Postprint: Research on the Construction and Reliability of Copyright Innovation Ecosystem for Online Information Resources

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Abstract

[Objective/Significance] Under the new circumstances, advancing the construction of a copyright innovation ecosystem for network information resources and evaluating its reliability is conducive to activating the innovation vitality of copyright activities and guiding the sustainable development of the network copyright industry. [Method/Process] First, construct an evolutionary model for the copyright innovation ecosystem of network information resources, and propose a system reliability assessment method based on Markov processes with corresponding analytical equations. Then, utilize a Bayesian network model to calculate the fundamental data for operational state transition rates, solve for the system's transient availability, and simultaneously explore the key factors influencing the development of the network information resource copyright business format through studying steady-state availability. Finally, validate the model's applicability using the copyright innovation ecosystem of network video resources as an example. [Results/Conclusion] During the operation of the network video resource copyright innovation ecosystem, it reaches an evolutionary stable value of 0.758 0 at 254h. Among them, innovation investment risk poses the most severe potential harm to the development of the network information resource copyright business format, followed by innovation environment risk and copyright infringement risk, with technical risk, fusion innovation risk, and network information resource risk being less critical; the suspension adjustment rate and periodic adjustment rate exhibit significant corrective effects on restoring system stability. Based on these simulation results, several strategies for promoting the development of the network video copyright industry are proposed.

Full Text

Preamble

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Research on the Construction and Reliability of Network Information Resource Copyright Innovation Ecosystem

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Abstract:
[Purpose/Significance] Under the new situation, advancing the construction of a network information resource copyright innovation ecosystem and evaluating its reliability is conducive to activating the innovative vitality of copyright activities and guiding the sustainable development of the network copyright industry. [Method/Process] First, this paper constructs an evolution model of the network information resource copyright innovation ecosystem and proposes a system reliability evaluation method based on the Markov process, providing corresponding analytical equations. Then, the Bayesian network model is used to calculate the basic data of operating state transition rates, solving the system's transient availability. Meanwhile, by studying steady-state availability, key factors affecting the development of the network information resource copyright industry are explored. Finally, the applicability of the model is verified using the network video resource copyright innovation ecosystem as an example. [Result/Conclusion] During the operation of the network video resource copyright innovation ecosystem, the evolutionary stable value of 0.7580 is reached at 254 hours. Among them, innovation investment risk poses the most serious potential harm to the development of the network information resource copyright industry, followed by innovation environment risk and copyright infringement risk, with technology risk, integration innovation risk, and network information resource risk being less severe. The suspension adjustment rate and periodic adjustment rate have obvious corrective effects on restoring system stability. Based on these simulation results, several strategies are proposed to promote the development of the network video copyright industry.

Keywords: network information resources; copyright; innovation ecosystem; innovation risk; Markov process; Bayesian network
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On November 11, 2020, the 23rd session of the Standing Committee of the 13th National People's Congress passed the decision to amend the Copyright

Law, which came into effect on June 1, 2021 [?]. This represents a powerful response to the realities of network information resource copyright industry development and indicates that network copyright protection has entered a new stage. Shortly after the amendment, Xi Jinping emphasized during the 25th collective study session of the Political Bureau that upholding the core position of innovation is the primary driving force for leading the development of the network copyright industry. He stressed the need to comprehensively strengthen intellectual property protection, reinforce the entire chain of intellectual property protection, and stimulate innovation vitality to promote the construction of a new development pattern [?].

However, through literature review and in-depth investigation of copyright utilization on some platforms, we find that China's network copyright industry development is unstable, with prominent issues such as frequent copyright disputes, rigid copyright transaction models, and uneven distribution of copyright benefits. The core manifestation is the contradiction between the value creation demand for network information resources and the severe copyright innovation risks. Therefore, effectively integrating internal and external information resources, talent, technology, capital, and other production factors to optimize the existing copyright industry structure through collaborative innovation has become an inevitable choice for copyright industry development under the new situation. Currently, the innovation paradigm is undergoing a new round of transformation and upgrading, with independent innovation systems gradually shifting toward ecological and collaborative innovation ecosystems. An innovation ecosystem, as an open collaborative innovation network based on a cooperative environment, can precisely explain the complexity of the network copyright environment and stakeholder growth, providing new ideas and directions for China's network information resource copyright industry development—namely, developing a network information resource copyright innovation ecosystem. Nevertheless, during the evolution of this ecosystem, uncertainties in both the external innovation environment and the system's own evolution can induce innovation risks. Failure to predict the evolution mechanism of these innovation risks will seriously harm the overall interests of the network information resource copyright innovation ecosystem and hinder the promotion and diffusion of this innovation paradigm in the network copyright industry. Therefore, it is necessary to conduct reliability analysis of the constructed innovation ecosystem to provide a theoretical basis for forming a network copyright risk early warning and emergency prevention and control system, which will facilitate the healthy and sustainable development of the network copyright industry and foster a social atmosphere that respects copyright and innovation.

Current research on copyright ecosystems focuses on three dimensions: ecosystem element construction [?], value creation [?], and ecosystem evolution [?]. However, there has been no holistic revelation of the commonalities in various types of network information resource copyright operations, nor breakthrough research on ensuring stable operation of the innovation ecosystem in the face of innovation risks. Innovation risks in the system are complex and intertwined, making it necessary to appropriately reduce risk factors before conducting system reliability analysis and to effectively organize them using a network structure to ensure the accuracy and efficiency of the analysis.

Bayesian networks, as important tools for uncertainty knowledge representation and reasoning based on probability theory and graph theory, have been widely applied in complex modeling fields such as intelligent reasoning [?], reliability analysis [?], risk analysis [?], and diagnostic prediction [?]. The Markov process excels at abstracting a system's operation into a stochastic temporal model, using the current state and transition direction of variables to predict system trends, thereby providing a basis for decision-making. It has achieved considerable success in system reliability research [?].

In summary, the innovation of this paper lies in: first, constructing an evolution model of the network information resource copyright innovation ecosystem and integrating an innovation risk index system based on this model; then, introducing the Markov process to establish a reliability model for quantitative analysis of the system's reliability, further accurately grasping the system's operational performance and change patterns, thereby effectively providing forward-looking guidance for collaborative innovation among innovation entities and ensuring sustainable operation of the copyright industry.

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1 Theoretical Framework of Network Information Resource Copyright Innovation Ecosystem

1.1 Evolution Model of Network Information Resource Copyright Innovation Ecosystem

The network information resource copyright innovation ecosystem comprehensively employs legal, administrative, economic, and technological means to open up the entire chain of network information resource copyright creation, utilization, protection, management, and service, promoting the autonomous, orderly flow and efficient allocation of innovation elements. This ecosystem is an infinitely expandable and stable community [?]. Analogous to natural ecosystems, it also contains two key components: biological elements (innovation subjects) and abiotic elements (innovation environment). As shown in Figure 1 [Figure 1: see original paper], biological innovation subjects mainly include new producers, innovation consumers, and innovation decomposers, as well as other innovation subjects that play auxiliary supporting roles in the system's operation, such as government, copyright collective management organizations, technology R&D companies, and other industry organizations. Abiotic innovation environment mainly includes legal, policy, technological, cultural, economic, and social environments. These constituent elements engage in open collaborative innovation, continuously undergoing material cycling, energy flow, and information transfer, and act on copyright innovation through competition-cooperation mechanisms, supply-demand mechanisms, symbiosis mechanisms, and transformation mechanisms [?], ultimately obtaining innovation benefits such as network information resource innovation, copyright utilization innovation, and copyright service innovation, thereby feeding back into the sustainable development of the innovation ecosystem.

Among these, the interaction between information resource creators, network content service providers, and users is the core of network information resource copyright value creation and utilization. Information resource creators, as innovation producers, represent the main body of new information resource production. They primarily distribute information resources to the dissemination platforms provided by network content service providers through resource sharing, copyright licensing, copyright transfer, and other contracts. Network content service providers, as innovation consumers, absorb the innovation achievements of producers as a prerequisite for their own survival and development, and possess control rights over information resources. They are key subjects in copyright utilization, management, and service. On one hand, they screen, integrate, recommend, and classify received resources to provide more intelligent and efficient services for network users and maximize market demand satisfaction. On the other hand, they carry out copyright operation model innovations, specifically treating copyright as capital to participate in financing activities through various forms such as copyright securitization, pledge, and investment, diversifying copyright revenue sources and creating maximum economic value. Network users, as innovation decomposers, provide resource evaluations and information demand feedback to information resource creators and network content service providers through private messages, comments, bullet comments, and rewards. The latter receive this feedback to produce higher-quality information resource content, forming an information resource innovation cycle that helps alleviate the problem of China's network information resources being "large but not strong, numerous but not excellent." Additionally, in the User-Generated Content (UGC) era, the boundary between creators and users is increasingly blurred, and users can easily transition from innovation decomposers to innovation producers.

Meanwhile, government legislative departments and copyright collective management organizations contribute absolute strength to copyright protection. The former constantly reforms copyright-related laws in response to development barriers in the network copyright industry, ensuring fairness and justice in copyright activities of innovation subjects. The latter centrally exercises the rights of copyright owners and conducts litigation and arbitration involving copyright and related rights to protect the legitimate rights and interests of copyright innovation producers.

In addition, capital flows from financial institution investments and technology flows supported by technology R&D companies, as abiotic elements, flow into the innovation ecosystem, stimulating fluctuations within the system. As abiotic elements change, some fluctuation components quickly decay, promoting random system evolution, while others gradually accumulate. When accumulated to a critical state, the copyright utilization process enters an innovation process, ultimately forming a new ordered network information resource copyright ecology.

1.2 Identification of Innovation Risks in Network Information Resource Copyright Innovation Ecosystem

Identifying innovation risks in the evolution process of the network information resource copyright innovation ecosystem is a prerequisite for system reliability analysis. Based on the evolution process of the network information resource copyright innovation ecosystem, previous research results on index system construction, and consultation with six authoritative experts, this paper organizes an innovation risk system containing 6 first-level indicators and 20 innovation risk inducing factors, as shown in Table 1 .

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2 Markov Process Reliability Modeling

Sampling the operating states of the network information resource copyright innovation ecosystem at time interval t, the network state at the next moment t_{n+1} depends only on the current state at t_n and its actions, independent of historical states. Therefore, the risk evolution process of this ecosystem can be modeled as a time-discrete, state-continuous Markov process.

The steps to establish a Markov process reliability model [**?**] are:

Step 1: Analyze system risk states and establish the system's risk state space transition diagram.

Step 2: Based on the system's risk state space transition diagram, write the system equation coefficient matrix and state transition probability matrix, then multiply them to obtain the system state equation:

$$P'(t) = Ap(t) \quad \text{or} \quad P'(t) = p(t)A \tag{1}$$

Step 3: Use Laplace transform to solve the system's transient availability. The solution formula is:

$$A = \lim_{t\to\infty} A(t) = \lim_{s\to 0} sA^*(s) \tag{2}$$

where p(t) is the sum of system states during normal operation.

Step 4: Solve for steady-state availability:

$$Ap(\infty) = 0 \quad \text{or} \quad p(\infty)A = 0 \tag{3}$$

$$\sum p_i(\infty) = 1$$

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3 Markov Reliability Modeling of Network Information Resource Copyright Innovation Ecosystem

3.1 Markov Reliability Structure of the System

The network information resource copyright innovation ecosystem faces innovation risks as shown in Table 1 during its evolution. Based on consultation with six authoritative experts, when the system encounters innovation environment risk and innovation investment risk, it must suspend the innovation process for temporary adjustment due to the close relationship between legal policies, market demand, talent investment, and capital turnover with the system's evolution direction and required resources. Additionally, during normal system operation, regular adjustments to innovation strategies are necessary [?] to ensure stability and reliability, though these do not affect continuous operation. Based on these characteristics and risk descriptions, this paper establishes the system state space transition diagram shown in Figure 2 [Figure 2: see original paper].

The nine operational states are described in Table 2 . The state space can be represented as E = {0,1,2,3,4,5,6,7,8}, where normal operating states are W = {0,1,2,3,6,7,8} and suspended innovation states are F = {4,5}.

In Figure 2, λ_1-λ_{12} represent transition rates from state i at the previous moment to state j at the next moment, with meanings shown in Table 3 .

3.2 Establishing the System State Transition Matrix

Based on the premise that transition states of different component nodes are independent, the system state transition matrix is derived from the Markov operating state transition diagram:

$$A = \begin{bmatrix} -(\lambda_1+\lambda_2+\lambda_3+\lambda_4+\lambda_5+\lambda_9) & \lambda_1 & \lambda_2 & \lambda_3 & \lambda_4 & \lambda_5 & 0 & \lambda_9 & 0 \\ 0 & -\lambda_6 & 0 & 0 & 0 & 0 & \lambda_6 & 0 & 0 \\ 0 & 0 & -\lambda_7 & 0 & 0 & 0 & \lambda_7 & 0 & 0 \\ 0 & 0 & 0 & -\lambda_8 & 0 & 0 & \lambda_8 & 0 & 0 \\ 0 & 0 & 0 & 0 & -\lambda_{11} & 0 & 0 & 0 & \lambda_{11} \\ 0 & 0 & 0 & 0 & 0 & -\lambda_{11} & 0 & 0 & \lambda_{11} \\ 0 & 0 & 0 & 0 & 0 & 0 & -\lambda_9 & \lambda_9 & 0 \\ \lambda_{10} & 0 & 0 & 0 & 0 & 0 & \lambda_{10} & -2\lambda_{10} & 0 \\ \lambda_{12} & 0 & 0 & 0 & \lambda_{12} & \lambda_{12} & 0 & 0 & -3\lambda_{12} \end{bmatrix} \tag{4}$$

3.3 Constructing the System's Transient Availability Differential Equations

Let P_i(t) = P{X(T) = i} (i   E) be the probability of state E(i) occurring at time t, satisfying:

$$\sum_{i=0}^{8} P_i(t) = 1 \tag{5}$$

From equation (1), we obtain:

$$[P_0'(t), P_1'(t), \dots, P_8'(t)] = [P_0(t), P_1(t), \dots, P_8(t)]A \tag{6}$$

Combining with equation (5), the system differential equations are:

$$\begin{cases} P_0'(t) = \lambda_{10}P_7(t) + \lambda_{12}P_8(t) - (\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 + \lambda_5 + \lambda_9)P_0(t) \\ P_1'(t) = \lambda_{1P}0(t) - \lambda_{6P}1(t) \\ P_2'(t) = \lambda_{2P}0(t) - \lambda_{7P}2(t) \\ P_3'(t) = \lambda_{3P}0(t) - \lambda_{8P}3(t) \\ P_4'(t) = \lambda_{4P}0(t) + \lambda_{12}P_8(t) - \lambda_{11}P_4(t) \\ P_5'(t) = \lambda_{5P}0(t) + \lambda_{12}P_8(t) - \lambda_{11}P_5(t) \\ P_6'(t) = \lambda_{6P}1(t) + \lambda_{7P}2(t) + \lambda_{8P}3(t) + \lambda_{10}P_7(t) - \lambda_{9P}6(t) \\ P_7'(t) = \lambda_9(P_0(t) + P_6(t)) - 2\lambda_{10}P_7(t) \\ P_8'(t) = \lambda_{11}(P_4(t) + P_5(t)) - 3\lambda_{12}P_8(t) \end{cases} \tag{7}$$

The system's transient availability during normal operation is:

$$A(t) = P_0(t) + P_1(t) + P_2(t) + P_3(t) + P_6(t) + P_7(t) + P_8(t) \tag{8}$$

3.4 Constructing the System's Steady-State Availability Differential Equations

Let P_i = {i = 0,1,2,…,8} be the steady-state availability of each state. By definition, as t → ∞, transient availability equals steady-state availability, i.e., P_i = lim_{t→∞} P_i(t), assuming the system operates without risk at the initial moment. From equation (3):

$$(P_0, P_1, P_2, P_3, P_4, P_5, P_6, P_7, P_8)A = (0, 0, 0, 0, 0, 0, 0, 0, 0) \tag{9}$$

$$\sum_{i=0}^{8} P_i = 1$$

Solving these equations yields:

$$\begin{cases} P_1 = \frac{\lambda_1}{\lambda_6}P_0, \quad P_2 = \frac{\lambda_2}{\lambda_7}P_0, \quad P_3 = \frac{\lambda_3}{\lambda_8}P_0 \\ P_4 = \frac{\lambda_4+\lambda_5}{2\lambda_{11}}P_0, \quad P_5 = \frac{\lambda_4+\lambda_5}{2\lambda_{11}}P_0 \\ P_6 = \frac{\lambda_1+\lambda_2+\lambda_3+\lambda_9}{\lambda_9}P_0, \quad P_7 = \frac{\lambda_9}{\lambda_{10}}P_0, \quad P_8 = \frac{\lambda_4+\lambda_5}{3\lambda_{12}}P_0 \end{cases} \tag{10}$$

The system's steady-state availability during normal operation is:

$$A = P_0 + P_1 + P_2 + P_3 + P_6 + P_7 + P_8 \tag{11}$$

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4 Case Study Analysis

4.1 Data Source

In recent years, China's video industry has flourished, with the short-video sector emerging as a new force. Internal and external innovation elements have aggregated and connected, gradually forming a relatively complete network video resource copyright innovation ecosystem. However, in reality, copyright disputes continuously occur during the innovation process of China's video industry, hindering value creation of video resource copyrights. Therefore, this paper takes China's video industry as an example to conduct a case analysis of the reliability model based on the Markov process. This approach not only verifies the feasibility and applicability of the method but also identifies key risk factors affecting network video resource copyright innovation, providing guidance for stakeholders to take preventive measures. Currently, the network copyright industry lacks regulatory experience for innovation risks, and quantitative analysis related to innovation risks in copyright innovation ecosystems is scarce, making historical data collection for operating state transition rates difficult. Consequently, this paper primarily obtains prior probabilities through expert experience and opinions from innovation entity representatives. On May 31, 2021, the research team selected 36 experts from the copyright field and network video industry management field (including the six previously consulted experts) based on Table 1 and distributed questionnaires asking them to estimate the occurrence probabilities of child nodes (B1-B20) and conditional probabilities of parent nodes (A1-A6) according to their understanding of network video resource copyright collaborative innovation. Questionnaires were collected by June 10. Experts were divided into three levels with specific numbers and weights shown in Table 4 .

4.2 Calculation of Operating State Transition Rates

Expert survey data were processed using equation (12) [**?**]:

$$\rho_{mn} = \frac{\sum_{k=1}^{s} \omega_{mnk}}{\sum_{k=1}^{s} \omega_{mnk}}, \quad m = 1,2; \quad n = 1,2,\ldots,20; \quad k = 1,2,\ldots,s \tag{12}$$

where m represents innovation risk status (occurrence/non-occurrence), n represents nodes in the Bayesian network, _{mn} represents the probability of node n being in risk status m, s represents the number of surveyed experts, and ω_{mnk} represents the weight coefficient of the k-th expert who believes node n's risk status is m. Here, m=2, n=20, s=36. After data processing, the marginal probability values of child nodes B1-B20 were obtained, as shown in Table 5 .

Using the total probability formula (13), the probability distribution of parent node events can be obtained from child node marginal probabilities and parent node conditional probabilities. Taking integration innovation risk A1 as an example: From Table 5, P(B1)=0.3868, P(B2)=0.4434, P(B3)=0.6635, P(B4)=0.4403. Based on conditional probability means from first-level experts (Table 6), using equation (13):

$$P(A) = \sum P(A|B_i)P(B_i) \tag{13}$$

The calculation yields P(A1) = 0.5792. Similarly, other parent node occurrence probabilities are obtained (Table 7).

Transition rates λ_6-λ_8 are obtained by multiplying P(A1)-P(A3) with P(A6), respectively. λ_9-λ_{12} are derived from probability means provided by the first-level expert group. Due to space limitations, detailed survey results and calculation processes are not presented here but are available from the authors upon request. Based on parent node probability distributions, the operating state transition rates are obtained (Table 8).

4.3 Analysis of System Innovation Transient Availability

Using Mathematica and MATLAB for calculation and simulation, Laplace transform was applied to equation (7), and the system's innovation transient availability was solved based on equation (8) and Table 8. The transient availability within 1000 hours is shown in Figure 3 [Figure 3: see original paper].

At time 0, the system's innovation transient availability is 1, indicating the network video resource copyright innovation ecosystem operates without risk initially. As the system evolves, derived innovation risks damage stability, causing transient availability to drop rapidly below 0.73. Subsequently, through suspension adjustment or periodic adjustment strategies, transient availability gradually recovers. However, under continued innovation risk impacts, it declines again, though the decline gradually slows. Eventually, the system reaches equilibrium between risk damage and adjustment repair, achieving a stable evolutionary value of 0.7580 at 254 hours.

4.4 Analysis of System Innovation Steady-State Availability

Compared with transient availability, steady-state availability characterizes the system's long-term operational performance and better illustrates the mechanism of factors affecting system evolution instability [?]. To meet the practical needs of video resource copyright innovation entities, this paper further explores the impact of each state transition rate on system steady-state availability. Based on equations (10), (11), and Table 8, the variation 规律 of network video resource copyright innovation ecosystem steady-state availability with each state transition rate is shown in Figure 4 [Figure 4: see original paper].

Figures 4(a) and 4(b) show that steady-state availability is closely related to five types of innovation risk occurrence rates. Innovation investment risk λ_5 has the greatest impact, followed by innovation environment risk λ_4, with technology risk λ_3, integration innovation risk λ_1, and network information resource risk λ_2 being less significant. Quantitatively, as innovation risk rates λ_1-λ_3 increase, steady-state availability shows an overall downward trend, but the decline is relatively small (within 0.12). In contrast, as λ_4 and λ_5 increase, the decline rate and amplitude are much greater, indicating that innovation environment risk and innovation investment risk have more severe negative impacts. This aligns with expert opinions that suspension for adjustment is necessary when encountering these risks.

Copyright infringement risk, as a derivative risk under the influence of integration innovation risk, network information resource risk, and technology risk, has transition rates λ_6-λ_8 related to λ_1-λ_3. As shown in Figure 4(c), the three lines representing λ_6-λ_8 follow similar trends to λ_1-λ_3 but decline more rapidly, which is consistent with reality since λ_6-λ_8 are products of these risk rates and copyright infringement risk rates. The near-overlap of the three lines indicates that the three types of copyright infringement risks have very similar impacts on system operation.

Figure 4(d) shows that ecosystem steady-state availability increases with periodic adjustment rate λ_9 and suspension adjustment rate λ_{11}. The suspension adjustment rate λ_{11} can almost restore steady-state availability to its initial state, demonstrating that timely suspension and strategy adjustment when facing innovation environment and investment risks positively impacts normal operation. However, the curve for λ_{11} flattens after reaching a certain value, and the periodic adjustment rate λ_9 can only restore the system to a steady-state value of 0.845, indicating that adjustment rates have limitations in repairing the innovation ecosystem. Additionally, periodic adjustment completion rate λ_{10} and suspension adjustment completion rate λ_{11} have insignificant effects on steady-state availability.

4.5 Strategies for Promoting Sustainable Development of Network Video Resource Copyright Innovation

The case analysis results show that to improve the reliability of the network video resource copyright innovation ecosystem, it is necessary not only to enhance periodic and suspension adjustment rates but also to minimize derived innovation risks. Only by considering both can system reliability be fully improved. Specific guidance measures include:

1. **Innovation investment risk poses the most serious threat to reliable operation.** Continuous investment of multiple innovation elements is the lifeline of the ecosystem. Innovation entities should establish a

diversified innovation investment system through aggregation and allocation of innovative talent, capital, and scientific achievements to improve input-output ratios. Capital sources should primarily come from platform revenue, guided by government special funds, supplemented by financial institution investments and copyright association fundraising. Simultaneously, attracting outstanding innovative talent to dynamically adjust and optimize the network video resource copyright utilization process will enhance copyright benefits.

2. **Innovation environment risk's negative impact is second only to innovation investment risk.** Since the innovation environment guides system operation, all innovation activities depend on legal and policy innovations for continuous 激励, and all innovation achievements rely on market circulation for knowledge transfer and value appreciation. Innovation entities should closely monitor national copyright law reforms and policy changes, pay attention to market shifts and user demand changes, coordinate the overall direction of the innovation ecosystem, and adjust innovation strategies promptly to seize market opportunities.

3. **Integration innovation risk, network information resource risk, technology risk, and copyright infringement risk, though less significant, also negatively impact sustainable operation and require preventive measures.** On one hand, society should establish a network copyright moral system to improve intellectual property literacy, using self-discipline to regulate individual behavior and taking video resource copyright innovation as its responsibility. On the other hand, promoting deep cultural integration, business model integration, and technological innovation integration among innovation entities will nurture a favorable innovation atmosphere, providing more environmental response and trial-and-error space to further improve the ecosystem's robustness.

4. **Suspension adjustment rate and periodic adjustment rate have significant positive feedback effects on improving operational performance.** Without innovation element input, the copyright innovation ecosystem will stagnate; without adapting to industry development trends, it will become obsolete and perish. Timely suspension of erroneous innovation directions and rapid adjustment of innovation strategies are the only choices to restore vitality before irreparable damage occurs. Additionally, regular inspection and adjustment should be valued as both timely repair of minor issues and preventive adjustment, enabling early detection of system status and eliminating innovation risks in their infancy to ensure sustainable operation.

Conclusion

Based on innovation ecosystem theory, this paper examines the network information resource copyright innovation ecosystem and its risks, serving network information resource copyright innovation subjects, using Markov processes and Bayesian networks as research tools to explore reliability issues. Taking the network video resource copyright innovation ecosystem as a case study, the system's transient availability steady-state value is calculated as 0.7580. The impact of each Markov process state transition rate on system steady-state availability is analyzed. The simulation results for transient and steady-state availability align with expert cognition of the entire network video resource copyright innovation ecosystem, proving the method's rationality.

The Markov process-based reliability analysis model for network information resource copyright innovation ecosystems is applicable to any type of network information resource copyright activity development research. If the evolution of different types of network information resource copyright innovation ecosystems matches the constructed innovation risk index system characteristics and innovation evolution state transition paths, this model can be applied to explore the intensity of innovation risks encountered during innovation processes, enabling targeted preventive measures to ensure sustainable and robust operation. However, this study has limitations. First, the innovation risk index system and operating state transition paths are established based on the overall network information resource copyright innovation ecosystem, and their applicability to different types of information resource copyright innovation ecosystems requires further exploration. Second, in practical application, data acquisition for operating states relies heavily on experts' prior knowledge structures, making it highly subjective. Whether more reasonable data acquisition methods exist requires further investigation.

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Author Contributions

Li Shan: Framework development, figure creation, calculations, programming, and paper writing.
Zhang Wende: Overall concept coordination and paper revision.
Zeng Jinjing: Guidance on figure creation, calculation methods, and questionnaire design.

Note: Figure translations are in progress. See original paper for figures.

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