockchain technology provides a powerful application scenario for music copyright management with its features of non-tampering, decentralization and openness and transparency. Each block contains its own hash value, which is a kind of fingerprint of the data, and when the data in the block changes, its hash value also changes, which makes the blockchain tamperproof, and all the copyright transactions in music copyright management can be well tracked, providing a pillar for the management of enterprise operation [13-14]. And the smart contract can automatically execute the pre-set rules and terms to improve the efficiency and accuracy of the transaction and realize the automatic sub-execution of copyright [15-16]. In addition, its pass-through economy can realize the programming of pass-through certificates through smart contracts and other technologies, so as to realize automated value transfer and exchange and provide support for value realization [17].

In recent years, the application of artificial intelligence (AI) technology in the field of music creation is becoming more and more mature, and AI universal composition frameworks such as Multimedia Lab's self-developed XMusic have commercial-grade music generation capabilities, and the music industry is experiencing an unprecedented digital transformation. However, the copyright of AI-generated music has become a key bottleneck restricting the healthy development of the industry. The existing legal framework has not yet clearly defined the copyright subject of AI-generated content, leading to ambiguity in the relationship of rights and obligations among creators, developers and users. Creativity theory advocates that copyright belongs to AI developers, arguing that complex thought-generating models reflect the personalized choices of the development team; tool theory tends to prefer that users enjoy copyright, emphasizing the decisive role of user commands in the creation process; and commission theory argues that copyright should belong to the operator, based on the definition of the legal relationship between commissioned creations. This theoretical difference not only increases the legal risk of business operation, but also hinders the commercialization of AI-generated music. Blockchain technology, with its decentralization, non-tampering, smart contracts and other features, provides technical support for solving the problem of copyright, and through the establishment of a transparent and credible copyright registration and transaction system, it can effectively protect the rights and interests of creators, reduce the risk of enterprise operation, and promote the realization of the value of the music industry. Currently, the operational risks faced by enterprises involve the system security at the technical level, the perfection of regulations at the legal level, the awareness of copyright protection at the social level, the management decision at the corporate level, and the policy support of the external environment, and so on, which need to be systematically analyzed through the establishment of a scientific risk assessment system. Aiming at the above problems, this study firstly constructs the enterprise operation risk identification system under the copyright confirmation mechanism of AI-generated music through literature review and expert research, determines the subjective weights of indicators at all levels by using hierarchical analysis, calculates the objective weights by combining with the entropy weight method to form a comprehensive weight evaluation system, and quantitatively evaluates the risk level by using fuzzy comprehensive evaluation method, and then designs the operation risk control mechanism based on the blockchain technology. On this basis, it designs the operation and control mechanism based on blockchain technology, constructs the risk prevention and control system from the aspects of credit management and contract management, and finally puts forward the four-in-one value realization path of copyright registration, copyright trading, music authorization, and usage tracking to form a complete AI-generated music copyright solution, which will provide theoretical guidance and technical support for the formulation of relevant policies and enterprise practice.

2. Risk Assessment of Business Operations under AI-Generated Music Copyright Enforcement Mechanisms

2.1. AI-Generated Music Copyright Validation Mechanism

2.1.1. AIGC Conditional Access to Music Copyrights

Multimedia Lab has self-researched AI universal composition framework XMusic, which already has the ability to generate commercial-grade music. Music involves auditory experience, visual presentation, social sharing, and traversal of reality and reality, etc. Along with continuous financing, research and development, and market expansion, the music industry has ushered in prosperous development. At this stage and for a long time to come, AI does not have the ability to bear legal responsibility, and therefore cannot be the subject of copyright.AIGC (Artificial Intelligence Generated Content) users can claim copyrights for their own contributions to the work, and then use the work. However, the work should be marked for identification, and AIGC service providers should provide users with the ability to categorize and label the way in which it was generated, such as creative traces, markers, digital watermarks, etc., as well as ensure that the source, purpose and function of the generated material are ethical, and provide a compliance record that excludes the risk of liability when it arises.

2.1.2. Attribution of Copyright

If AIGC establishes a work, who should own the copyright? To address this issue, there are currently three different views, namely, creativity, tools, and entrustment, which believe that the copyright belongs to the developer, the user, and the operator, respectively. Creativity says that the copyright belongs to the owner of the AI "mind". The complex AI "thinking" generating model is designed and improved by the developer, and the data format processing, trigger condition setting, creation framework selection and model training in creation all reflect the personalized choices and arrangements of the creative team, so the copyright of AIGC music should be attributed to the developer. The tool says that the copyright should be owned by the user. Because the machine cannot think and create independently, and the generated content is subject to the requirements and restrictions of the user's instructions, the user controls the AI's creative process more closely. AIGC users entrust the operator to customize the required works, the operation platform belongs to the trustee, the copyright of the works should be in accordance with the provisions of Article 17 of the Copyright Law, by the principal and the trustee through the contract, the contract does not make a clear agreement or did not enter into a contract, the copyright belongs to the trustee, i.e., the operator of the AIGC. AIGC music copyright is a double-edged sword, and the user must own the copyright while the user must control the creation process more closely. While owning the copyright, it must be responsible for whether the work is infringing or not.Open AI mentioned in ChatGPT's Sharing and Distribution Policy that the copyright of the content co-created with ChatGPT belongs to the user, and at the same time, declared that it does not exclude the situation where ChatGPT generates the same content.The huge amount of works generated by AI may also cause infringement among each other, and in order to avoid this groundless situation, AIGC chose to use the copyright of the work as the basis of the copyright. In order to avoid this situation, AIGC chose to give up the copyright of the works by prioritizing the agreement and entrusting the company with a free choice. Is this waiver a legal circumvention? If there is a circumvention, the agreement has no legal effect, and the copyright belongs to the law. However, there is no legal basis for this, and copyright ownership carries with it the risk of liability, which needs to be clearly stipulated in the law.

2.2. Enterprise Operational Risk Assessment Model

Through the theoretical analysis of the AI-generated music copyright mechanism above, it can be seen that AI-generated musical works may also cause infringement among each other, and copyright attribution will cause certain risks to enterprise operation. In view of the above problems, the enterprise operation risk assessment model under the AI-generated music copyright mechanism is formulated. The detailed formulation is shown below:

2.2.1. Risk Identification Methods

For the enterprise operation risk under the AI-generated music copyright mechanism, the identification of the risk can generally be assisted by a number of tools and technologies to make up for the shortcomings of each method. Finally, a comprehensive analysis is carried out in combination with the actual situation. Combined with the actual application of blockchain technology in enterprise operation risk control, the risk identification methods adopted are literature review method, expert scoring method, scenario analysis method, Delphi method. This paper mainly adopts the literature review method and expert scoring method in the process of establishing the risk system, and the initial risk system is derived from the research of previous scholars at the initial stage, and expert opinions are comprehensively considered in the questionnaire survey process, and the final risk system is derived from the combination of expert opinions and the characteristics of the enterprise operation risk after correction.

2.2.2. Risk Identification System

The questionnaire was issued 500 questionnaires, 100 valid questionnaires on risk factors are supplemented, of which 200 are industry experts who have been working for more than 20 years, and it is concluded in the experts' feedback that the company's management problems should likewise be included in the risk analysis of the factors that are indispensable to risk management and control, and at the same time, the limited application scenarios of the blockchain also have a certain risk impact on the platform. Secondly, some experts have proposed that the external environment also has a large impact factor on the risk of enterprise operation under the AI-generated copyright confirmation mechanism, and the author believes that the impact of the external environment is worthwhile as an independent research perspective by summarizing that the risk identification system is shown in Table 1. Therefore, through the combing of previous scholars' research perspectives, this paper identifies the risk assessment factors as the technical level, legal level, social level, company level, and external environment level as the risk categories for evaluation, which can be additionally subdivided into 20 secondary indicators.

Table 1. Risk identification system.

Primary risk factor	Symbol	Secondary risk factors	Symbol
Technical aspect	X1	Technological updates and iterations make the system insecure	X11
		Node storage space affects the working efficiency of the system	X12
		The operations of each node consume a large amount of resources	X13
		The application scenarios of blockchain technology are limited	X14
		The issue of standard norms for blockchain technology	X15
Legal aspect	X2	The laws and regulations are not sound	X21
		Lax law enforcement and weak punishment	X22
		There are limitations in the application of law	X23
Social level	X3	The public's awareness of digital copyright protection is weak	X31
		The copyright ownership is unclear	X32
		Online piracy occurs frequently	X33
		The distribution of benefits is chaotic.	X34
At the company level	X4	Personnel Management	X41
		Rules and regulations	X42
		Strategic decision	X43
		Product positioning	X44
External environment	X5	Digital copyright protection technology lags behind the development of digital publishing	X51
		The atmosphere of the digital publishing industry	X52
		Network environment	X53
		Digital Copyright Protection Policy	X54

2.2.3. Hierarchical Analysis-Based Weighting of Subjective Indicators

When using the hierarchical analysis method for the calculation of initial weights, the decision maker divides the elements into different levels by subjectively analyzing the elements, compares the different elements of each level, establishes the judgment matrix, calculates the eigenvalues and eigenvectors of the judgment matrix, and determines the weights of the indicators by consistency test [18-19]. In this paper, we analyze the subjectivity of each indicator and use hierarchical analysis to find the initial weights, the process is as follows:

In accordance with the scoring scale and the above principles of judgment matrix construction, the judgment matrix about n elements is established as follows:

$$C = \begin{bmatrix} C_{11} & \cdots & C_{1s} \\ \vdots & \ddots & \vdots \\ C_{s1} & \cdots & C_{ss} \end{bmatrix} \tag{1}$$

Determine that the matrix C has the following property:
The elements on the main diagonal of the matrix are all 1. i.e.,:

$$C_i = 1(i = 1, 2, ..., n) \tag{2}$$

All elements of the matrix are greater than 1, i.e.,:

$$C_{ij} > 0 \tag{3}$$

The centrally symmetric elements of the matrix are inverses of each other, i.e.,:

$$C_{ij} = \frac{1}{C_{ji}}(i \neq j) \tag{4}$$

Consistency test to determine the initial weights. Constructed judgment matrix, you need to use a special mathematical formula, and the matrix eigenvectors and the largest characteristic root into the formula calculation, in order to carry out consistency check, when the required values through the consistency check conditions, in order to determine the eigenvectors for the weights, otherwise the judgment matrix needs to be re-constructed, did not pass the consistency check of the evaluator's lack of knowledge of the relevant matrices or The reason for not passing the consistency check may be due to the evaluator's lack of knowledge of the relevant matrix or calculation errors.

The constructed judgment matrix needs to use a special mathematical formula and bring the eigenvectors and the largest eigenroot of the matrix into the formula to carry out the consistency check, and only after the requested value passes the consistency check condition can the eigenvectors be determined as the weights, otherwise the judgment matrix needs to be reconstructed, and the reason for failing to pass the consistency check may be due to the lack of evaluator's knowledge of the relevant matrices or a calculation error. The reason for not passing the consistency check may be due to the evaluator's lack of knowledge about the matrix or calculation errors.

In general, the square root method can be used to solve the judgment matrix and further find the eigenvector W and the eigenroot λ corresponding to the judgment matrix, and the specific calculation steps are as follows:

Step 1: Calculate the product of the elements of each row of the judgment matrix:

$$M_i = \prod_{j=1}^{n} c_{ij} \tag{5}$$

where: M_i - the product of the elements of each row, where $i = 1, 2, \ldots, n$.

Step 2: Compute the n th root of M_i:

$$\overline{W_i} = \sqrt[n]{M_i} \tag{6}$$

Step 3: Normalize the vector $\overline{W_i}$:

$$W_i = \overline{W_i} / \sum_{j=1}^{n} \overline{W_j} \tag{7}$$

where: W_i - the eigenvectors of the judgment matrix, $W_i = [W_1, W_2, ..., W_n]^T$.

Step 4: Find the maximum characteristic root:

$$CW = \begin{bmatrix} C_{11} & \cdots & C_{1\pi} \\ \vdots & \ddots & \vdots \\ C_{n1} & \cdots & C_{n\pi} \end{bmatrix} \times \begin{bmatrix} W_1 \\ \vdots \\ W_n \end{bmatrix} \tag{8}$$

$$\lambda_{\max} = \sum_{i=1}^{n} \frac{(CW)_i}{nW_i} \tag{9}$$

Eq:

$\lambda_{\max}$ - the largest characteristic root of the judgment matrix.

$(CW)_i$ - the i th element of the vector CW.

Use equation (10) to find the consistency check index CI. The degree of consistency of the judgment matrix and the CI has a link between, if the CI is smaller, the degree of consistency of the judgment matrix will be better, otherwise it will be worse.

$$CI = \frac{\lambda_{\max} - n}{n-1} \tag{10}$$

Consistency calibration passed:

$$CR = \frac{CI}{RI} < 0.1 \tag{11}$$

Satisfaction gives the corresponding weight W, otherwise the judgment matrix is reconstructed for computation.

2.2.4. Weighting of Objective Indicators Based on the Entropy Weighting Method

Due to the wide scope of application of the entropy weight method, it is not affected by subjective factors, and the index weights calculated by this method have high precision, meanwhile, when jointly seeking weights with other subjective assignment methods, the entropy weight method can fully utilize its own advantages of strong objectivity and play a very good corrective characteristics [20-21]. Therefore, this paper utilizes the entropy weight method to find out the correction coefficient, and then corrects the initial weight obtained from the hierarchical analysis method, and finally finds out the comprehensive weight.

The specific calculation process is as follows:

(1) Construct the evaluation matrix X: Let the evaluation matrix $X = (x_{ij})_{m\times n}$ be constituted by m evaluation programs n indicators, $i = l,2,....,m; j = l,2,...,n$.

(2) Normalize the data for each indicator to eliminate the incommensurability between indicators. For:

$$P_{ij} = x_{ij} / \sum_{i=1}^{m} x_{ij} \tag{12}$$

(3) Calculate the entropy E_j of each evaluation index. When $P_{ij} = 0$, let $P_{ij} \ln P_{ij} = 0$. For:

$$E_j = \sum_{i=1}^{m} P_{ij} \ln P_{ij} / \ln m \tag{13}$$

(4) Using the entropy E_j of each indicator, find the deviation d_j of the indicator j:

$$d_j = 1 - E_j \tag{14}$$

(5) Determine the correction coefficients μ_j using the degree of deviation d_j for each indicator:

$$\mu_j = d_j / \sum_{j=1}^{n} d_j \quad (15)$$

(6) Use each correction coefficient μ_j to correct the initial weight W_j derived from the hierarchical analysis method, and derive the corrected weight θ_j from the entropy weight method:

$$\theta_j = \mu_j W_j / \sum_{j=1}^{n} \mu_j W_j \quad (16)$$

2.2.5. Combined Evaluation Indicator Weights

The initial weight W_j obtained by the hierarchical analysis method and the weight θ_j corrected by the entropy weight method are combined and calculated according to Eq. (17), and the combined weight W_j obtained by the combined AHP-entropy weight method is obtained. For:

$$w_j = \rho W_j + (1-\rho)\theta_j \quad (17)$$

In Eq. (17): ρ - resolution factor, usually taken as 0.5.

2.2.6. Fuzzy Integrated Evaluation

(1) Establish the evaluation index system, with $U_i(i = 1 \ldots n)$ denoting the first-level risk indicators, and $V_{ij}(j = 1 \ldots n)$ denoting the second-level risk indicators [22].

(2) Establish the evaluation set, and the degree of influence of each indicator on the enterprise operation risk under the AI-generated music copyright confirmation mechanism is expressed as $Y_i(i = 1 \ldots n)$.

(3) Create a single-factor fuzzy evaluation matrix P.

(4) Determine the weight set, the first level risk indicator weight set is $W_i(i = 1.....n)$, and the second-level risk indicator weight set is $V_{ij}(j = 1 \ldots n)$.

(5) Comprehensive evaluation. According to the basic model of fuzzy comprehensive evaluation to determine the fuzzy evaluation matrix R formula is expressed as:

$$R = \begin{bmatrix} R11 & R12 \ldots R1n \\ R21 & R22 \ldots R2n \\ R31 & R32 \ldots R3n \\ Rn1 & Pn2 \ldots Rmn \end{bmatrix} \quad (18)$$

The formula for the fuzzy comprehensive evaluation matrix is expressed as:

$$B = W \times R = (W1 \ldots Wn) = R = \begin{bmatrix} R11 & R12...R1n \\ R21 & R22...R2n \\ R31 & R32...R3n \\ Rn1 & Rn2...Rmn \end{bmatrix} \quad (19)$$

3. Example Analysis of Assessment Models

3.1. Analysis of the Results of the Weighting of Evaluation Indicators

3.1.1. Analysis of Subjective Weighting Results

According to the above calculation process, the subjective weights of the indicators in the enterprise operation risk evaluation index system under the mechanism of AI-generated music copyright confirmation are calculated, and all the indicators are compared two by two with the other indicators according to the level, and a questionnaire is made by using the quantitative value of the evaluation scale of the 1-9 degree method, and ten experts in the relevant fields are invited to make the judgment of the relevant importance, and the experts' views are integrated, and the data obtained are used as the basis to calculate the weights of each indicator, and the judgment matrix is constructed by using the EXCEL software. The data obtained is used as the basis to calculate the weight of each indicator, processed using EXCEL software, and construct the judgment matrix. The judgment matrices of the indicators constructed in this study are shown in Tables 2-7 below:

Table 2 First-level indicator judgment matrix

Index	X1	X2	X3	X4	X5
X1	1	0.5	0.125	0.2	0.2
X2	0.2	1	0.2	0.2	0.3
X3	0.33	0.33	1	0.1	0.5
X4	0.1	0.1	0.5	1	0.5
X5	0.2	0.1	0.5	0.33	1

Table 3. The secondary index judgment matrix under X1.

Index	X11	X12	X13	X14	X15
X11	1	0.33	0.2	0.5	0.1
X12	0.33	1	0.125	0.33	0.1
X13	0.125	0.1	1	0.2	0.5
X14	0.2	0.1	0.33	1	0.5
X15	0.33	0.2	0.5	0.33	1

Table 4. The secondary index judgment matrix under X2.

Index	X21	X22	X23
X21	1	0.5	0.125
X22	0.5	1	0.125
X23	0.125	0.33	1

Table 5. The secondary index judgment matrix under X3.

Index	X31	X32	X33	X34
X31	1	0.5	0.1	0.5
X32	0.1	1	0.2	0.33
X33	0.5	0.1	1	0.125
X34	0.2	0.33	0.125	1

Table 6. The secondary index judgment matrix under X4.

Index	X41	X42	X43	X44
X41	1	0.25	0.33	0.1
X42	0.1	1	0.2	0.33
X43	0.5	0.1	1	0.125
X44	0.2	0.33	0.125	1

Table 7. The secondary index judgment matrix under X5.

Index	X51	X52	X53	X54
X51	1	0.25	0.125	0.1
X52	0.125	1	0.1	0.33
X53	0.25	0.33	1	0.125
X54	0.5	0.1	0.125	1

For example, the judgment matrix of the first-level indicators is used as an example to calculate the weights of the indicators, and the matrix is solved based on the steps of the above calculation principle, and its corresponding eigenvectors (0.1917, 0.1901, 0.2240, 0.1917, 0.2026), with the largest eigen-root of $\lambda_{\max} = 5.0119$, and the consistency test is carried out on them:

$$CI = \frac{\lambda_{\max} - n}{n-1} = \frac{5.0119 - 5}{5-1} = 0.02975$$

Consistency ratio when n is 5 and RI = 1.12:

$$CR = \frac{CI}{RI} = \frac{0.02975}{1.12} = 0.02656 < 0.1$$

Therefore, it is judged that the consistency of this matrix is relatively satisfactory and the single-level weight vector of the judgment matrix of the first-level indicators (0.1917, 0.1901, 0.2240, 0.1917, 0.2026) is acceptable.

Similarly, the single-level weights, maximum eigenvalue consistency index CI, and consistency ratio CR of the other three matrix vectors can be calculated to determine whether they can pass the combined consistency test. In this study, when calculating the judgment matrix vectors that do not pass the consistency test, under the premise of fully respecting the opinions of the experts participating in the assessment of the importance of the indexes, the problematic data are appropriately adjusted until their calculation results can pass the consistency test, and the eigenvectors of the matrices are shown in Table 8. The final calculation of the subjective weights of the indicators in the enterprise operation risk evaluation index system under the AI-generated music copyright confirmation mechanism is shown in Table 9.

Table 8. Eigenvectors of each matrix.

Matrix name	Feature vector (single-level weight)	Maximum eigenvalue	CI	RI	CR
X	0.1917, 0.1901, 0.2240, 0.1917, 0.2026	5.0119	0.02975	1.12	0.02656
X1	0.2028, 0.1699, 0.1670, 0.2028, 0.2575	5.1105	0.02763	1.12	0.0247
X2	0.3484, 0.3484, 0.3033	4.0648	0.02161	0.58	0.0373
X3	0.3143, 0.2253, 0.2222, 0.2382	3.0448	0.02242	0.9	0.0249
X4	0.2578, 0.2438, 0.2406, 0.2578	4.0707	0.02356	0.9	0.0262
X5	0.2170, 0.2326, 0.2924, 0.2580	4.0625	0.02084	0.9	0.0232

Table 9. The subjective weight results of each indicator.

Primary risk factor	Weight	Secondary risk factors	Single sorting weight	Total sorting weight
X1	0.1917	X11	0.2028	0.0389
		X12	0.1699	0.0326
		X13	0.1670	0.0320
		X14	0.2028	0.0389
		X15	0.2575	0.0494
X2	0.1901	X21	0.3484	0.0662
		X22	0.3484	0.0662
		X23	0.3033	0.0577
X3	0.2240	X31	0.3143	0.0704
		X32	0.2253	0.0505
		X33	0.2222	0.0498
		X34	0.2382	0.0534
X4	0.1917	X41	0.2578	0.0494
		X42	0.2438	0.0467
		X43	0.2406	0.0461
		X44	0.2578	0.0493
X5	0.2026	X51	0.2170	0.0440
		X52	0.2326	0.0471
		X53	0.2924	0.0592
		X54	0.2580	0.0523

3.1.2. Analysis of Objective Weighting Results

At present, the AI-generated music industry has developed earlier, and after years of case practice, more objective data on enterprise operation risks have been accumulated. In order to ensure the objectivity of the weight of the indicators in this paper, with reference to the relevant literature and a series of statistical data, the investigation and research of 200 cases of enterprise operation risk that occurred in the mechanism of AI-generated music copyright confirmation over the years, this paper categorizes the data according to the time series, and for the convenience of the statistics, the objective data statistics of the indicators are shown in Table 10. The data show that the objective data range of each indicator is within 60~100.

Table 10. Objective data of various indicators.

Index	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
X11	65	78	90	76	61	73	92	64	87	64
X12	78	65	86	80	70	63	86	100	78	94
X13	61	62	69	83	69	94	72	70	84	91
X14	76	98	70	82	90	60	88	60	63	85
X15	100	91	95	72	71	73	78	76	83	68
X21	99	90	89	60	81	65	89	69	73	61
X22	72	92	100	97	85	80	98	86	61	62
X23	62	84	89	63	61	62	63	82	75	92
X31	72	83	82	79	91	97	64	81	90	70
X32	88	89	99	63	94	93	86	76	81	89
X33	86	66	74	91	72	88	96	72	88	60
X34	90	85	69	78	89	84	73	71	66	97
X41	76	98	72	85	80	86	86	96	79	68
X42	70	61	99	91	69	76	100	62	63	77
X43	98	77	80	60	64	67	80	100	95	95
X44	76	87	91	78	90	80	85	84	93	92
X51	63	71	61	75	95	76	97	70	69	94
X52	98	82	91	91	97	98	100	84	95	81
X53	79	80	84	97	91	82	63	75	71	76
X54	70	93	98	61	98	74	65	74	60	80

In order to facilitate the later research work, the objective data in Table 10 were normalized, and the results of the normalization process are shown in Table 11. After the normalization process, the objective weight values of the evaluation indicators are maintained in the interval of 0 to 1.

Table 11. Normalization processing.

Index	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
X11	0.1290	0.5484	0.9355	0.4839	0.0000	0.3871	1.0000	0.0968	0.8387	0.0968
X12	0.4054	0.0541	0.6216	0.4595	0.1892	0.0000	0.6216	1.0000	0.4054	0.8378
X13	0.0000	0.0303	0.2424	0.6667	0.2424	1.0000	0.3333	0.2727	0.6970	0.9091
X14	0.4211	1.0000	0.2632	0.5789	0.7895	0.0000	0.7368	0.0000	0.0789	0.6579
X15	1.0000	0.7188	0.8438	0.1250	0.0938	0.1563	0.3125	0.2500	0.4688	0.0000
X21	1.0000	0.7692	0.7436	0.0000	0.5385	0.1282	0.7436	0.2308	0.3333	0.0256
X22	0.2821	0.7949	1.0000	0.9231	0.6154	0.4872	0.9487	0.6410	0.0000	0.0256
X23	0.0323	0.7419	0.9032	0.0645	0.0000	0.0323	0.0645	0.6774	0.4516	1.0000
X31	0.2424	0.5758	0.5455	0.4545	0.8182	1.0000	0.0000	0.5152	0.7879	0.1818
X32	0.6944	0.7222	1.0000	0.0000	0.8611	0.8333	0.6389	0.3611	0.5000	0.7222
X33	0.7222	0.1667	0.3889	0.8611	0.3333	0.7778	1.0000	0.3333	0.7778	0.0000
X34	0.7742	0.6129	0.0968	0.3871	0.7419	0.5806	0.2258	0.1613	0.0000	1.0000
X41	0.2667	1.0000	0.1333	0.5667	0.4000	0.6000	0.6000	0.9333	0.3667	0.0000
X42	0.2308	0.0000	0.9744	0.7692	0.2051	0.3846	1.0000	0.0256	0.0513	0.4103
X43	0.9500	0.4250	0.5000	0.0000	0.1000	0.1750	0.5000	1.0000	0.8750	0.8750
X44	0.0000	0.6471	0.8824	0.1176	0.8235	0.2353	0.5294	0.4706	1.0000	0.9412
X51	0.0556	0.2778	0.0000	0.3889	0.9444	0.4167	1.0000	0.2500	0.2222	0.9167
X52	0.8947	0.0526	0.5263	0.5263	0.8421	0.8947	1.0000	0.1579	0.7368	0.0000
X53	0.4706	0.5000	0.6176	1.0000	0.8235	0.5588	0.0000	0.3529	0.2353	0.3824
X54	0.2632	0.8684	1.0000	0.0263	1.0000	0.3684	0.1316	0.3684	0.0000	0.5263

On the basis of this normalization process, the entropy weight method is used to calculate the P_{ij} values of each indicator, and the P_{ij} values of each indicator are shown in Table 12.

Table 12. The P_{ij} values of each indicator.

Index	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
X11	0.0286	0.1214	0.2071	0.1071	0.0000	0.0857	0.2214	0.0214	0.1857	0.0214
X12	0.0882	0.0118	0.1353	0.1000	0.0412	0.0000	0.1353	0.2176	0.0882	0.1824
X13	0.0000	0.0069	0.0552	0.1517	0.0552	0.2276	0.0759	0.0621	0.1586	0.2069
X14	0.0930	0.2209	0.0581	0.1279	0.1744	0.0000	0.1628	0.0000	0.0174	0.1453
X15	0.2520	0.1811	0.2126	0.0315	0.0236	0.0394	0.0787	0.0630	0.1181	0.0000
X21	0.2216	0.1705	0.1648	0.0000	0.1193	0.0284	0.1648	0.0511	0.0739	0.0057
X22	0.0493	0.1390	0.1749	0.1614	0.1076	0.0852	0.1659	0.1121	0.0000	0.0045
X23	0.0081	0.1870	0.2276	0.0163	0.0000	0.0081	0.0163	0.1707	0.1138	0.2520
X31	0.0473	0.1124	0.1065	0.0888	0.1598	0.1953	0.0000	0.1006	0.1538	0.0355
X32	0.1096	0.1140	0.1579	0.0000	0.1360	0.1316	0.1009	0.0570	0.0789	0.1140
X33	0.1347	0.0311	0.0725	0.1606	0.0622	0.1451	0.1865	0.0622	0.1451	0.0000
X34	0.1690	0.1338	0.0211	0.0845	0.1620	0.1268	0.0493	0.0352	0.0000	0.2183
X41	0.0548	0.2055	0.0274	0.1164	0.0822	0.1233	0.1233	0.1918	0.0753	0.0000
X42	0.0570	0.0000	0.2405	0.1899	0.0506	0.0949	0.2468	0.0063	0.0127	0.1013
X43	0.1759	0.0787	0.0926	0.0000	0.0185	0.0324	0.0926	0.1852	0.1620	0.1620
X44	0.0000	0.1146	0.1563	0.0208	0.1458	0.0417	0.0938	0.0833	0.1771	0.1667
X51	0.0124	0.0621	0.0000	0.0870	0.2112	0.0932	0.2236	0.0559	0.0497	0.2050
X52	0.1589	0.0093	0.0935	0.0935	0.1495	0.1589	0.1776	0.0280	0.1308	0.0000
X53	0.0952	0.1012	0.1250	0.2024	0.1667	0.1131	0.0000	0.0714	0.0476	0.0774
X54	0.0578	0.1908	0.2197	0.0058	0.2197	0.0809	0.0289	0.0809	0.0000	0.1156

Combined with each indicator P_{ij} value and entropy weight method formula, the entropy value, difference coefficient and entropy weight of each indicator are obtained respectively, and the objective weight of each indicator in the enterprise operation risk evaluation index system under the mechanism of AI-generated music copyright confirmation is finally calculated, and the results of the objective weights are shown in Table 13. The results show that the distribution range of the objective weight values of the secondary indicators is 0.0231~0.0895, while the distribution range of the corresponding weight values of the primary indicators is 0.1415~0.2813, which describes in detail the size of the objective weight values of the indicators.

Table 13. Objective weight result.

Primary risk factor	Weight	Secondary risk factors	Entropy value	Coefficient of difference	Weight
X1	0.2813	X11	0.8446	0.1554	0.0589
		X12	0.8798	0.1202	0.0456
		X13	0.8526	0.1474	0.0559
		X14	0.8399	0.1601	0.0607
		X15	0.8413	0.1587	0.0602
X2	0.1895	X21	0.8505	0.1495	0.0567
		X22	0.8857	0.1143	0.0433
		X23	0.7640	0.2360	0.0895
X3	0.1415	X31	0.9090	0.0910	0.0345
		X32	0.9391	0.0609	0.0231
		X33	0.9037	0.0963	0.0365
		X34	0.8751	0.1249	0.0474
X4	0.1949	X41	0.8974	0.1026	0.0389
		X42	0.8080	0.1920	0.0728
		X43	0.8831	0.1169	0.0443
		X44	0.8974	0.1026	0.0389
X5	0.1929	X51	0.8509	0.1491	0.0565
		X52	0.8810	0.1190	0.0451
		X53	0.9188	0.0812	0.0308
		X54	0.8405	0.1595	0.0605

3.1.3. Analysis of Combined Weighting Results

Under the premise of known objective weights and subjective weights of the indicators, according to the comprehensive weight calculation formula described in the previous section, the comprehensive weights of the indicators in the enterprise operation risk evaluation index system under the AI-generated music copyright confirmation mechanism can be derived, and the results of the comprehensive weights of the indicators are shown in Table 14. Taking X11 as an example, X11=0.5*0.0389+0.5*0.0589=0.0489, and the same for the remaining evaluation indicators.

Table 14. The comprehensive weight results of each indicator.

Index	Subjective weight	Objective weight	Comprehensive weight	Index	Subjective weight	Objective weight	Comprehensive weight
X1	0.1917	0.2813	0.2663	X11	0.0389	0.0589	0.0489
				X12	0.0326	0.0456	0.0391
				X13	0.0320	0.0559	0.0440
				X14	0.0389	0.0607	0.0498
				X15	0.0494	0.0602	0.0548
X2	0.1901	0.1895	0.1898	X21	0.0662	0.0567	0.0615
				X22	0.0662	0.0433	0.0548
				X23	0.0577	0.0895	0.0736
X3	0.2240	0.1415	0.1828	X31	0.0704	0.0345	0.0525
				X32	0.0505	0.0231	0.0368
				X33	0.0498	0.0365	0.0432
				X34	0.0534	0.0474	0.0504
X4	0.1917	0.1949	0.1933	X41	0.0494	0.0389	0.0442
				X42	0.0467	0.0728	0.0598
				X43	0.0461	0.0443	0.0452
				X44	0.0493	0.0389	0.0441
X5	0.2026	0.1929	0.1978	X51	0.0440	0.0565	0.0503
				X52	0.0471	0.0451	0.0461
				X53	0.0592	0.0308	0.0450
				X54	0.0523	0.0605	0.0564

3.2. Enterprise Operational Risk Assessment

In order to further classify the risk level of enterprise operation risk indicators under the AI-generated music copyright mechanism, this paper adopts the expert scoring method to carry out a fuzzy comprehensive evaluation of the risk indicators by considering the probability of occurrence of the risk indicators and the degree of harm caused by the occurrence of the risk. As the enterprise operation risk indicators in this paper are qualitative indicators that are difficult to quantify, the expert scoring method is used to quantify them according to the scores of the experts, and the score value is used to convert the qualitative evaluation into quantitative evaluation, and the final enterprise operation risk evaluation value under the AI-generated music copyright mechanism is calculated by combining with the weights obtained in the above article. According to the enterprise operation risk evaluation index model under the AI-generated music copyright confirmation mechanism, the fuzzy comprehensive evaluation in this section is divided into the fuzzy comprehensive evaluation of first-level risk indicators and the fuzzy comprehensive evaluation of second-level risk indicators, of which the first-level fuzzy comprehensive evaluation contains 5 risk indicators and the second-level fuzzy comprehensive evaluation contains 20 risk indicators.

3.2.1. Expert Scoring

According to the general principles of rubric set construction, this paper adopts the rubric set V={high risk, higher risk, medium risk, low risk}, invites 10 experts to score the risk level of risk evaluation indexes, and each expert can only choose one rubric for each evaluation index to score, and the specific scoring is shown in Table 15.

Table 15. Scoring summary.

Primary risk factor	Secondary risk factors	High risk	Higher risk	Medium-risk	Low risk
X1	X11	1	2	3	4
	X12	2	3	4	1
	X13	3	1	4	2
	X14	1	2	3	4
	X15	3	1	4	2
X2	X21	1	1	3	5
	X22	1	3	5	1
	X23	2	2	4	2
X3	X31	2	2	3	3
	X32	3	2	3	2
	X33	2	2	4	2
	X34	1	2	3	4
X4	X41	2	2	4	2
	X42	1	2	5	2
	X43	2	1	3	4
	X44	2	1	5	2
X5	X51	2	2	4	2
	X52	2	2	3	3
	X53	2	3	3	2
	X54	3	2	2	3

3.2.2. Fuzzy Comprehensive Evaluation of Secondary Risk Indicators

Still taking X1 as an example, according to the expert scoring, the result of its comment is (1, 2, 3, 4), divided by 10, and it is normalized to get the affiliation degree of this indicator R11 = (0.1, 0.2, 0.3, 0.4), and the affiliation degree calculation of all the second-level indexes under the indicator of X1 is carried out by the method to get the affiliation degree matrix R1, and the affiliation matrix is shown in Tables 16 to 20. Take X1 as an example to start the detailed calculation. The calculation process is as follows:

$$B_1 = W_1 \square R_1 \left(0.0489, 0.0391, 0.0440, 0.0498, 0.0548\right)\begin{pmatrix} 0.1 & 0.2 & 0.3 & 0.4 \\ 0.2 & 0.3 & 0.4 & 0.1 \\ 0.3 & 0.1 & 0.4 & 0.2 \\ 0.1 & 0.2 & 0.3 & 0.4 \\ 0.3 & 0.1 & 0.4 & 0.2 \end{pmatrix}$$

$$= \left(0.04733, 0.04135, 0.08477, 0.06315\right)$$

ccording to the principle of maximum affiliation, the risk level of the final indicator X1 is medium risk, and the other X2~X5 are the same.

Table 16. Membership degree matrix R1.

X1	Weight	R1			
X11	0.0489	0.1	0.2	0.3	0.4
X12	0.0391	0.2	0.3	0.4	0.1
X13	0.0440	0.3	0.1	0.4	0.2
X14	0.0498	0.1	0.2	0.3	0.4
X15	0.0548	0.3	0.1	0.4	0.2

Table 17. Membership degree matrix R2.

X2	Weight	R2			
X21	0.0615	0.1	0.1	0.3	0.5
X22	0.0548	0.1	0.3	0.5	0.1
X23	0.0736	0.2	0.2	0.4	0.2

Table 18. Membership degree matrix R3.

X3	Weight	R3			
X31	0.0525	0.2	0.2	0.3	0.3
X32	0.0368	0.3	0.2	0.3	0.2
X33	0.0432	0.2	0.2	0.4	0.2
X34	0.0504	0.1	0.2	0.3	0.4

Table 19. Membership degree matrix R4.

X4	Weight	R4			
X41	0.0442	0.2	0.2	0.4	0.2
X42	0.0598	0.1	0.2	0.5	0.2
X43	0.0452	0.2	0.1	0.3	0.4
X44	0.0441	0.2	0.1	0.5	0.2

Table 20. Membership degree matrix R5.

X5	Weight	R5			
X51	0.0503	0.2	0.2	0.4	0.2
X52	0.0461	0.2	0.2	0.3	0.3
X53	0.0450	0.2	0.3	0.3	0.2
X54	0.0564	0.3	0.2	0.2	0.3

3.2.3. Fuzzy Integrated Evaluation of Tier 1 Risk Indicators

Based on the fuzzy evaluation results of the second-level risk indicators, the fuzzy evaluation matrix of the first-level risk indicators is constructed, and the fuzzy comprehensive evaluation matrix of the first-level risk indicators is shown in Table 21. The weighted average is used as the fuzzy operator to calculate the fuzzy evaluation of the first-level risk indicators B. The calculation is as follows:

$$B = W \circ R$$

$$= (0.2633, 0.1898, 0.1828, 0.1933, 0.1978) \begin{pmatrix} 0.04733 & 0.04135 & 0.08477 & 0.06315 \\ 0.02635 & 0.03731 & 0.07529 & 0.05095 \\ 0.03522 & 0.03658 & 0.05919 & 0.05191 \\ 0.03268 & 0.02973 & 0.08319 & 0.0477 \\ 0.0452 & 0.04406 & 0.05873 & 0.04981 \end{pmatrix}$$

$$= (0.039301, 0.039242, 0.075382, 0.055049)$$

Based on the principle of maximum affiliation, it can be concluded that the evaluation level of the risk of enterprise operation under the mechanism of AI-generated music copyright rights is medium risk.

Table 21. Fuzzy comprehensive evaluation matrix.

Index	Weight	R			
X1	0.2663	0.04733	0.04135	0.08477	0.06315
X2	0.1898	0.02635	0.03731	0.07529	0.05095
X3	0.1828	0.03522	0.03658	0.05919	0.05191
X4	0.1933	0.03268	0.02973	0.08319	0.0477
X5	0.1978	0.0452	0.04406	0.05873	0.04981

4. Operational Risk Control Based on Blockchain Technology

The analysis of the evaluation model above shows that the current enterprise operation risk under the AI-generated music copyright confirmation mechanism is in medium risk. In order to solve this risk, this chapter formulates a kind of operation risk control based on blockchain technology. The specific description is as follows:

4.1. Credit Management

Through the registration module of blockchain technology, the company can collect industrial and commercial data of potential music enterprises, forming a rather large-scale database of music industry information. By comparing the registration information of potential music enterprises with the publicly available industrial and commercial data and public prosecutor's data, the integrity risk of potential music enterprises can be detected at the admission stage, and cooperation on music copyrights with faithless music enterprises can be effectively avoided. In addition, it has set up functions such as music enterprise satisfaction survey and enterprise regular inspection form, so that not only the legal department can evaluate the existing music copyright authorization and infringement of music version, but also the relevant user department can also evaluate and score the enterprises that have cooperated, and use the "big data blockchain" model to manage the evaluation of enterprises, so as to provide effective support for enterprise ratings and the establishment of enterprise black and gray lists.

4.2 Contract Management.

Through the blockchain technology of music copyright contract management, enterprises can carry out online legal review of the proposed music copyright contract, external lawyers by giving feedback on the legal review opinions, and enterprise legal personnel record and give feedback on the lawyers' legal review opinions on the contract, so as to provide legal protection for the formal signing of the contract and avoid legal risks. Secondly, through the accumulation of the feedback records of contract legal review issues, a list of common contract issues can be formed, which is convenient for the enterprise departments to design and improve the contract terms, curbing the occurrence of enterprise operation risks from the source, and playing an auxiliary role in the control of enterprise operation risks under the mechanism of AI-generated music copyright confirmation.

5. Value Realization Path Based on Blockchain Technology

In order to further improve the enterprise operation risk control based on blockchain technology under the AI-generated music copyright confirmation mechanism, the value realization path based on blockchain technology is proposed from the four aspects of copyright registration, copyright transaction, music authorization and usage tracking.

5.1. Registration of Copyright

Utilizing the blockchain's non-tampering and distributed ledger characteristics, key data such as AI-generated creation information, author information, timestamps and other key data are recorded on the blockchain to complete the copyright registration, which provides non-disputable evidence of copyright ownership and facilitates the subsequent realization of AI-generated music copyrights, as well as avoids the problem of music copyright disputes.

5.2. Copyright Transactions

Creators can use the blockchain platform to record the music copyright meter plan, split it into digital assets, and trade it on the blockchain copyright trading market. Buyers can directly purchase copyrights or obtain specific authorization to use them, and the transactions are recorded on the blockchain, which ensures transparent and safe transactions and reduces business operation risks.

5.3. Music Licensing

With the help of smart contracts, creators can flexibly set the conditions for music licensing, such as the scope of use, the period of use, and the number of times of use. When the user or platform meets the conditions, the smart contract automatically executes the authorization, realizing fast and efficient realization of music copyright value.

5.4. Utilization Tracking

Blockchain can record the use of music on different platforms and in different scenarios, such as the number of times it is played, the number of times it is downloaded, and its use in advertisements or film and television soundtracks and other specific uses, and creators can realize the value of music copyrights based on these data, while also reducing the problem of business operation risks.

6. Conclusion

By constructing a risk assessment model of enterprise operation under the mechanism of AI-generated music copyright, the study finds that the current risk level faced by enterprises is medium risk, which requires effective control measures. The risk identification system covers five dimensions: technology, law, society, company, and external environment, in which the weight of the technology dimension reaches 0.2663, which becomes the main risk factor affecting the operation of the enterprise. The expert evaluation results show that 10 experts scored and assessed the risk indicators, and that unsound laws and regulations and the lack of technical standards and norms are the prominent problems currently faced. The risk control mechanism based on blockchain technology can effectively reduce the risk of enterprise operation in terms of credit management and contract management, and provide all-around risk prevention and control support for enterprises through the establishment of a music industry information database and an online legal audit system. The construction of the value realization path provides a feasible solution for the commercial application of AI-generated music. Copyright registration makes use of the blockchain's tamper-proof characteristics to ensure clear ownership, copyright trading realizes flexible circulation through digital asset division, music authorization improves execution efficiency with the help of smart contracts, and the use of tracking function supports accurate revenue distribution. This complete system not only solves the technical problems of copyright, but also provides a new development mode for the digital transformation of the music industry. In the future, it is necessary to further improve relevant laws and regulations, establish unified technical standards, promote the large-scale application of blockchain in the field of music copyright, and realize the organic combination of technological innovation and legal protection.

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