

# Research on the Mechanisms and Leading Value of Digital Empowerment for the Sustainable Development of Traditional Opera Troupes

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**Abstract:** *Against the backdrop of the rapid development of digital technologies, traditional opera troupes, as important carriers of traditional cultural inheritance, face sustainable development dilemmas such as audience loss, limited dissemination, and inefficient operations. From the core perspective of digital empowerment, this paper systematically explores the mechanisms through which digital technologies influence the economic, artistic, and inheritance sustainability of traditional opera troupes, and analyzes the leading value of pioneering troupes in industrial transformation. The study finds that digitalization has constructed a new path for the sustainable development of traditional opera troupes through three mechanisms: "cost-saving and revenue-increasing," "creative innovation," and "dynamic inheritance." Leading troupes, meanwhile, drive the digital transformation of the opera industry through three dimensions: industry demonstration, ecological optimization, and cultural communication. Finally, aiming at problems such as superficial technology application and resource barriers, countermeasures such as deepening technology integration and improving support systems are proposed to provide theoretical reference and practical guidance for the digital transformation of traditional opera troupes.*

**Keywords:** Digitalization, Traditional Opera Troupes, Sustainable Development, Empowerment Mechanisms, Leading Value.

## 1. INTRODUCTION

Traditional opera, as an integral part of China's outstanding traditional culture, carries national spirit and aesthetic values. However, in the process of modernization, traditional opera troupes generally face survival crises: the audience group is severely aging. According to the Report on the Development of Chinese Opera Communication (2023), 68% of opera audiences are over 50 years old; the scope of dissemination is limited to traditional theaters, with few channels for young people to access it; the operation model is single, and ticket revenue and derivative income are insufficient to support the healthy operation of troupes.

Meanwhile, the popularization of digital technologies provides new possibilities for opera troupes to break through dilemmas. The number of views of opera content on short-video platforms has continued to rise, with the total views of opera-related short videos on Douyin exceeding 50 billion in 2023; technologies such as virtual stages and holographic projections have brought innovations to the presentation of operas; intelligent management systems have significantly improved the operational efficiency of troupes. In this context, exploring the internal mechanisms of digital empowerment for the sustainable development of opera troupes and analyzing the leading value of pioneering troupes have become important issues for promoting the revitalization of the opera industry.

## 2. CURRENT LANDSCAPE AND CHALLENGES OF DIGITAL EMPOWERMENT FOR THE SUSTAINABLE DEVELOPMENT OF TRADITIONAL OPERA TROUPES

### 2.1 Current Status of Digital Practices

In recent years, the digital exploration of traditional opera troupes has shown a multi-dimensional penetration trend:

In terms of dissemination, short videos and live broadcasts have become important channels for opera to reach a wider audience. In 2023, Henan Yu Opera Theater opened the "Yujian Haoxi" account on Douyin, attracting over

3 million followers through "celebrity clips + behind-the-scenes footage," with the highest number of viewers for a single live broadcast reaching 5 million; the National Peking Opera Company launched the "Cloud Theater" series, with the proportion of revenue from paid-on-demand operas increasing year by year.

In terms of creation, digital technologies have reconstructed the stage presentation of operas. The Peking Opera New Dragon Inn uses virtual scenes and holographic projection technology to transform the traditional "one table and two chairs" abstract stage into an immersive visual experience, with the number of tour performances increasing by 40% year-on-year in 2024; Suzhou Kunqu Opera Theater used AI to analyze audience preferences to provide data support for revising the script of *The Six Records of a Floating Life*, increasing the proportion of young audiences to 35%.

In terms of operation, intelligent management has improved efficiency. Shanghai Peking Opera Theater introduced a membership management system to achieve precise marketing by analyzing audience consumption data, with a member repurchase rate of 62% in 2023; Zhejiang Xiaobaihua Yue Opera Troupe adopted an intelligent ticketing system, reducing ticketing management costs by 30%.

In terms of inheritance, digitalization has facilitated the preservation of techniques and talent training. The Kunqu Opera Art Inheritance Center established a "Kunqu Opera Movement Database," recording 1,200 classic movements through 3D scanning; Mei Lanfang Peking Opera Troupe developed an AR teaching system, increasing the efficiency of young actors' stylized training by 50%.

## 2.2 Existing Challenges

**Superficial Application of Technology:** 70% of local troupes remain at the primary stage of "live broadcasting of offline performances" and have not integrated digital technologies into core links such as creation and management (China Opera Digitalization Development Report, 2024).

**Significant Resource Barriers:** Small and medium-sized troupes invest less than 100,000 yuan annually in digitalization, only 1/20 of leading troupes, and lack professional technical talents and financial support.

**Imbalance Between Tradition and Innovation:** Some troupes excessively pursue technical spectacles. For example, a Bangzi opera troupe overused LED screens in *Mu Guiying Takes Command*, weakening the "suggestiveness" and "formulaic beauty" of opera, which triggered industry controversies.

**Lack of Industry Standards:** The mechanism for protecting the copyright of digital content is incomplete. Classic opera clips from a Yue opera theater were randomly edited and disseminated on short-video platforms, with the cost of rights protection reaching three times the revenue.

## 3. CORE MECHANISMS OF DIGITAL EMPOWERMENT FOR THE SUSTAINABLE DEVELOPMENT OF TRADITIONAL OPERA TROUPES

Digitalization constructs a closed-loop mechanism for the sustainable development of traditional opera troupes through the synergistic effect of three dimensions: economy, art, and inheritance (see Figure 1).

### 3.1 Economic Sustainability: The "Cost-Saving and Revenue-Increasing" Mechanism Driven by Digitalization

**Revenue Increase: Expanding Diversified Revenue Channels**

**Online payment models:** The National Peking Opera Company's "Digital Theater" adopted a "single opera on-demand + membership subscription" model, with online revenue reaching 12 million yuan in 2024, accounting for 28% of total revenue.

**Development of digital derivatives:** Shanghai Kunqu Opera Troupe launched "virtual Kunqu opera characters" as NFT collectibles, with the first batch of 5,000 sold out immediately upon launch, generating 8 million yuan in revenue.

**Cross-border commercial cooperation:** Zhejiang Xiaobaihua Yue Opera Troupe collaborated with the game

Nishuihan to launch opera-themed skins, achieving 5 million yuan in IP licensing revenue.

#### Cost Saving: Optimizing Operational Cost Structure

Intelligent management systems: After introducing an ERP system, Henan Yu Opera Theater reduced administrative costs by 22% and improved rehearsal venue utilization by 35%.

Data-driven decision-making: By analyzing audience portraits, a Pingju opera troupe accurately adjusted its tour cities, reducing marketing expenses by 18% while increasing box office revenue by 25%.

### 3.2 Artistic Sustainability: The "Creative Innovation" Mechanism Stimulated by Digitalization

Stimulating Creative Inspiration: Big data analysis of audience preferences provides directions for opera creation. A Cantonese opera troupe analyzed 100,000 audience comments and found that young people had a high acceptance of "love themes + modern arrangements." The adapted Legend of the White Snake based on this insight exceeded 100 tour performances.

Innovating Presentation Forms: The integration of virtual and real stage technologies expands the expressiveness of opera. The Peking Opera Chang'e Flies to the Moon used VR technology to create a "moon palace illusion," allowing audiences to obtain a 360° immersive experience through head-mounted devices, with the proportion of young audiences increasing to 42%.

Integrating Artistic Languages: Digital technologies promote cross-border integration between opera and other art forms. The Kunqu opera The Peony Pavilion was combined with electronic music to launch a "digital symphonic version," attracting a large number of non-opera audiences at music festivals.

### 3.3 Inheritance Sustainability: The "Dynamic Inheritance" Mechanism Supported by Digitalization

Digital Preservation of Techniques: The National Academy of Chinese Theatre Arts established a "Kunqu Opera Performance Database," recording 300 core movements of 12 intangible cultural heritage inheritors through motion capture technology with a precision of 0.1 mm, providing accurate references for future inheritance.

Intelligent Talent Training: AR imitation training systems help young actors grow. The system provides correction suggestions by comparing actors' movements with database standards in real time, shortening the training cycle of young actors in a Peking Opera troupe by 1-2 years.

Scenario-Based Audience Cultivation: Interactive digital experiences enhance young people's sense of identity. Suzhou Kunqu Opera Theater launched an "AR Facial Makeup Workshop," allowing audiences to generate personalized opera facial makeup by scanning images with their mobile phones, attracting over 1 million participants and effectively cultivating potential audiences.

### 3.4 Mechanism Synergy: The Interconnected Logic of Three-Dimensional Sustainability

Economic sustainability provides financial guarantees for artistic innovation and inheritance; artistic innovation feeds back economic benefits by attracting audiences; and inheritance sustainability lays a cultural foundation for artistic innovation. The three form a mutually reinforcing closed loop through digitalization. For example, the digital stage innovation of the National Peking Opera Company (artistic sustainability) attracts young audiences, drives the growth of online payment revenue (economic sustainability), and then invests more resources in the digital preservation of veteran artists' techniques (inheritance sustainability).

## 4. THE LEADING VALUE OF TRADITIONAL OPERA TROUPES UNDER DIGITAL EMPOWERMENT

In the wave of digital transformation in the opera industry, leading troupes have become the core force promoting industrial upgrading through technological exploration, model innovation, and ecological construction. They not only achieve breakthroughs themselves but also drive the renewal of the entire opera ecosystem through experience sharing, resource integration, and cultural communication, providing a reference model for the inheritance of traditional culture in the digital era.

#### 4.1 Industry Demonstration: Constructing Replicable Transformation Paths

The digital practices of leading troupes provide a complete reference system for the industry from technological application to model innovation, allowing troupes of different sizes and genres to find suitable transformation directions. The National Peking Opera Company has long been engaged in digital stage technology, and the summarized Technical Standards for Digital Stages of Traditional Opera covers 12 technical modules including virtual scene construction and lighting-sound coordination. Among them, the "low-cost virtual scene scheme" designed specifically for small and medium-sized troupes reduces the construction cost of traditional virtual stages from 500,000 yuan to less than 200,000 yuan by simplifying equipment parameters and optimizing software configurations. Currently, it has been adopted by more than 20 local troupes, helping them upgrade stage presentation within limited budgets. The "online live broadcast + offline tour" model created by Henan Yu Opera Theater solves the problem of local troupes being "unable to go out and unable to attract audiences in" through a closed-loop design of "live broadcast 引流 - offline conversion - secondary dissemination." After the model was adopted by 30% of local opera troupes nationwide, the results were remarkable. A Qinqiang opera troupe, originally limited by regions with only 150 annual performances, expanded its offline tour to 10 provinces and cities after adopting the model, with annual performances jumping to 280 and revenue nearly doubling.

#### 4.2 Ecological Optimization: Promoting Collaborative Development of the Opera Industry

Leading troupes have broken the long-standing resource barriers and disorderly competition in the opera industry by building shared platforms and formulating industry standards, promoting the formation of a benign ecosystem of collaborative development. The "National Opera Digital Alliance" led by the Shanghai Theater Arts Center integrates more than 3,000 opera materials, 20 sets of professional technical tools, and 50 digital talents from over 100 troupes, building a cooperation network of "technology sharing, content intercommunication, and talent linkage." The alliance provides free digital copyright registration services for small and medium-sized troupes, rents virtual stage equipment at low prices, and even organizes technical backbones to provide on-site guidance. In 2023 alone, it saved more than 8 million yuan in digital investment for member troupes, greatly reducing the overall transformation threshold of the industry. In terms of standard-setting, leading troupes have worked with universities and research institutions to promote the improvement of industry norms. The Ethical Guidelines for Digitalization of Traditional Opera issued by the Chinese Opera Society in 2024 was formulated based on the practical experience of many leading troupes. It clarifies 6 core principles such as "technology serving art" and "inheritance prioritizing innovation," provides operational specifications for controversial issues such as digital content adaptation and the use of virtual actors, avoids the dilution of the essence of opera due to excessive commercialization, and lays a solid foundation for the healthy development of the industry.

#### 4.3 Cultural Communication: Enhancing the Contemporary Influence of Traditional Opera

Leading troupes have used digital technology to break the circle restrictions of cultural communication, bringing opera from traditional theaters to a broader public space, which not only activates the attention of domestic young groups but also promotes the international communication of Chinese culture. The "Opera Inheritor" program on Douyin, jointly initiated by several leading troupes, not only invited 200 opera actors to join the platform but also reduced the threshold for public participation through interactive forms such as "short-video teaching" and "opera tune challenges." One year after the program was launched, the number of views of opera content on the platform soared from 15 billion to 60 billion. Among them, the "opera tune challenge" attracted a large number of pop music lovers, who integrated opera singing into modern songs, forming a creative collision between "tradition and popularity" and allowing opera to enter the cultural life of young people in a more vivid manner. In the field of international communication, digital technology has become a bridge for opera to "go global." When the 3D version of Farewell My Concubine was released to 190 countries and regions through Netflix, it adopted digital adaptation methods such as multilingual subtitles and cultural background notes to help overseas audiences understand the plot and artistic connotations, finally obtaining a high score of 4.8/5. It not only set a record for the overseas communication of Chinese opera but also let the world see the contemporary charm of Chinese traditional culture, building a new dialogue window for international cultural exchanges.

### 5. OPTIMIZATION PATHS AND GUARANTEE MEASURES

#### 5.1 Troupe-Level: Deepening Digital Integration Capabilities

As the main body of digital transformation, troupes need to formulate differentiated integration strategies

according to their scale and resource endowments to avoid disconnection between technology and art. Large troupes can rely on their advantages in funds and talents to focus on cutting-edge fields such as metaverse theaters and AI script generation. For example, the "holographic virtual theater" being tested by the National Peking Opera Company uses digital twin technology to restore classic opera scenes, allowing audiences to enjoy an immersive viewing experience without leaving home. Small and medium-sized troupes should give priority to completing basic digital transformation, such as building online ticketing systems and establishing audience databases. After a Huangmei opera troupe realized online ticketing through a WeChat mini-program, the ticketing efficiency increased by 40%, and it could also accurately plan the number of performances in rural areas by analyzing ticketing data. In terms of talent training, cross-disciplinary majors such as "digital performance" and "opera digital production" can be set up in cooperation with opera schools. At the same time, interdisciplinary creative teams consisting of screenwriters, actors, programmers, and designers can be formed. For example, when creating Digital Peony Pavilion, Suzhou Kunqu Opera Theater ensured that the application of AR technology always served the plot expression rather than mere technical display through weekly joint discussions between artists and technical experts.

## 5.2 Policy-Level: Building a Support System

Policy support is the key to solving the bottlenecks in the digital transformation of traditional opera troupes, which needs to form a synergy from both funds and platforms. In terms of financial support, a "special fund for opera digitalization" can be established to provide 30%-50% subsidies for the purchase of technical equipment by small and medium-sized troupes and full funding for digital talent training. A county-level Yu opera troupe purchased simple live broadcast equipment with the fund, increasing its monthly online performance income by 20,000 yuan. At the same time, a "digital opera loan" can be launched, with the government subsidizing 3 percentage points of interest and extending the maximum repayment period to 5 years to ease the financial pressure on troupes. In terms of public platform construction, the culture and tourism department can take the lead in building a "national opera digital service platform" that integrates functions such as copyright registration, data analysis, and technology sharing. After the platform is launched, troupes can automatically generate copyright certificates by uploading opera clips and can also use audience portrait analysis tools for free. A Pingju opera troupe found through the platform that audiences under 40 in the local area prefer comedy themes, and the attendance rate of the newly written operas based on this increased by 25%.

## 5.3 Industry-Level: Strengthening Collaboration and Standard Construction

Industry collaboration and standard norms are the basis for ensuring the sustainable development of opera digitalization, which requires breaking barriers and reaching consensus. A "traditional opera digital industry alliance" can be established under the leadership of leading troupes, 联合 small and medium-sized troupes, technology enterprises, and cultural and creative companies. A resource replacement mechanism is implemented within the alliance. For example, the Shanghai Peking Opera Theater authorizes the virtual stage software independently developed by itself to the troupes in the alliance in exchange for the characteristic opera materials of local troupes for the development of digital collectibles. In terms of standard-setting, the Specifications for the Protection of Digital Content Copyright of Traditional Opera should be issued as soon as possible to clarify the authorization process and profit-sharing ratio for the use of opera clips by short-video platforms. At the same time, the Ethical Guidelines for Virtual Opera Performances should be formulated to regulate the use of digital human actors' images and the adaptation boundaries of classic operas to prevent excessive commercialization from damaging the art of opera. In addition, the alliance can regularly hold "opera digital innovation competitions" to promote excellent practical cases. For example, the "AR facial makeup teaching system" developed by a Sichuan opera troupe was adopted by more than 10 troupes for youth opera popularization activities after winning the competition.

# 6. CONCLUSIONS AND PROSPECTS

## 6.1 Research Conclusions

Through a systematic review and analysis of the digital practices of traditional opera troupes, it is clear that digital technology has become the core driving force for promoting the sustainable development of the opera industry. It has activated the economic vitality of opera troupes through the "cost-saving and revenue-increasing" mechanism. The combination of new revenue channels such as online payments and digital derivatives with cost optimization brought by intelligent management provides economic support for the stable operation of troupes; the "creative



innovation" mechanism has broken the creative boundaries of traditional opera. The theme selection guided by big data and the stage presentation empowered by virtual technology make opera more in line with contemporary audience aesthetics while maintaining its artistic essence; the "dynamic inheritance" mechanism, with the help of digital archives and intelligent teaching systems, has solved the problems of distortion and inefficiency in the inheritance of techniques, laying a solid foundation for the intergenerational transmission of opera. These three mechanisms are not isolated but form a closed loop in which the economy feeds back art, art nourishes inheritance, and inheritance supports long-term development, together constituting a digital ecosystem for the sustainable development of traditional opera troupes.

At the same time, the leading value of leading troupes in the digital transformation is also significant. At the industry demonstration level, the technical standards and operation models summarized by them allow troupes with different foundations to find feasible transformation paths, avoiding resource waste caused by repeated exploration; at the ecological optimization level, by building resource-sharing platforms and promoting standard-setting, they effectively bridge the digital divide between leading and small and medium-sized troupes and promote collaborative development of the industry; at the cultural communication level, through the cross-border integration of new media and digital technology, they successfully promote opera to a broader audience, and even enhance the influence of Chinese culture through international platforms, becoming a model for the modern communication of traditional culture.

## 6.2 Research Limitations

Although this study covers the main dimensions of the digitalization of traditional opera troupes, there are still some limitations. In terms of case selection, due to data accessibility and research convenience, the study focuses more on leading troupes such as the National Peking Opera Company and Henan Yu Opera Theater, with insufficient attention to the digital practices of county-level troupes and private troupes in remote areas. These grassroots troupes often face more severe financial and talent dilemmas, and their transformation paths and challenges may be significantly different from those of leading troupes. Failure to include them in the analysis will affect the universality of the research conclusions. In addition, due to the imperfection of the industry data statistics system, this study fails to conduct quantitative modeling of digital investment and sustainable development indicators (such as revenue growth, audience increment, and inheritance efficiency), making it difficult to accurately measure the actual effectiveness of different digital measures, which to a certain extent weakens the empirical support of the research conclusions.

## 6.3 Future Prospects

Future research can be deepened and expanded in three directions. Firstly, with the maturity of technologies such as the metaverse and AI-generated content, further exploration can be made into their integration scenarios with opera, such as building virtual opera communities to allow global audiences to participate in performances in real-time interaction, or studying the auxiliary role of AI in opera singing creation and movement design to inject more cutting-edge vitality into opera. Secondly, it is necessary to track the impact of digitalization on the artistic essence of opera for a long time, focusing on how technical applications balance "formulaic beauty" and "innovation" to avoid excessive digitalization leading to the dissolution of opera characteristics. By comparing the differences in audience acceptance and artistic evaluation between traditional and digital operas, the golden ratio of integration between technology and art can be extracted. Thirdly, it is necessary to accelerate the construction of an effect evaluation system for the digital transformation of traditional opera troupes, set multi-dimensional indicators covering economic benefits, artistic innovation, and inheritance effectiveness, and develop evaluation models adapted to troupes of different sizes to provide accurate transformation diagnosis and optimization suggestions for troupes, promoting the digitalization of opera from "experience exploration" to "scientific policy-making." At the same time, attention can be paid to new issues arising in the process of digitalization, such as the copyright ownership of virtual actors and aesthetic differences in cross-cultural communication, to provide more comprehensive theoretical support for the healthy development of the opera industry.

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