Analysis of the Development of the Music Industry Based on AI-Powered CAD and Cloud Service Platform

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Abstract. The arrival of the digital music era has not only had an unprecedented impact but also created an unprecedented market opportunity. The value chain of the record industry will add new value chains. In order to improve the development effect of the digital music industry, this paper applies big data technology to the analysis of the development of the music industry and proposes a virtual network mapping algorithm without reconfiguration and a virtual network mapping algorithm with reconfiguration. Moreover, in order to describe load balance, this paper defines node load rate and link load rate and builds a music industry development analysis system based on a big data cloud service platform. In addition, this paper designs experiments to verify the system's performance in this paper. The experimental results show that the music industry development analysis system based on big data cloud services constructed in this paper has a good industry analysis effect.

Keywords: Big data; cloud services; music; industry development; AI-Powered CAD
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1 INTRODUCTION

The large number of illegal sharing of music on the public Internet has caused the traditional recording industry to suffer huge economic losses. Therefore, they urgently need to find a new and safe mode of communication. Mobile music just provides them with an ideal choice with its security and high coverage. More importantly, mobile phone users have developed good payment habits, which brings hope to all parties in the music industry chain who are accustomed to obtaining free content from Internet users [1].In addition, the mobile terminal market has entered an advanced stage of competition, and the market continues to be segmented and technology continues to improve. Moreover, music phones have become another hot spot in the mobile terminal market after camera phones. When the needs of the three major industry chain members are met, the mobile music business will be born and grow rapidly [18]. With the advancement of technology and the further stimulation of user needs, all parties in the mobile music industry chain will eventually work together. With the help of matching music phones, mobile music seeks to expand into the direction of high-speed data services such as whole song downloading. Music phones need to use mobile services to accelerate the penetration of the low-end market. Therefore, content providers such as record companies urgently need mobile music as a life-saving straw, and operators also need to attract consumers through services such as mobile music with huge market prospects. In addition, various factors have caused corresponding changes in the role of the industrial chain and the interrelationship between subjects. At the same time, the operating model of the industrial chain will also change accordingly [2]. The impact of 5G technology and big data in music creation, distribution, and consumption. We aim to identify the challenges and opportunities that have arisen. As a result, examining the evolution of business models, artist strategies, and listener behaviors. Our objective is to illuminate the path that the music industry is traversing in this digital age and to offer insights into the changing dynamics of an industry that remains at the intersection of art and innovation.

In recent years, there has been a dark horse in the music industry that has received widespread attention and is increasingly showing its strong vitality: digital music. Unlike traditional music, which is mainly based on physical media such as CDs and tapes, digital music refers to music that uses digital technology to produce, disseminate, and store music. Digital music is often expressed in the form of MP3 or WMAt21. According to the use of terminals, digital music is usually divided into online music and mobile music. The former mainly uses a PC as a terminal, while the latter mainly uses a mobile device such as a mobile phone as a terminal. Online music refers to digital music that can be viewed online through the Internet or can be directly downloaded to a computer and transferred to other playback devices. iTunes is a successful example of online music. Mobile music is a digital music service provided through mobile communication networks and terminal mobile phones. Its services include mobile phone ring tones, color ring back tones, mobile music on-demand, music downloads (including WAP/MMS), online listening, and other music services.

The Internet has well supplemented the lack of content in China's recording industry. Many music lovers use MIDI technology to produce music, which reduces the cost of music production and the threshold for distribution and realizes fast and convenient dissemination. Many popular songs have been successfully spread through the Internet, and the emergence of a large number of cover sites has also increased the entertainment and interactivity of music. But at the same time, because piracy has not been effectively controlled, online music is almost unprofitable. Most of the digital music revenue comes from mobile phone ringtone downloads and CRBT, and almost all revenue from online music comes from advertising revenue. However, in general, compared with the business model of the traditional recording industry, digital music channels have low cost, transparent and simple copyright supervision, and are closer to consumers, so they also have more powerful vitality.

Based on the above analysis, this paper applies big data technology to the analysis of the development of the music industry, verifies the future development of the music industry, and analyses the methods proposed in this paper in combination with experiments.

2 RELATED WORK

In creating digital music works, from an aesthetic point of view, literature [9] believed that the aesthetic value of music works lies in the form and quality of experiencing music. Through the uniqueness of the work in form, expression, or a specific combination of form and expression, the listener can feel that music is born or melted in our hearts. From a social point of view, the literature [11] believes that music works have an undeniable role as a social adhesive and stabilizing tool. It can help create, maintain, and strengthen the community's consciousness and is an important part of social life. From the perspective of copyright, the creation of musical works is the result of the intellectual labor of the songwriter, and originality is the basis for the creation of copyright rights in music.

In terms of the digital music copyright operation model, literature [10] discussed the integrated development model of the digital music industry chain under the new copyright environment from a macro perspective. Moreover, it proposes a vertical integration model of vertical integration and joint copyright development, as well as a horizontal integration model that reduces copyright fees and improves profit models, optimizes industry resource allocation, and improves copyright operation efficiency. From a micro perspective, the literature [14] proposed that under the influence of P2P technology, traditional record companies should accelerate the expansion of copyright cooperation channels, carry out diversified operations, and integrate limited resources to maximize their effectiveness.

Literature [5] divides the copyright operation mode of digital music platforms in detail. In addition, targeted research has been conducted on specific operating models such as music copyright securitization, digital music copyright film and television adaptation, digital music albums, and fan economy. In terms of digital music copyright protection methods, on the one hand, in terms of legal protection, the literature [5] pointed out that with the continuous impact of digital music on the record market, more and more countries have strengthened the legal protection of digital music copyright. Literature [3] analyses the conflict of interest and balance of digital music copyright protection from different jurisprudence, civil law, and intellectual property rights perspectives. It proposes to improve the fair use rules, statutory licensing system, compulsory licensing system, and collective management system of musical works. The establishment of copyright compensation under the network environment and other aspects to further strengthen legal protection; on the other hand, in terms of technical protection, the document [16] addresses the widespread illegal use and piracy in the digital music industry and proposes to develop encryption, digital distortion, and specific use, Trusted systems, digital watermarking, electronic deception, and other technologies increase the threshold for music copyright piracy, illegal uploading, and sharing, and protect the legal rights of music copyright owners; document [17] demonstrates the use of DRM digital technology in the content dissemination and network download of digital music works The document [7] proposes to increase the application of blockchain technology in the aspects of digital music copyright confirmation, copyright trading, and copyright value realization to improve the level of digital music copyright. Literature [8] believes that the copyright governance mechanism of the digital music industry has problems such as unclear stakeholders, difficulty in identifying copyright, lagging technological development, and frequent infringements. Literature [6] believes that there are long-standing problems in the music industry chain, such as music creation attaching importance to singers and not authors, music communication attaching importance to the scene and not attaching importance to records, music sales attaching importance to output and not attaching importance to quality, which has caused an imbalance in the digital music industry chain. Literature [4] believes that the lagging copyright laws, the lack of copyright evaluation systems, and the unequal distribution of copyright benefits in the music industry chain in digital music copyright management are hidden crises behind the prosperity and development of the digital music industry. In addition, scholars have also conducted research on issues such as digital music piracy and weak awareness of copyright protection [19]. In the study of the copyright ecology of the digital music industry, the literature [12] proposed that the copyright ecology is the sum of the relationship between the copyright growth environment and the mutual restriction and mutual promotion of copyright and various influencing factors. Any change in any factor will affect the realization of copyright value. This results in differences in the copyright industry and users' demand for copyright protection, which is an important reason for the innovation of the copyright ecosystem. Literature [13] starts with the ecological relationship of copyright protection of digital music works in the industrial development process and conducts an in-depth analysis of the inner triangle relationship of the copyright ecology of digital music works, the outer closed loop of the copyright ecology of the digital music industry, and the multiple differentiation of user roles. Literature [15] pointed out that building a good music copyright ecology requires resolutely cracking down on piracy and infringement of music works, strengthening the supervision of key music copyrights, and actively developing industry self-discipline and copyright cooperation to strengthen the construction of digital music copyright ecology.

3 MUSIC DATA MAPPING ANALYSIS ALGORITHM

In the underlying physical network, appropriate physical resources are sought to ensure the resource requests of its virtual nodes and links. A virtual node will be mapped to a physical node, and a virtual link will be mapped to a physical link or a physical path, that is

$$G_v\ V_v, E_v, A_v^v, A_v^e \xrightarrow{Mapping} G_s\ V_s, E_s, A_s^v, A_s^e$$

In the virtual network mapping algorithm, each virtual network performance optimization objective function is defined U^k , and the link rate z^k and the virtual link capacity y^k are function arguments. Therefore, the traffic management protocol running in each virtual network can be regarded as an optimization problem, as in formula 1. The overall underlying network needs to consider the performance of each virtual network when performing virtual network remapping, and the resource requests of each virtual network are guaranteed as much as possible. Therefore, the total optimization problem of all virtual networks is shown in Equation 2. However, this algorithm only considers the problem of network bandwidth resource requests and does not consider the problem of virtual node mapping and resource allocation. In addition, the algorithm periodically adjusts the bandwidth resource allocation of all virtual networks, which makes it difficult to guarantee the stability of the system, and network services are easily interrupted. In addition, the algorithm assumes that the virtual network mapping in the network is known, which is too ideal.

$$\begin{aligned} &\max imize\ U^k\left(z^k, \mathrm{y}^k\right) \\ &s.t. \\ &\left.\begin{aligned} &H^k z^k \le y^k \\ &g^k\left(z^k\right) \le 0 \\ &z^k \ge 0 \end{aligned}\right\} \end{aligned} \tag{1}$$

$$\begin{aligned} &\max imize \sum_k \omega^k U^k\left(z^k, \mathrm{y}^k\right) \\ &s.t. \\ &\left.\begin{aligned} &H^k z^k \le y^k, \forall k \\ &\sum_k y^k \le C \\ &g^k\left(z^k\right) \le 0, \forall k \\ &z^k \ge 0, \forall k \end{aligned}\right\} \end{aligned} \tag{2}$$

In order to improve the utilization of underlying network resources and achieve network load balancing, this paper proposes a virtual network mapping algorithm without reconfiguration (VNA-I) and a virtual network mapping algorithm with reconfiguration (VNA-II). In order to describe the load balance, this paper defines the node load rate and link load rate, which are defined in Equation 3.

$$\left.\begin{aligned} R_N(t) &= \frac{\max_{v\in V_s} S_N(t,\mathrm{v})}{\left[\sum_{v\in V_S} S_N(t,\mathrm{v})\right]/\left|V_S\right|} \\ R_L(t) &= \frac{\max_{e\in E_s} S_L(t,\mathrm{e})}{\left[\sum_{e\in E_S} S_L(t,\mathrm{e})\right]/\left|E_S\right|} \end{aligned}\right\} \tag{3}$$

n_i is the neighbor node of s. When Equation 4 is satisfied, node n_i is added to the backup node set of s, so that it can quickly switch to the backup node and link when the link fails.

$$\mathrm{cost}(n_i,d) < \mathrm{cost}(n_i,s) + \mathrm{cost}(s,d) \tag{4}$$

This article defines the revenue function of mapping a virtual network G^V as shown in formula 5. When the underlying physical link l fails, we use v to represent the set of virtual links affected by the faulty link 1. We define the cost function introduced by link I failure as shown in formula 6. The optimization goal of virtual network mapping SVNE is to maximize the difference between the system revenue and the cost of link failure, as shown in Equation 7.

$$\prod(G^V) = T(G^V)\cdot\left[C_1\sum_{v\in E^V} b(v) + C_2\sum_{x\in N^V} cpu(x)\right] \tag{5}$$

The objective function of the model proposed in this paper is shown in Formula 8. In the formula, Ls and Lv respectively represent the collection of the underlying network link and the virtual network link, BW(1v) represents the bandwidth resource demand of the virtual network link lv, and f_{ij}^{uv} is a binary variable.

$$Minimize \sum_{(u,v)\in L_v} \sum_{(i,j)\in L_s} f_{ij}^{uv} \times BW(l_{uv}) \tag{6}$$

Although this algorithm can improve the utilization of the underlying physical bandwidth resources, the use of non-cooperative game strategies can easily lead to the vicious competition when allocating resources among multiple virtual networks, and resource supply and resource demand cannot be equal. Moreover, the accuracy and fairness of resource pricing rules cannot be guaranteed.

$$\begin{aligned} &MAX_{x_i\geq 0}\sum_i U_i(x_i) = MAX_{x_{ij}\geq 0}\sum_i\sum_{j=1}^{J} U_i(x_{ij}) \\ &= MAX_{x_{i1}\geq 0}\sum_i\sum_{j=1}^{J} U_i(x_{i1}) + MAX_{x_{i2}\geq 0}\sum_i\sum_{j=1}^{J} U_i(x_{i2}) +,\ldots, MAX_{x_{iJ}\geq 0}\sum_i\sum_{j=1}^{J} U_i(x_{iJ}) \\ &\qquad x \leq C \end{aligned} \tag{7}$$

$$lost(l,b,\lambda) = \begin{cases} \dfrac{(1-\lambda/l)(\lambda l)^{b+1}}{1-(\lambda/l)^{b+2}}, \lambda \neq l \\ \dfrac{1}{b+2}, \lambda = 1 \end{cases} \tag{8}$$

$$
\begin{aligned}
&s.t. \\
&\overline{px_i} \le serviceprice * \lambda_i, i \in I \\
&u_i\ \ x_i\ \ \le u_i\ \ \overline{x_i} \\
&\sum_{i=1}^{n} \overline{x_i} = X
\end{aligned}
\qquad (9)
$$

In order to measure the quality of service of the network QoS, this paper defines the message loss rate in the network as shown in formula 10, the utility function of service i is defined as $U_i\ \ l_i, b_i, \lambda_i\ \ = -lost\ \ l_i, b_i, \lambda_i$, and the constraint condition is formula 11.

We provide three network expansion methods to realise ToF to accommodate more switches and server devices.

1. Horizontal expansion. We keep m unchanged in ToF(m, k) and increase the value of k. That is, we keep the number of basic En-hanced Fat-tree modules in ToF unchanged, and enhance the ability of each Enhanced Fat-tree module to accommodate servers. The details are as follows:

a. According to the needs of network expansion scale R, we increase the number of Pods included in each basic module from k to k+2n, and the value of n is determined by Equation 12. At the same time, we increase the number of columns in Torus, and the network is expanded from Torus in $m \cdot\ \ k+2n\ \ ^2 / 4$ to Torus in $m \cdot k^2 / 4$:

$$m \cdot (k + 2^3 n) \ge /4 \qquad (10)$$

b. According to the 2n Pod number added in the Enhanced Fat-tree basic module, we add physical ports to the original switches in each basic module, which are used to connect newly added network devices. For each edge layer, aggregation layer, and middle layer switches, we add n uplink ports and n downlink ports, respectively. For each core layer switch, we add 2n downstream ports.

C. $n \cdot\ \ k+n$ core layer switch is newly added in each basic module, and each core layer switch includes k+2n downstream ports and 4 additional ports. The edge layer, the convergence layer and the middle layer in the basic module are each newly added $2n \cdot\ \ k+n$ switches, and each switch includes k/2+n uplink ports and k/2+n downlink ports. $n \cdot\ \ 3k^2 + 6nk + 4n^2\ \ / 2$ servers are added in each basic module:

d. We dismantle the original Torus connection relationship of the ToF network and construct the rules according to the basic module. The newly added switch and server equipment are connected to each basic module to realise the update of the basic module. Then, we connect the updated basic modules to a new ToF(m, k+2n) data center network according to the wiring rules between the basic modules.

As shown in Figure 1, ToF (3, 4) accommodates 48 servers. If we assume that due to business needs, we need to expand to 108 servers and adopt a horizontal expansion method. According to formula 12, 2n=2 is calculated. That is, 2 Pods need to be added in each Enhanced Fat-tree module, and ToF(3,4) can be expanded to ToF(3,6) to meet business needs.

When ToF(3,4) is expanded to ToF(3,6), we first need to add 2 ports for each switch in ToF(3,4) to realize the interconnection of new network devices. In addition, we need to purchase 15 10-port switches as the core layer switches and 90 6-port switches as middle layer switches/aggregation layer switches/edge layer switches, and 60 servers are added. ToF(3,6) expanded from ToF(3,4) is shown in Figure 1.

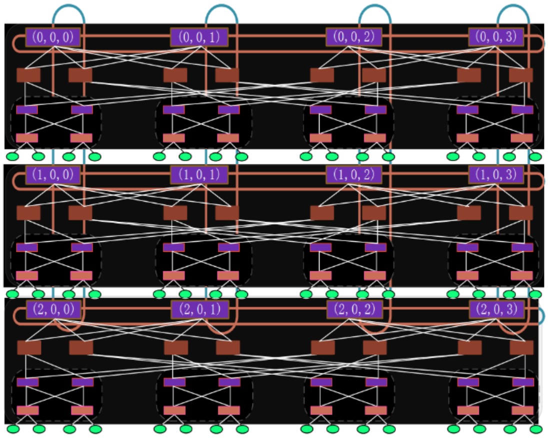

Figure 1: ToF(3,6) expanded from ToF(3,4).

2. Vertical expansion. We keep k unchanged in ToF(m,k) and increase the value of m.

According to the needs of network expansion scale R, we increase the number of basic modules in the network architecture. The number of modules is increased from m to mtr. According to Equation 13, the value of r is determined. The network is increased from m rows and k2/4 columns to m+r rows and k2/4 columns;

$$m+r^{3}\cdot k\geq /4 \quad (11)$$

The number of basic modules increases from m to m+r, and the number of Pods increases from k to k+2n. According to the need R of the scale of network expansion, the values of r and n are determined by formula 14. At the same time, the network increases from m rows and k/4 columns to m+r rows and $k+2n^{2}/4$ columns:

$$m+r \quad k+2n^{3} \quad (12)$$

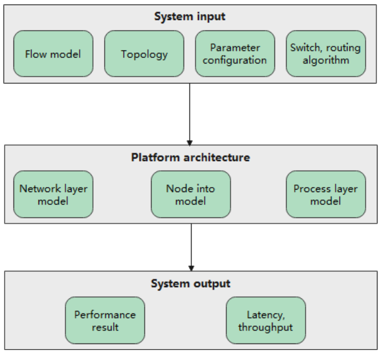

Figure 2: System platform.

The simulation system is shown in Figure 2, which mainly includes three parts: system input, simulation platform architecture, and system output.

According to the defined ToF network architecture and addressing mechanism, we can build the network layer model, as shown in the figure below.

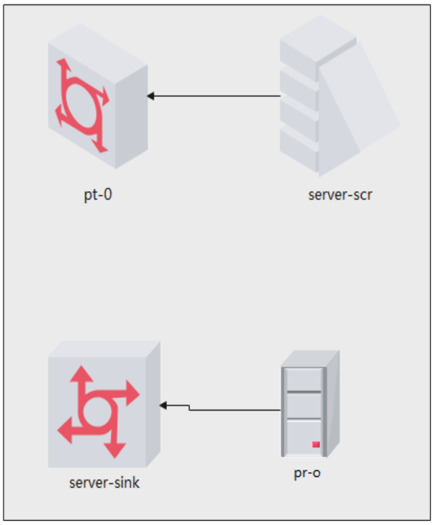

Figure 3: Server node model.

Figure 4 shows the server model in the ToF network.

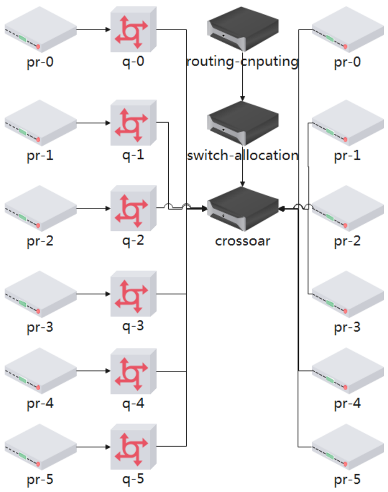

Figure 4: A type switch node model.

According to the functional requirements of each module of the server and switch, the process model (Finite State Machine FSM) under the node model is designed. Here, we focus on the four process models under the switch node model.

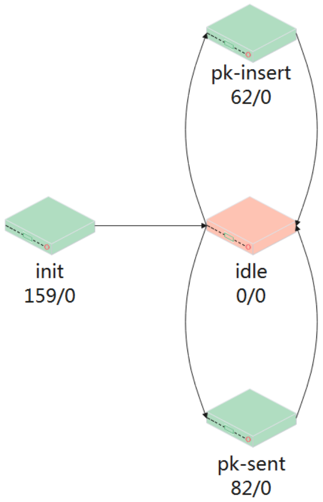

Figure 5: The process model of the input port cache queue.

Figure 5 is the process model of the input port cache in the switch node model, including four states: init, idle, pk_insert, pk_sent, and the jump relationships of the four states are given.

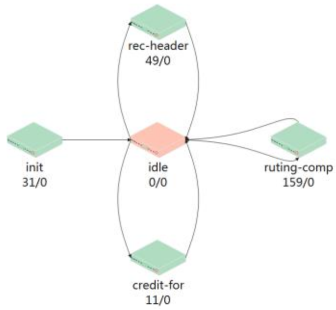

Figure 6: Process model of routing calculation unit.

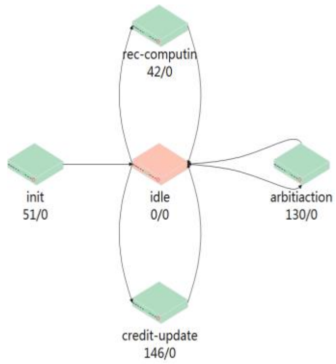

Figure 7: Process model of switch distribution unit.

Figure 6 is the process model of the routing calculation module in the switch node model, including five states: init, idle, rec_header_insert, rotuing_computing, and credit_for_rc. The jump relationship between the states is given. Here, the init state mainly reads the simulation parameters and related network attribute values required by the simulation environment from the outside, completes the variable initialization work, and generates the initial self-interruption.

Figure 7 is the process model of the crossbar distribution module, including five states: init, idle, rec_compting_result, credit_update, and arbitration. The i init state mainly reads the simulation parameters and related network attribute values required by the simulation environment from the outside, completes the variable initialization work, and generates the initial self-interruption. Idle is responsible for completing the transition of the network state. Figure 8 is the switch transmission process model, including three states: init, idle, and crossing.

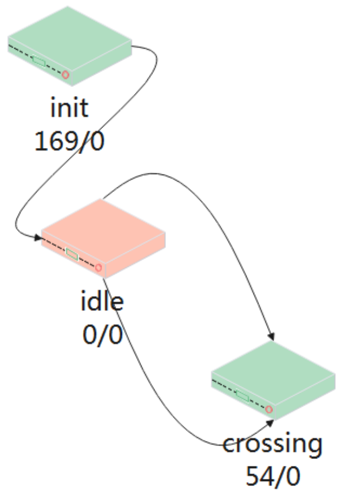

Figure 8: Switching transmission process model.

4 MUSIC INDUSTRY DEVELOPMENT ANALYSIS SYSTEM BASED ON BIG DATA CLOUD SERVICE PLATFORM

On the basis of the above research, a music industry analysis system based on a big data service platform is carried out. When the digital music era comes, the value chain of the record industry will undergo new changes. These changes are not only the inevitable result of changes in consumer demand, but also an inevitable phenomenon brought about by technological innovation. In the era of digital music, the record industry value chain will add the following new value chains.

The traditional recording and digital music industries can be divided into three links. The first is creation. Music creation is the source and upstream of the music industry. The second is spread. Music production companies represented by record companies are responsible for publishing and disseminating songs. The last one is the consumption link. Its main body is the vast number of consumers downstream of the music industry, as shown in Figure 10.

In record consumption, the factors that affect the changes in the industrial value chain mainly include consumer demand, technological level, and market environment. No matter which of these three aspects undergoes major changes, it may destroy or reshape the industrial chain. Among them, the market environment mainly includes whether the laws and regulations are perfect, whether the market mechanism is sound, etc.; the technical level is mainly reflected in whether it has brought the greatest convenience to consumers; the consumer demand is mainly analyzed from the aspects of price and utility.

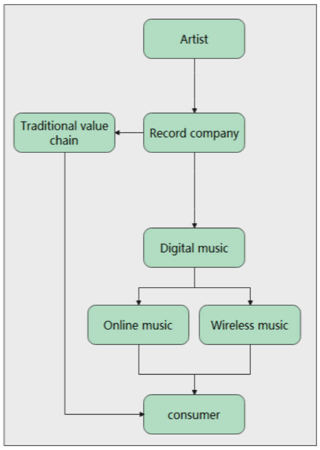

Figure 9: Changes in the value chain of the record industry in the digital music era.

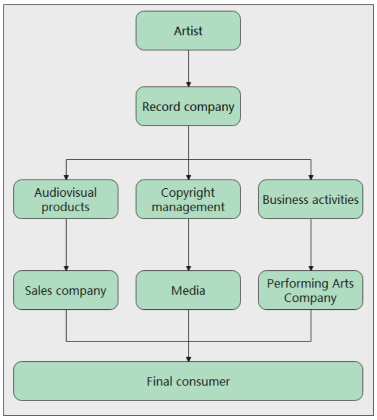

Figure 10: The three links of the music industry chain.

Consumer demand is not only the appearance of a particular era but also the potential consumer demand for record consumption. Most of this potential demand is stimulated and explodes when technology changes, such as the most apparent convenience. Almost every time the recording industry produces technological changes, the value chain of the recording industry will undergo tremendous changes. At the same time, market environmental factors restrict the stability of the macro environment of the recording industry. The most obvious manifestation lies in the completeness and enforcement of laws, regulations, and policies. The impact of the market environment is mainly reflected in the issue of pirated records. A good market environment can ensure the healthy and orderly development of the record industry (such as the U.S. record industry). A bad market environment will lead to rampant piracy and difficult cost recovery for record companies and industry. There are many problems, such as the abnormal development of the value chain, and these problems have been prominent in the history of the development of my country's recording industry.

Based on the above analysis, this paper uses big data technology to build a cloud platform to analyze the development of the music industry. Moreover, this paper designs experiments to verify the system performance, calculates the data mining effect of the music industry and, evaluation of the recommended effect, and obtains the results shown in Table 1 and Figure 11.

NO	*Data mining*	*Decision suggestion*
1	*92.42*	*86.75*
2	*90.22*	*78.94*
3	*92.39*	*81.62*
4	*88.33*	*80.74*
5	*91.21*	*84.42*
6	*89.34*	*88.73*
7	*94.60*	*92.33*
8	*85.13*	*76.37*
9	*96.75*	*91.23*
10	*88.12*	*84.14*
11	*95.97*	*89.25*
12	*96.93*	*89.37*
13	*91.46*	*87.01*
14	*91.06*	*79.67*
15	*96.17*	*89.75*

Table 1: System practice effect.

From the above experimental research, it can be seen that the music industry development analysis system based on big data cloud services constructed in this paper has a good effect on industry analysis.

5 CONCLUSIONS

At present, music operators are too strong, exerting a strong influence on the upstream and downstream of the industry chain. At the same time, the attitude of the operators to penetrate the SP at full capacity also makes other links in the industry chain worry. The value innovation of mobile music requires the joint efforts of all parties in the industry chain to establish a profitable and win-

win operation model for the industry chain, and it is essential to build a complete industry chain with consistent goals and close cooperation and to meet the deep and individual needs of consumers.

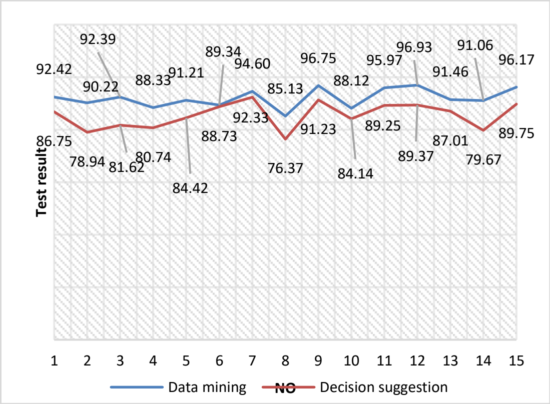

Figure 11: The performance of the data mining system.

The various links of the industrial chain still need to be integrated into an organic whole. Moreover, although the industrial chain has taken shape initially, with the upstream and downstream penetration of operators, the integration of CP and SP, and the search for larger market space by terminal manufacturers, major changes will occur in the overall industrial situation. This also requires a more reasonable profit sharing and industry chain operation model to ensure the lasting innovation and healthy development of the entire mobile music industry chain.

From the consumer's point of view, mobile music meets their emotional needs, which means that users need to feel independence, autonomy, and entertainment. This also requires that operators accustomed to technology orientation plan mobile music products and services based on consumers' emotional needs. When launching new products, it is necessary to follow a consumer-oriented process and pay attention to the trial of the new product and the analysis of the effect after the official launch to ensure that the new product can meet the emotional needs of consumers.

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